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RADIOCARBON

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Editors

EDWARD S. DEEVEY—RICHARD FOSTER FLINT

J. GORDON OGDEN, III—IRVING ROUSE

Managing Editor

RENEE S. KRA

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YALE UNIVERSITY
NEW HAVEN, CONNECTICUT

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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. 13, no. 2 must be submitted in *duplicate* by August 1, 1971, and for vol. 14, no. 1 by February 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. 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.

Reprints. Thirty copies of each article, without covers, will be furnished without cost. Additional copies and printed covers can be specially ordered.

Back issues. Back issues (vols. 1-9) are available at a reduced rate to subscribers at $52.00 a set, includes postage; vol. 10 and subsequent volumes are $20.00 for individual subscribers and $30.00 for institutions; single issues $10.00 each; comprehensive index $10.00 each.

* 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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Vol. 13, No. 1 Radiocarbon 1971

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Radiocarbon

1971

ARIZONA RADIOCARBON DATES VIII*

C. VANCE HAYNES, JR.**, DONALD C. GREY†, and AUSTIN LONG

Dept. of Geosciences, University of Arizona, Tucson, Arizona 85721

INTRODUCTION

The carbon isotopic analyses reported here covers the period since the last list (Haynes *et al.*, 1967) until summer 1969. All results relating to secular C^{14} fluctuations in atmospheric CO_2 are now published separately (Damon *et al.*, 1970). Sample preparation and counting procedures remain essentially unchanged since completion of our conversion to CO_2 in 1960. All δC^{13} values are reported relative to PDB and all C^{14} dates, unless otherwise noted, are based on the 5568 year half-life, but are not corrected for C^{13} content. 0.95 NBS oxalic acid activity is our routine standard periodically monitored for isotopic fractionation.

Sample descriptions are classified as follows:

I. Geochemical Samples
II. Experimental Bone Samples
III. Geologic-Paleoclimatologic Samples
IV. Archaeologic Samples

ACKNOWLEDGMENTS

Without R. A. Palmer's dedicated efforts and R. J. Donnelly's conscientious assistance, neither the electronics nor the general lab operation would have functioned smoothly. We are also indebted to Mrs. Z. Kuck for assisting in sample preparation. Special thanks to T. C. Hoering, Carnegie Inst. Geophys. Lab. in Washington, D.C., and to I. I. Friedman, U.S.G.S., Denver, for allowing us to use their stable isotope analysis facilities.

This work was supported by NSF Grant GA-1288 and the State of Arizona.

SAMPLE DESCRIPTIONS

I. GEOCHEMICAL SAMPLES

Sambaquis de Carnica I series, Brazil

Samples of shell and charcoal to test simultaneity of C^{14} variations in sea and air, Sambaquis de Carnica I and Carnica IA (28° 32′ S Lat,

* University of Arizona Geosciences Contribution No. 4.

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49° 12′ W Long), Municipio de Laguna, Santa Catarina, Brazil. Coll. 1966 by W. R. Hurt, Indiana Univ. Mus.; subm. by D. C. Grey.

A-833:1. Shell fragments — **2200 ± 500**, **250 B.C.**, $\delta C^{13} = +0.49‰$

Mound SCLL13, 1.4 cm below (b).

A-844. Charcoal — **2410 ± 110**, **460 B.C.**, $\delta C^{13} = -25.96‰$

Same location as 883:1.

A-912. Shell fragments — **3310 ± 140**, **1360 B.C.**, $\delta C^{13} = +0.68‰$

Mound SCLL13, 10.9 cm below (X).

A-914. Shell fragments — **2550 ± 110**, **600 B.C.**, $\delta C^{13} = +0.16‰$

Mound SCLL13, 5.1 cm below (A).

A-917. Shell fragments — **3210 ± 150**, **1260 B.C.**, $\delta C^{13} = +1.98‰$

Mound SCLL13, .18 cm below (X).

A-918. Charcoal — **3370 ± 150**, **1420 B.C.**, $\delta C^{13} = -23.36‰$

Mound SCLL13, 5 cm below (X).

A-919. Shell fragments — **3370 ± 110**, **1420 B.C.**

Same location as A-918.

A-956. Charcoal — **3280 ± 120**, **1330 B.C.**

Mound SCLL13A, 1.3 cm below (O.D.).

A-959. Shell — **2460 ± 110**, **510 B.C.**

Mound SCLL13A, basal. *Comment*: the Sambaquis (shell-mounds) provide paired samples of shell and charcoal which lie in a time range exhibiting rapidly changing C^{14} concentration in the atmosphere. Samples were measured to test whether the mixed ocean and the atmosphere varied synchronously. No significant differences were noted, indicating that the mixed layer of the ocean followed the atmosphere closely. Many of the charcoal samples were too small for accurate measurement. All reported values were measured at least twice and averaged.

II. EXPERIMENTAL BONE SAMPLES

We have continued to investigate the suitability of various chemical fractions of bone for radiocarbon dating. Some results have been reported by Haynes (1968a).

11,990 ± 170
A-582. Bartow Mammoth, Oklahoma **10,040 B.C.**

Acid-soluble organic matter from rib of mammoth exposed in a borrow pit 11.3 km NE of Moorland, Oklahoma (36° 31′ N Lat, 99° 08′ W Long). Coll. 1964 by H. Kerr and T. Barr, Univ. of Oklahoma and subm. by A. B. Fisher, Northwestern State College, Alva, Oklahoma. *Comment*: date is geologically reasonable, but soluble bone organic matter commonly gives erroneous results (see A-806D and A-753D below).

8890 ± 300
A-584. Stein Ranch Mammoth, Montana **6940 B.C.**

Acid-soluble organic matter from mammoth bone exposed in arroyo wall, Stein Ranch, Park Co., Montana (45° 47′ N Lat, 110° 34′ W Long). Coll. 1963 and subm. by J. Schulte. *Comment*: bone organic matter commonly gives erroneous results (see A-806D and A-753D below).

6050 ± 750
A-587. Manhattan Mammoth, Montana **4100 B.C.**

Acid-soluble organic matter from jaw of mammoth in sand of 24.4 m terrace of Gallatin R. 2 mi. NW of Manhattan, Montana (45° 52′ N Lat, 111° 23′ W Long). Coll. 1963 by W. J. McMannis, Montana State College and subm. by R. Bennett, Univ. of Arizona. *Comment*: bone organic matter commonly gives erroneous results (see A806D and A-753D below).

8650 ± 400
A-619. Kyle Mammoth, Saskatchewan **6700 B.C.**
$\delta C^{13} = -22.80‰$

Acid-soluble organic matter from mammoth vertebra ca. 2 m below surface at Kyle Mammoth site (EfO_a-5), Saskatchewan, Canada (50° 50′ N Lat, 108° 06′ 30″ W Long). Coll. 1964 and subm. by T. F. Kehoe, Mus. of Nat. History, Regina. *Comment*: date is significantly younger than that obtained by Canada Geol. Survey (unpub.) which is not surprising considering that this fraction commonly gives erroneous results (see A-806D and A-753D below).

Lehner mammoth bone series

Several fractions of carbon from mammoth bone from Lehner site (31° 25′ 23″ N Lat, 110° 06′ 48″ W Long) Cochise Co., Arizona, were analyzed for comparison to charcoal reliably dated at 11, 260 ± 360 B.P. (R., 1966, v. 8, p. 12.) Coll. and subm. 1966 by P. J. Mehringer and C. V. Haynes.

A-806A:3. Insoluble organic matter **5610 ± 350**
3660 B.C.
$\delta C^{13} = -16.73‰$

Grayish-brown residue after gentle treatment in 1N HCl under vacuum followed by 0.5% NaOH at room temperature. *Comment*: collagen, if present, is degraded and contaminated by younger organic residue.

A-806D. Soluble organic matter **7930 ± 490**
5980 B.C.
$\delta C^{13} = -21.50‰$

Solution from acid treatment was made basic with NaOH. Organic matter co-precipitated with hydroxides dried and pyrolized to yield CO_2. *Comment*: sample obviously contaminated.

A-806C. Secondary $CaCO_3$ **1190 ± 90**
A.D. 760
$\delta C^{13} = -3.55‰$

Initial yield of CO_2 from acid treatment of powdered bone. *Comment*: obviously secondary and apparently deposited from ground water because overlying secondary carbonates are successively older up the sec. (A-715 and A-746, R., 1969, v. 11, p. 1-14).

A-874C. CO_2 from bone apatite **9980 ± 220**
8030 B.C.
$\delta C^{13} = -4.99‰$

CO_2 from carbonyl apatite of bone, hydrolized after removal of secondary $CaCO_3$ by acetic acid under vacuum (Haynes, 1968a). *Comment*: the oldest date yet obtained from Lehner mammoth bone.

A-876C. CO_2 from tooth apatite **7780 ± 150**
5830 B.C.
$\delta C^{13} = -2.38‰$

Enamel from mammoth tooth treated in same manner as A-874C. *Comment*: exchange of apatite CO_2 with ground water CO_2 appears to be greater in tooth enamel than in bone, but variation in permeability of sedimentary matrix should also affect chemical exchange.

Hell Gap bone series

Several fractions of carbon from bison bone from Eden level of Loc. III S, Hell Gap site (42° 25′ N Lat, 104° 38′ W Long), Goshen Co., Wyoming, were analyzed for comparison with charcoal reliably dated at 8600 ± 300 B.P. (A-501, R., 1966, v. 8, p. 15). Coll. and subm. 1966 by L. Brew and H. T. Irwin.

A-753A. Collagen **8890 ± 110**
6940 B.C.
$\delta C^{13} = -15.92‰$

Bison bone from Eden occupation level at Loc. III S.

A-753D. Soluble organic matter **5430 ± 110**
3480 B.C.
$\delta C^{13} = -20.00‰$

Filtrate from collagen separation made basic to co-precipitate hydroxides and organic matter. Filter cake dried, weighed, and combusted.

A-753C$_1$. Secondary carbonate **700 ± 260**
A.D. 1250
$\delta C^{13} = -7.27‰$

First evolution of CO_2 from HCl treatment of bone.

A-753C$_2$. **6130 ± 500**
4180 B.C.
$\delta C^{13} = -9.15‰$

Second evolution of CO_2 from HCl treatment of bone.

A-753C$_3$. Bone apatite **9050 ± 160**
7100 B.C.
$\delta C^{13} = -7.56‰$

Evolution of CO_2 from HCl treatment after initial treatment of bone with acetic acid under vacuum. *Comment*: both collagen and bone apatite CO_2 appear to yield correct ages in this case.

Murray Springs bovid bone series

Several fractions of carbon from bones of a yearling bovid found in recent deposit at the Murray Springs site (31° 34′ 17″ N Lat, 110° 10′ 44″ W Long) Arizona, were analyzed as a pre-nuclear-age specimen for comparison with the Lehner mammoth bone series. From geologic evidence, specimen is 50 to 500 yr old (Haynes, 1968a). Coll. and subm. 1966 by C. V. Haynes.

A-819A. Collagen **103.5 ± 3.0% Modern**
$\delta C^{13} = -13.90‰$

A-819B. Humates **102.4 ± 2.8% Modern**

A-819C. Secondary carbonate **124.9 ± 4.6% Modern**

A-819D. Soluble organic matter **100.9 ± 2.4% Modern**
$\delta C^{13} = -12.35‰$

A-819E. Fulvic acids **98.8 ± 6.7% Modern**

Comment: because a nuclear age is precluded by the geologic occurrence, the yearling is believed to have lived within a few yr of A.D. 1700 when there was a 2.5% increase in atmospheric C^{14} budget (Damon, Long, and Grey, 1966).

A-988. Hurley Mammoth site, Arizona **21,210 ± 770**
19,260 B.C.
$\delta C^{13} = -20.98‰$

CO_2 from bone apatite from *Mammuthus columbi*(?), Hurley site (31° 37′ N Lat, 110° 12′ W Long), Cochise Co., Arizona. Coll. 1967 by

E. T. Hemmings; subm. by C. V. Haynes. *Comment* (C.V.H.): bones occurred in mudstone of Unit D dated 29,000 ± 2000 B.P. (A-896A) at Murray Springs (this list). Contamination by exchanged CO_2 is likely.

III. GEOLOGIC-PALEOCLIMATOLOGIC SAMPLES

Hell Gap series, Wyoming

Hell Gap site (42° 24′ 35″ N Lat, 104° 38′ 25″ W Long), Goshen Co., Wyoming is a multiple component early man site where artifacts and bones of extinct bison occur within a sequence of late Quaternary sediments (Irwin, 1967). Investigations supported by Natl. Geog. Soc. Coll. 1965 and subm. by C. V. Haynes, H. T. Irwin, and C. Irwin-Williams.

9250 ± 500
A-748A. Insoluble soil residue **7300 B.C.**

Gray silt soil immediately below Folsom level at Loc. I. Residue after removal of carbonates and humates. *Comment*: date indicates presence of contaminants, probably vegetable remains.

6450 ± 300
A-755A. Insoluble soil residue **4500 B.C.**
$\delta C^{13} = -23.23‰$

CCa-horizon of truncated silt soil at Loc. II. Residue after removal of carbonate (A-755C) and humates (A-755B). Soil underlies a buried fire pit dated 5740 ± 230 (A-498, R., 1966, v. 8, p. 15).

8050 ± 400
A-755B. Humates **6100 B.C.**

Base-soluble fraction from A-755.

1420 ± 300
A-755C. Carbonates **A.D. 530**

Carbonate CO_2 from A-755. *Comment*: all fractions show some degree of contamination from overlying soil roots.

6110 ± 120
A-754B. Soil humates **4160 B.C.**
$\delta C^{13} = -23.59‰$

Base-soluble fraction of B-horizon of late "Altithermal" soil at Loc. II. Soil overlies a buried fire pit dated 5740 ± 230 (A-498, R., 1966, v. 8, p. 15). *Comment*: either soil was contaminated by older humic acids or fire pit was dug after development of B-horizon. Stratigraphic level from which pit was dug is not known because bulldozer removed strata immediately overlying it.

Gilcrease Spring mound series, Las Vegas Valley, Nevada

Gilcrease Spring No. 4 (36° 17′ 47″ N Lat, 115° 28′ W Long) is a silt mound 3.66 m high and 30.5 m diam. that has been dry since early 1920's, when it was damp. It was dissected by dulldozer trench in 1963 in order to investigate the stratigraphy (R., 1966, v. 8, p. 8-9). Analyses of fossil pollen and plant macrofossils (Mehringer, 1967) augmented stratigraphic and geochronologic studies (Haynes, 1967a). Coll. 1965 and subm. by P. J. Mehringer and C. V. Haynes, Univ. of Arizona, and D. R. Tuohy, Nevada State Mus.

A-709A. Peat **9090 ± 210**
7140 B.C.
δC^{13} = –29.69‰

A-709B. Humates **9910 ± 500**
7960 B.C.

A-709A A. Carbonized grape vine (*Vitis* sp.), hand-picked from A-709 **9160 ± 170**
7210 B.C.

Insoluble organic residues (A and AA) and humates (B) extracted from spring laid clayey peat at Pollen Profile VI, 84.4 to 96.5 cm below local datum. *Comment*: A-709A A is considered most reliable material and was run as a check on A-709A and A-709B. Data indicate humates may be slightly contaminated from ancient ground water.

A-710A. Peat **10,200 ± 400**
8250 B.C.
δC^{13} = –27.57‰

A-710B. Humates **10,500 ± 170**
8550 B.C.

Insoluble organic residue (A) and humates (B) extracted from spring laid clayey peat at Pollen Profile VI, 1.22 to 1.42 m below datum. *Comment*: dates are not significantly different.

A-953. Carson Slough, Nevada **3550 ± 300**
1600 B.C.

Scirpus sp. seeds from 1.25 to 1.35 m below floor of commercial peat mine stripped of ca. 0.5 m of peat, Carson Slough (36° 29′ N Lat, 116° 21′ W Long) near Ash Meadows, Nevada. Coll. and subm. 1967 by P. J. Mehringer, Jr.

Warm Sulphur Springs series, California

Sediment core samples from playa-edge springs (36° 7′ N Lat, 117° 13′ W Long) were taken for pollen analyses and radiocarbon dating in order to determine the geochronology of lake level fluctuations. Coll. and subm. 1966-1967 by P. J. Mehringer, Jr.

A-848. Organic silt **99.8 ± 4.4% Modern**

Core II, 128 to 132 cm depth.

A-849A A. Coarse (>2 mm) organic matter **110.4 ± 2.4% Modern**

Core II, 71 to 77 cm depth.

A-849A. Fine (<2 mm) organic matter **107.1 ± 4.5% Modern**

Core II, 71 to 77 cm depth.

A-849B. Humates **100.9 ± 1.5% Modern**

Core II, 71 to 77 cm depth.

A-952. Seeds and charcoal **3450 ± 500**
1500 B.C.

Seed fragments (*Scirpus* sp.) and small pieces of charcoal hand-picked from 4 in. core secs. 66 to 78 cm depth. *Comment* (P.J.M., Jr.): A-848 and A-849 indicate that desert salt marsh cores contain modern contaminants not removed by routine mechanical methods. On the basis of the pollen chronology and stratigraphy, A-952 agrees well with other dated fossil seeds from salt marsh deposits of the Death Valley region: A-953, A-1064, A-1069, and I-3766 (last three unpub.).

San Pedro Valley series, Arizona

With the collaboration of archaeologists, paleontologists, and geologists, the Quaternary geochronology of upper San Pedro Valley, Cochise Co., Arizona, has been under investigation for over 40 yr (Gidley, 1922; Antevs, 1955; Lance, 1960; Gray, 1967). A radiocarbon-based chronology is being established by dating archaeologic sites and fossil localities buried in alluvium of the valley and its tributaries (Haynes, 1968b).

A-902. Moson site, Arizona **2520 ± 140**
570 B.C.
$\delta C^{13} = -26.02‰$

Charcoal from rock-filled fire pit buried in silt 1.2 m below surface of 4.6 m terrace of Moson Wash (31° 36′ 13″ N Lat, 110° 10′ 25″ W Long). Assoc. with Cochise artifacts. Coll. and subm. 1967 by E. T. Hemmings and C. V. Haynes. *Comment*: date applies to occupation during end of period of aggradation.

A-903. Hereford Dairy Ranch, Arizona **3350 ± 150**
1400 B.C.

Charcoal from rock-filled hearth buried in silty sand 1.2 m below top of 5.5 m terrace of unnamed tributary arroyo (31° 25′ N Lat, 110° 05′ 38″ W Long). Coll. and subm. 1967 by C. V., Elizabeth, and Lisa Haynes. *Comment*: dates late stage of Unit G_{2a} deposition.

A-904. Wiek Ranch, Arizona **3760 ± 100**
1810 B.C.

Charcoal from rock-filled hearth buried under 1 m silt on ancient erosional slope ca. 15 m above San Pedro R. Coll. and subm. 1966 by D. F. Libbey. *Comment*: dates early stage of deposition of Unit G_{2a}.

4820 ± 250
A-940B. Moson black mat, Arizona **2870 B.C.**
$\delta C^{13} = -21.43‰$

Dark brownish-gray organic clay within Unit G_1 of 4.6 m terrace at Moson site. Coll. and subm. 1967 by C. V. Haynes. *Comment*: dates middle of Unit G_1 deposition.

5500 ± 400
A-879. Murray Springs Pollen Profile 1, Arizona **3550 B.C.**
$\delta C^{13} = -26.67‰$

Partially decomposed wood from lower part of Unit G_1 (Unit B of Mehringer *et al.*, 1967) at Pollen Loc. 1 (31° 34′ 28″ N Lat, 110° 10′ 7″ W Long). Coll. and subm. 1967 by C. V. Haynes, C. F. Hickox, Jr., and P. S. Martin. *Comment*: date is consistent with stratigraphic position between A-697B and A-696 (R., 1967, v. 9, p. 5; Mehringer *et al.*, 1967).

Gray-Seff locality series, Arizona

Dark-colored organic clayey silt at this loc. (31° 59′ 30″ N Lat, 110° 19′ 15″ W Long) overlies clayey sand containing Rancholabrean vertebrate fossils and is separated from an overlying brownish-gray silt by an erosional unconformity. Paleo-Indian artifacts found on surface appear to have come from basal contact of the "black mat." Cochise artifacts on the surface come from the grayish-brown silt. Coll. and subm. 1967 by I. Zarins, D. L. Livingston, and C. V. Haynes.

7800 ± 600
A-970A. Organic residue **5850 B.C.**

Insoluble organic residue after repeated decantation to remove floating matter and acid-base treatment. *Comment*: excessively young date suggests that removal of contaminant vegetable matter from modern soil by flotation and decantation was incomplete.

10,150 ± 600
A-970B. Humates **8200 B.C.**
$\delta C^{13} = -23.64‰$

Base-soluble organic matter precipitated in acid. *Comment*: date is minimal and comparable to similar samples from the Murray Springs site (this list).

Murray Springs series, Arizona

Murray Springs site (31° 34′ 15″ N Lat, 110° 10′ 38″ W Long), San Pedro Valley, Cochise Co., Arizona (Ariz: EE:8:25) is a buried Clovis hunting camp and kill site where artifacts assoc. with mammoth, bison, and horse occur within a sequence of late Quaternary sediments. Investigations supported by Natl. Geog. Soc. (Archaeol.) and Natl. Sci. Foundation (Geol.). Coll. 1967-1968 and subm. by C. V. Haynes.

A-896A. Organic clay **29,000 ± 2000**
27,050 B.C.
$\delta C^{13} = -25.92‰$

A-896B. Humates **19,200 ± 1600**
17,250 B.C.
$\delta C^{13} = -24.97‰$

Organic, laminated lacustrine clay in Unit D, 80 cm below base of Unit F_2 ("black mat"). Acid insoluble residue (A) and base-soluble organic matter precipitated in acid (B). Coll. and subm. 1966 by C. V. Haynes and P. J. Mehringer, Jr. *Comment*: dates existence of pond or lake and a pluvial climate.

A-897. Marl **21,200 ± 500**
19,250 B.C.
$\delta C^{13} = -4.38‰$

Clayey $CaCO_3$ from near base of Unit E (Pollen Sample #1) at Pollen Profile 6. Coll. and subm. 1966 by P. J. Mehringer, G. Batchelder, and C. V. Haynes. *Comment*: dates early part of carbonate phase of lacustrine deposition.

A-905A. Charcoal **5750 ± 250**
3800 B.C.
$\delta C^{13} = -16.56‰$

A-905B. Humates **5520 ± 200**
3570 B.C.
$\delta C^{13} = -11.38‰$

Average 5640 ± 200
3690 B.C.

Charcoal from below gray wet-meadow soil in Unit G_1 at Loc. 1. Coll. and subm. 1966 by L. D. Agenbroad and C. V. Haynes. *Comment*: date is consistent with those from Unit G_1 at Pollen Loc. 1 (Mehringer *et al.*, 1967).

Murray Springs "black mat" series, Arizona

Black organic layer (Unit F_2) bifurcates at Loc. 1 (31° 34′ 15″ N Lat, 110° 10′ 38″ W Long) into an upper (F_{2c}) and lower (F_{2a}) layer separated by ca. 35 cm of soft marl (F_{2b}). Organic samples separated into insoluble organic residue (A) and humates (B). Listed in stratigraphic order. Coll. and subm. 1967 by B. Walton and C. V. Haynes.

A-969A. Organic residue, F_{2c} **8900 ± 400**
6950 B.C.

A-969B. Humates, F_{2c} **9270 ± 800**
7320 B.C.
$\delta C^{13} = -25.63‰$

A-977. $CaCO_3$, F_{2b} **10,250 ± 170**
8300 B.C.

A-989B. Humates, F_{2a} **10,360 ± 90**
8410 B.C.
$\delta C^{13} = -25.11‰$

Comment: dates suggest >1000 yr was required to deposit sequence. Date, 11,230 ± 340 (A-805, R., 1967, v. 9, p. 11) for top of underlying Unit (F_1) indicates more time was required to form black organic layers than carbonate layer.

A-730. Fairbank, Arizona **2630 ± 150**
680 B.C.

Charcoal from rock-lined hearth 3 m below top of 4.6 m alluvial terrace of the San Pedro R. at Fairbank bridge (31 °43′ N Lat, 110° 12′ W Long). Coll. 1965 and subm. by C. V. Haynes, N. M. Johnson, and P. J. Mehringer, Univ. of Arizona. *Comment*: dates erosional contact between 2 alluvial units.

A-854. Cerros Negros site, Arizona **12,000 ± 300**
10,050 B.C.

Marl from top of sedimentary sec. at Cerros Negros fossil loc. (32° 32′ N Lat, 110° 33′ W Long), Arizona. Coll. and subm. 1966 by L. D. Agenbroad (1967), Univ. of Arizona. *Comment*: date is approx. for end of lacustrine deposition.

Coyote Draw series, Arizona

Charcoal samples from an arroyo (32° 35′ 43″ N Lat, 110° 30′ 15″ W Long) tributary to San Pedro R. were coll. at several levels in late Holocene alluvium of 3.7 m terrace. Coll. and subm. 1966 by L. D. Agenbroad and C. V. Haynes. *Comment*: dates indicate period of general aggradation 1000-3500 yr ago with brief erosional episode shortly before 2300 yr ago.

A-861. Charred log **1360 ± 190**
A.D. 590

Buried 1.4 m below top of 3.7 m terrace.

A-862. Charcoal **2270 ± 150**
320 B.C.

Aboriginal rock-filled hearth 1.7 m below top of 3.7 m terrace and on a buried erosion surface.

A-866. Charred twigs **3210 ± 240**
1260 B.C.

Layer of burned vegetation 3 m below top of 3.7 m terrace.

Malawi, Africa series

Under Natl. Sci. Foundation sponsorship archaeologic, paleontologic, and geologic investigations were conducted in NW Malawi to determine Quaternary paleoecology of area in relation to Lake Nyasa history.

A-782A:2. Ngara Court **10,170 ± 140**
8220 B.C.

Charcoal entrapped in pumiceous tuff exposed at Ngara Court on right bank of Songwe R. (9° 36′ S Lat, 33° 48′ E Long). Coll. and subm. 1966 by J. D. Clark, J. E. Mawby, and C. V. Haynes. *Comment*: re-collected for comparison with A-782B (R., 1967, v. 9, p. 7).

Charcoal from 4 levels of archaeologic test trench excavated at Mbande Court (9° 56′ S Lat, 33° 54′ E Long). Coll. 1965 by A. Van Eggers; subm. 1966 by J. D. Clark, Univ. of California, Berkeley.

A-783. 76 to 91 cm below surface **4290 ± 100**
2340 B.C.

A-784. 91 to 107 cm below surface **3480 ± 90**
1530 B.C.
$\delta C^{13} = -25.67‰$

A-785. 107 to 122 cm below surface **2370 ± 120**
420 B.C.

Comment: A-783 and A-785 were possibly mislabeled which seems even more likely considering these results.

Rungwe volcanic ash series, Tanzania

Late Quaternary ash deposits of Rungwe volcano, S Tanzania, are separated by 3 paleosols containing flecks of charcoal apparently burned during fall of hot pumiceous ash that buried soil. Coll. and subm. 1966 by C. V. Haynes and J. D. Clark. *Comment*: last explosive phases of Rungwe volcano occurred during Holocene. Samples listed in stratigraphic order.

A-893. Charcoal **2800 ± 400**
850 B.C.
$\delta C^{13} = -24.10‰$

Upper buried soil exposed in mud-brick pit (8° 59′ S Lat, 33° 39′ E Long) at intersection of Mbeya-Tukuyu rd. and new Elton Plateau rd. near Ikoma.

A-892. Charcoal **3200 ± 100**
1250 B.C.

Intermediate buried soil exposed in mud-brick pit (8° 58′ S Lat, 33° 38′ E Long) in Isionje Village.

A-895. Charcoal **3920 ± 80**
1970 B.C.
$\delta C^{13} = -23.86‰$

Top of lower buried soil exposed in road-metal pit (9° 00′ S Lat, 33° 40′ E Long) ca. 2 mi E of Ikoma on Elton Plateau rd.

A-894. Charcoal **7510 ± 150**
5560 B.C.

Middle of lower buried soil exposed in same pit as A-895.

Lake Rukwa series, Tanzania

Late Quaternary sediments of pluvial Lake Rukwa are exposed by Songwe R. gorge (8° 42′ S Lat, 33° 02′ E Long) S of Galula. Lacustrine sediments contain pumice and ash transported from Rungwe-Ngozi volcanic field. Coll. and subm. 1966 by C. V. Haynes and J. D. Clark. *Comment*: high pluvial stand of ancient Lake Rukwa occurred during early Holocene when Rungwe-Ngozi volcanic field was intensely active.

A-944. Clam shells — **8060 ± 120** — **6110 B.C.** — $\delta C^{13} = -1.36‰$

Near top of lacustrine sand and tuffaceous mudstone exposed near road S of Galula.

A-945. Oyster shells — **9740 ± 130** — **7790 B.C.** — $\delta C^{13} = -2.05‰$

In mudstone overlain by nodular carbonate zone near top of 41 m sec. of fluvio-lacustrine ash beds S of Galula.

A-946. Nara River, Tanzania — **>24,600** — $\delta C^{13} = +1.70‰$

Lacustrine marl from Nara R. sec. (8° 57′ S Lat, 33° 14′ E Long) near Mbeya Lime works, S Tanzania. Upper of 2 marl layers below calcareous paleosol. Coll. and subm. 1966 by C. V. Haynes and J. D. Clark.

IV. ARCHAEOLOGIC SAMPLES

Rodgers shelter series, Missouri

NSF sponsored excavations of Rodgers Rock Shelter (38° 05′ 30″ N Lat, 93° 20′ 40″ W Long) Benton Co., Missouri, have revealed an unusually complete stratigraphic sequence of buried Archaic cultural levels in ancient sediments of Pomme de Terre R. Coll. and subm. 1966 by W. R. Wood and R. B. McMillan (1967), Univ. of Missouri.

A-867. Charcoal — **430 ± 100** — **A.D. 1520** — $\delta C^{13} = -25.26‰$

Scattered flecks of charcoal from ca. 60 cm below top of 3.7 m terrace (coordinates 174NW120, 5.84 m below datum).

A-868A. Charcoal — **8100 ± 300** — **6150 B.C.** — $\delta C^{13} = -24.59‰$

Charred log from uppermost level of Stratum I and 2 m below surface of 8 to 9 m terrace.

A-868B. Humates **9010 ± 190**
7060 B.C.
$\delta C^{13} = -25.07‰$

Base soluble organic matter extracted from A-868A and analyzed to evaluate potential of humic acids to contaminate samples. *Comment*: ancient humic acids in ground water are indicated.

A-744. Olsen-Chubbuck site, Colorado **10,150 ± 500**
8200 B.C.

Collagen extracted from hooves of extinct bison (*Occidentalis*) killed by early man at the Olsen-Chubbuck site in SE Colorado (38° 41′ 15″ N Lat, 102° 31′ 45″ W Long). Coll. 1960 and subm. by J. B. Wheat, Univ. of Colorado. *Comment* (C.V.H.): on basis of existing stratigraphic evidence, date appears 1000 yr too early (Haynes, 1967b), but may be correct if recent interpretation of Eden and Scottsbluff complex and re-definition as Firstview complex (Wheat, pers. commun.) is correct.

Armijo site, New Mexico

Charcoal from Test Trench 5, lowest San Jose level, Pollen Zone IV, on top of yellow silt (35° 25′ 30″ N Lat, 106° 55′ 47″ W Long) analyzed to compare insoluble and base soluble fractions. Coll. and subm. 1966 by C. V. Haynes and C. Irwin-Williams.

A-809A. Charcoal **7630 ± 140**
5680 B.C.
$\delta C^{13} = -18.28‰$

A-809B. Humates **6770 ± 220**
4820 B.C.
$\delta C^{13} = -18.06‰$

A-812. Pithouse 4, Northern Arizona **3920 ± 80**
1340 B.C.

Charcoal flecks from sand of floor of pre-ceramic Pithouse 4 (35° 14′ N Lat, 109° 22′ W Long) N Arizona. Coll. and subm. by G. J. Gumerman (1966).

A-578. Borax Lake, California **Modern**
$\delta C^{13} = -25.1‰$

Charcoal from rodent hole at Borax Lake site (38° 59′ 00″ N Lat, 122° 39′ 46″ W Long) in Trench I. Analysis to determine if rodents have brought up material from lower levels. Coll. 1964 and subm. by C. V. Haynes. *Comment*: age indicates modern charcoal intruded Unit E via rodent activity.

Tlapacoya site series, Mexico

Excavations in deposits of volcanic ash, beach gravel, and peat (19° 18′ 30″ N Lat, 98° 54′ 30″ W Long) related to ancient Lake Chalco were sponsored by Inst. Nac. Antropol. Hist. (INAH), Mexico. In addition to finding fossil wood and bones of extinct animals, past presence of early man is suggested (Mirambell, 1967; Haynes, 1967c). Coll. 1966 by C. V. Haynes and J. M. and Elizabeth Goodliffe; subm. 1966 by J. L. Lorenzo, dir. INAH.

A-790A. Charred log, Layer XII **22,400 ± 2600**
20,450 B.C.

A-793. Wood, middle of lower peat layer **24,500 ± 900**
22,550 B.C.

A-794B. Base soluble organic matter extracted from finely divided charcoal in lens between A-790A and A-793 **24,200 ± 400**
22,250 B.C.

Comment: purified charcoal (A-794A) from A-794B yielded insufficient CO_2 for analysis.

Snaketown series, Arizona

Wood charcoal and charred corn from a Hohokam village site (33° 11′ 12″ N Lat, 111° 55′ 18″ W Long) in Pinal Co. Coll. 1964 and 1965; subm. by E. W. Haury. See Gladwin *et al.* (1937) and Haury (1966). Final report on Snaketown is currently in preparation which will include a discussion by Haynes and Long of the radiocarbon dating.

A-598. No. 4 **220 ± 110**
A.D. 1730

Charcoal from 10D: Crematorium 1, Sacaton phase.

A-603. No. 9 **1010 ± 100**
A.D. 940

Charcoal from 10F: House 1, Sacaton phase.

A-604. No. 10 **1050 ± 100**
A.D. 900

Charcoal from 10F: House 1, Sacaton phase.

A-817. No. 69 **1310 ± 180**
A.D. 640

Charcoal from Hearth under crematory floor Mound 38, Gila Butte phase. *Comment*: A-817 and A-601 (this list) agree with SI-190 (R., 1967, v. 9, p 375).

A-601. No. 7 **1370 ± 130**
A.D. 580

Charcoal from 9E: Pit 6, fill, Gila Butte phase.

A-741-1. No. 46 **1430 ± 110**
A.D. 520

Charcoal from 11F: Pit 33, Level 3, Gila Butte-Snaketown Transition phase.

A-731. No. 25 **1240 ± 160**
A.D. 710

Charcoal from 11F: Md. 40, Tier 1, Level 6, Snaketown phase.

1340 ± 100
A-734. No. 31A **A.D. 610**

Charcoal from 15E: House 1, Snaketown phase.

1050 ± 100
A-596. No. 2 **A.D. 900**

Charcoal from 10D: Strat. Test 1, Level 4, Sweetwater-Snaketown Transition phase. *Comment*: agrees with SI-187 (R., 1967, v. 9, p. 375).

920 ± 120
A-599. No. 5A **A.D. 1030**

Burnt corn from 9E: House 2, Sweetwater phase. *Comment*: agrees with SI-188 (R., 1967, v. 9, p. 375), but not with GX-328, 1580 ± 105 (unpub.) or WSU-418, 2990 ± 210 (unpub.). A reasonable correction of +250 yr on this corn (R., 1969, v. 11, p. 391-393) brings A-599 and SI-188 into agreement with SI-189 (R., 1967, v. 9, p. 375).

1350 ± 80
A-786. No. 61 **A.D. 600**

Charcoal from 5G: House 12, Sub-floor pit, Estrella phase.

1510 ± 90
A-742. No. 57 **A.D. 440**

Charcoal from 10G: Test 4, Level 6, Estrella phase.

1540 ± 90
A-814. No. 65 **A.D. 410**

Charcoal from 11F: Pit 42, Test 3, Levels 7, 8; Estrella phase.

1640 ± 250
A-743. No. 58 **A.D. 310**

Charcoal from 10G: Test 4, Level 6, Estrella phase.

1810 ± 300
A-771. No. 59 **A.D. 140**

Charcoal from 11F: House 12, Sub-floor pit, Vahki-Estrella Transition phase.

1150 ± 120
A-815. No. 66 **A.D. 800**

Charcoal from 6G: House 2, Sub-floor test, Levels 3, 4; Vahki(?) phase.

1240 ± 110
A-735. No. 41 **A.D. 710**

Charcoal from 11F: Md. 40 Tier 12, Level 9, Early Pioneer phase.

900 ± 120
A-788. No. 63 **A.D. 1050**

Burnt corn from 7H: House 1, Vahki (?) phase. *Comment*: an estimated isotopic fraction correction would increase age by 250 yr (R., 1969, v. 11, p. 391-393).

A-689. No. 16 **1030 ± 120**
A.D. 920

Charcoal from 8E: Crematorium 1, Vahki (?) phase.

A-818. No. 72 **1400 ± 120**
A.D. 550

Charcoal from 11F, Pit 42, Test 2, Level 8, Vahki phase.

A-1072. No. 17 **1540 ± 70**
A.D. 410
$\delta C^{13} = -24.73‰$

Charcoal from 8E: Crematorium 1, Early Pioneer phase.

A-816. No. 68 **1710 ± 110**
A.D. 240

Charcoal from 6G: House 2, Sub-floor test, Levels 5, 6; Vahki phase.

A-873. No. 52 **1890 ± 220**
A.D. 60

Charcoal from 11I: Roasting Pit 1. *Comment* on Vahki phase samples: GX-329, 2375 ± 110 (unpub.) does not agree with Arizona data.

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[RADIOCARBON, VOL. 13, NO. 1, 1971, P. 19-25]

FLORIDA STATE UNIVERSITY RADIOCARBON DATES IV

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This list includes mainly the results of datings done from 1967 to 1969. Methods are essentially the same as those described in Radiocarbon, 1966, v. 8, p. 46-53, 1967, v. 9, p. 38-42, and 1969, v. 11, p. 15-21. Samples synthesized to benzene and counted by liquid scintillation spectrometry. Age calculations are based on 95% of the activity of the NBS oxalic acid standard and computed from the Libby half-life of 5570 yr and reference A.D. 1950. The error listed is the one-sigma statistical counting error. Most samples were counted for 2000 to 3000 min. HCL and NaOH pretreatments were applied to samples as required.

In January 1969, a Picker Nuclear Liquimat 220 was purchased to replace the ANS, Inc. spectrometer. Initial performance was excellent, with an E^2/B of ca. 1000 (efficiency 60-65%) and a background of ca. 4 cpm. However, trouble with the electronics and photomultiplier tubes resulted in the counter being inoperable for 11 of the 12 months prior to March 1970. This counter is now in excellent working order with an E^2/B of 800 (efficiency 65%) and a background of 5.4 cpm.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Leon Florida series

Soil and wood coll. and subm. 1967 by C. L. Coultas, Florida A & M Univ.

1760 ± 60
FSU-249. Shell Point **A.D. 190**

Bh horizon soil (30° 6′ 0″ N Lat, 84° 18′ 0″ W Long), from 42 to 52 cm below ground surface (pH 4.45, 1:1 H_2O). Coll. at junction of State Rds. 367 and 367a in St. Mark's Nat. Wildlife Refuge.

6020 ± 300
FSU-250. St. Mark's Lighthouse **4070 B.C.**

Bh Horizon soil (30° 5′ N Lat, 84° 10′ W Long), from 56 to 72 cm below ground surface (pH 5.9, 1:1 H_2O) from salt marsh ca. 1¼ mi NE of lighthouse.

3075 ± 75
FSU-251. Port Leon—1 **125 B.C.**

Sandy peat (30° 7′ 30″ N Lat, 84° 12′ W Long), 119 to 145 cm below ground surface in *Juncus* salt marsh along St. Mark's R.

* Present address: Cape Fear Technical Institute, Wilmington, North Carolina
** Present address: East Carolina University, Greenville, North Carolina

FSU-252. Port Leon—2 **5280 ± 160**
A.D. 3330

Wood found in sandy peat (30° 7′ 30″ N Lat, 84° 12′ W Long), 145 to 175 cm below ground surface in *Juncus* salt marsh along St. Mark's R.

General Comment (C.L.C.): FSU-249 and 250 are from an apparent organic pan formed under a leached A_2 horizon. These dates indicate that it took ca. 3000 yr to build up ca. 120 cm of soil in this area. FSU-250 seems much too old.

Carrabelle Beach series

Coll. and subm. 1967 by G. H. Dury, Univ. of Wisconsin.

FSU-192. Carrabelle Beach—1 **<185**

Peat (29° 50′ 07″ N Lat, 84° 41′ 30″ W Long).

FSU-193. Alligator Point **405 ± 155**
A.D. 1545

Peat (29° 53′ 37″ N Lat, 84° 22′ 30″ W Long), from intertidal zone on seaward face of spit.

FSU-194. Carrabelle Beach—2 **940 ± 80**
A.D. 1010

Wood (29° 50′ 07″ N Lat, 84° 41′ 30″ W Long), from dead tree bole in intertidal zone, surrounded by peat from which FSU-192 was taken.

FSU-195. Carrabelle Beach—3 **6340 ± 160**
4350 B.C.

Peat and humified wood (29° 46′ 57″ N Lat, 84° 46′ 21″ W Long), from intertidal zone at base of a low cliff. *Comment* (G.H.D.): peat and wood, dated separately, gave similar results. Both relate to a former swamp forest buried by dune sediments; present exposure indicates retrogradation in progress.

General Comment (G.H.D.): general evidence of retrogradation might be relevant to development of Crooked R., a double-ended tidal creek which is under geomorphic study. FSU-192 and FSU-194 indicate presence of swamp forest ca. 950 yr ago, swamp growth continuing until less than 200 yr ago, and subsequent retreat of shoreline.

II. ARCHAEOLOGIC SAMPLES

Borklund Mound, Florida

The site (8Ta35) is located approx. 15 mi SW of Perry, Florida, and 1 mi inland from Gulf of Mexico between the Enconfina and Fenholloway Rivers (30° 02′ 0″ N Lat, 83° 55′ 10″ W Long). Excavated by amateurs, the mound contained ceramics and burials of both early and late Swift Creek phase, and appears to have been in continuous use. Coll. and subm. 1965 by D. S. Phelps, Florida State Univ.

1380 ± 195
FSU-78. Borklund **A.D. 570**

Charred wood from mound fill 62 cm above base. *Comment*: date serves only as possible point along continuum of mound use; no relation to specific deposit within mound.

Nichols site series

The Nichols site near Panacea, Wakulla Co., Florida (29° 59′ 45″ N Lat, 84° 25′ 41″ W Long) encompasses a large midden (8Wa3), a 33 m diam. platform mound (Mound A, 8Wa35), and 2 destroyed mounds (8Wa53, 55) of unknown purpose. Primary occupation of the midden and construction of mounds was accomplished during Weeden Island phase. A later Fort Walton phase occupation of site was insignificant, but platform mound was used as a burial area by this component. Moore (1902) excavated parts of Mound A, and Willey (1949) coll. ceramics from midden during his survey. The intrusive Fort Walton burials caused Willey to state that the platform mound may have been a Fort Walton structure, an hypothesis negated by Florida State Univ. excavations in 1955 and 1966. Coll. and subm. 1964 by D. S. Phelps.

1550 ± 65
FSU-153. Nichols Mound A 1 **A.D. 400**

Shell (*Rangia cuneata*) from fill of 2nd construction stage of mound, assoc. with Weeded Island ceramics. *Comment*: both this date and FSU-155, below, can only provide limit for earliest mound construction, not to be interpreted as dating the actual event.

1145 ± 40
FSU-155. Nichols midden 1 **A.D. 805**

Charred wood from fill of Feature 2, a Weeden Island refuse pit remaining intact in midden area. Assoc. with late Weeden Island ceramics and ¼ of Wakulla Check Stamped vessel. *Comment*: dates late Weeden Island component of site.

1550 ± 55
FSU-155. Nichols midden A 2 **A.D. 400**

Shell (*Rangia cuneata*) from fill of 1st mound construction stage.

Stoutamire Site series, Florida

The Stoutamire site (8Le107) is in Leon Co., Florida, on Ochlockonee R. (30° 41′ 32″ N Lat, 84° 20′ 30″ W Long). Excavated by Florida State Univ. in 1966, it contained 2 distinct components separated by a sterile sand deposit. Earliest component, Norwood, was represented by fiber-tempered sherds and steatite vessel fragments. The following dates pertain to the Weeden Island component, a small shell and refuse midden containing typical Weeden Island ceramics, including small, but equal quantities of Swift Creek Complicated Stamped II and Wakulla Check Stamped. Coll. and subm. 1966 by D. S. Phelps.

FSU-166. Stoutamire 2 — **1285 ± 50** — **A.D. 665**

Charred wood from Pit 1, Sq. 30R40, Level 1.

FSU-167. Stoutamire 1 — **1415 ± 55** — **A.D. 535**

Charred wood from Pit 1, 30R30, Level 1.

General Comment: both dates apply to early Weeden Island phase.

Maltby site, Florida

Located on S shore of Santa Rosa Sound in Okaloosa Co., Florida (33° 62′ 35″ N Lat, 85° 40′ 30″ W Long). Maltby site (80k31c) is a shell midden occupied from Deptford through Fort Walton phases; Weeden Island phase is sparsely represented. Sample coll. and subm. by Y. W. Lazarus.

FSU-181. Maltby site C

Charcoal from Pit 65-2, 24 in. level, in W extremity of site. *Comment*: date probably applies to early Fort Walton component.

Zabski site, Florida

Located near extreme S end of Merritt I., Brevard Co., Florida (28° 09′ 20″ N Lat, 80° 36′ 30″ W Long). Zabski site (8Br165) is the 1st site in E Florida to yield a date for St. Johns I ceramics. This part of site was occupied during what Bullen (1959) termed the "Transitional Period." Coll. 1966 by S. Atkins and subm. by R. P. Bullen, Florida State Mus.

FSU-200. Zabski site, FSM 1 — **2910 ± 80** — **960 B.C.**

Charcoal combined from Levels 4-6 (6 in each) of test pit in midden. *Comment*: sample assoc. with St. Johns I ceramics; mixed level sample should be used with caution.

Caxambus site, Florida

This site is located in Collier Co., Florida (25° 54′ 56″ N Lat, 81° 42′ 55″ W Long). Assoc. ceramic sample was an undecorated, sand-tempered pottery throughout 140 cm of excavated midden. Coll. and subm. 1967 by L. R. Morrell, Florida Bur. of Historic Sites and Properties.

FSU-229. Caxambus 1 — **1670 ± 135** — **A.D. 280**

Charred wood from Sq. H, Level 7 (120 to 140 cm below surface), assoc. with a support post for an elevated Glades I residence structure. *Comment*: 1st radiocarbon date for Glades I phase in region.

Third Gulf Breeze Site series, Florida

The Third Gulf Breeze site (8Sa8), one of a series of middens along S shore of Santa Rosa Sound, located immediately E of town limits of Gulf Breeze, Florida (30° 22′ 0″ N Lat, 87° 08′ 30″ W Long). Excavations by Willey (1949, p. 89-94) established primary occupation in Santa Rosa-Swift Creek phase with a later occupation of site in Fort Walton phase. Later excavations (Phelps, 1969) refined Santa Rosa-Swift Creek context. Samples coll. and subm. 1969 by D. S. Phelps.

1485 ± 75
FSU-350. Third Gulf Breeze 2 **A.D. 465**

Charred wood from Zone II, Level 2, Sq. E.

1350 ± 75
FSU-351. Third Gulf Breeze 3 **A.D. 600**

Charred wood from Feature 1, Sq. E; a hearth filled with burned *Coquina* shell, ash, and charcoal.

General Comment: both dates seem late for Santa Rosa-Swift Creek, but FSU-350 may be proper for late segment of the continuum; some intrusive material may have been derived from overlying Fort Walton component.

Town Creek Mound series, North Carolina

A series of 3 more dates for various construction stages of Town Creek Mound (Mg2), Montgomery Co., North Carolina (35° 40′ 30″ N Lat, 75° 59′ 0″ W Long). This platform mound is assigned to the Pee Dee phase (Coe, 1952); ceramic complex from site was recently described by Reid (1965). Subm. 1958 by J. L. Coe, Univ. of North Carolina.

745 ± 140
FSU-184. Town Creek 3 **A.D. 1205**

Charred wood of post fragment from pre-mound humus in Sq. 60R30, Level A. Sample coll. 1940. *Comment*: sample from area beneath center of mound, ruling out later intrusive contaminants.

595 ± 50
FSU-185. Town Creek 4 **A.D. 1355**

Charred wood from Wall Post 106, Temple 1 on summit of 1st mound stage. Sample coll. 1948. *Comment*: compares favorably with earlier date of pre-mound level (FSU-184, above).

670 ± 40
FSU-186. Town Creek 5 **A.D. 1280**

Charred fragments of wood from Wall Post 1, Temple 2 on summit of mound. Charred post was buried by a collapsed clay wall. *Comment*: date is earlier than FSU-185 but a later construction date for this structure is justified within the 2-sigma range of this date. A previous sample from another post of this structure dated A.D. 1350 (FSU-154, 600 ± 140; Knauer *et al.*, 1967).

Quelepa series, El Salvador

Charcoal from Quelepa site, San Miguel Prov., El Salvador (13° 31′ N Lat, 88° 15′ W Long). Coll. 1968 and subm. by E. W. Andrews V, Tulane Univ.

FSU-337.	**Quelepa**	**Cache 6**	**2020 ± 55** **70 B.C.**
FSU-338.	**Quelepa**	**Cache 7**	**2055 ± 65** **105 B.C.**
FSU-353.	**Quelepa**	**Cache 13**	**1460 ± 90** **A.D. 490**
FSU-354.	**Quelepa**	**Structure 4**	**1285 ± 70** **A.D. 665**
FSU-366.	**Quelepa**	**Structure 23**	**2100 ± 75** **150 B.C.**
FSU-367.	**Quelepa**	**Structure 29**	**1540 ± 60** **A.D. 410**

General Comment (E.W.A.): Quelepa is largest and perhaps most important site in E El Salvador. FSU-337 and FSU-338 provide dates for Late Preclassic in El Salvador, which correspond closely to Miraflores phase in Maya Guatemala Highlands. FSU-353 and FSU-354 are the only C^{14} dates on Early Classic architecture in El Salvador and date burning of an Early Classic structure.

Spirit Cave series, Thailand

Wood charcoal from Spirit Cave, Maehongson Prov., N Thailand (19° 34′ N Lat, 98° 7′ E Long). Coll. 1966 and subm. by Chester Gorman, Univ. of Hawaii.

FSU-314.	**Spirit Cave**	**Layer 2**	**7905 ± 195** **5955 B.C.**
FSU-315.	**Spirit Cave**	**Layer 3**	**11,350 ± 280** **9400 B.C.**
FSU-316.	**Spirit Cave**	**Layer 5**	**10,900 ± 550** **8950 B.C.**
FSU-317.	**Spirit Cave**	**Layer 2**	**7400 ± 150** **5450 B.C.**
FSU-318.	**Spirit Cave**	**Layer 2a**	**8520 ± 145** **6570 B.C.**

General Comment (C.G.): recent excavation in Spirit Cave and assoc. C^{14} dates provided evidence for early (ca. 7000 B.C.) domestication of plants in SE Asia (Gorman, 1969). FSU-314 and FSU-318 date upper portion of deposit and agree well with other determinations (TF-802 and GAK-1846). FSU-315 and FSU-316 are thus far the earliest dates for mainland SE Asia. FSU-317 dates top of Spirit Cave sequence. These dates generally bracket Pleistocene/Recent boundary in SE Asia and show it to be of little significance. General conclusion concerning the C^{14} and cultural sequence will appear in Asian Perspectives, v. 11 (in press).

Non Nok Tha series, Thailand

Samples from Non Nok Tha site, Khon Kaen Prov., NE Thailand (16° 47′ 57″ N Lat, 102° 18′ 17″ E Long). Coll. 1968 and subm. by D. T. Bayard, Univ. of Hawaii.

FSU-339. Non Nok Tha Layer 5 **Modern**

Bamboo charcoal from Sq. 3e/3f, Level 8.

4435 ± 65
FSU-340. Non Nok Tha Layer 11 **2485 B.C.**

Carbonized wood containing considerable termite frass from Sq. 4g.

2470 ± 70
FSU-341. Non Nok Tha Layer 7 **520 B.C.**

Charcoal fragments from Sq. 4f.

3055 ± 65
FSU-342. Non Nok Tha Layer 8 **1105 B.C.**

Charcoal from Sq. 1e.

FSU-343. Non Nok Tha Layer 4 **Modern**

Charcoal from Sq. 1e.

3560 ± 65
FSU-345. Non Nok Tha Mound 125 **1610 B.C.**

Charcoal from Sq. 3e.

General Comment (D.T.B.): these dates are relevant to early development of metallurgy in SE Asia (see Solheim, 1968). Conclusions concerning these and other dates will appear in Asian Perspectives, v. 11 (in press). Most dates from this site support presence of metallurgy by ca. 3500 B.C., and of a fairly complex bronze technology prior to 2300 B.C. Above dates, however, tend to support simultaneous arrival of iron and bronze between 800 and 300 B.C. Samples possibly were contaminated either naturally or in shipment, although no source of contamination is apparent.

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[RADIOCARBON, VOL. 13, No. 1, 1971, P. 26-28]

INSTITUTE OF GEOLOGICAL SCIENCES RADIOCARBON DATES I

E. WELIN, L. ENGSTRAND, and S. VACZY

Radioactive Dating Laboratory, Stockholm, Sweden*

This date list was compiled by the Institute of Geological Sciences (U.K.) incorporating data supplied under contract by Dr. E. Welin, Radioactive Dating Laboratory, Stockholm. Unless otherwise stated age figures are in C^{14} years before A.D. 1950. The half-life of C^{14} is taken as 5568 years and the standard error is given as a standard deviation of 1σ. Correction for C^{13}/C^{12} has not been made. This is the first of a series of annotated lists of C^{14} dates of British and overseas material in course of preparation by the Institute.

IGS-C14/1. (St 3062) Leuchars, Fife **5830 ± 110**
3880 B.C.

Peat from borehole at St. Michael's Wood, (56° 24′ N Lat, 2° 53′ W Long, Grid Ref. NO 4541 2348) in peat bog at landward limit of post-Glacial raised beach. Depth below surface 1.00 to 1.15 m; overlies wedge of clastic deposits marking limit of Flandrian transgression. Coll. 1969 and subm. by J. I. Chisholm, Inst. of Geol. Sciences.

IGS-C14/2. (St 3063) Leuchars, Fife **7605 ± 130**
5655 B.C.

Peat from same borehole as IGS C14/1, at depth 2.35 to 2.50 m below surface. Underlies wedge of clastic deposits marking limit of Flandrian transgression. Coll. 1969 and subm. by J. I. Chisholm.

IGS-C14/3. (St 3064) Leuchars, Fife **9945 ± 160**
7995 B.C.

Peat from same borehole as IGS C14/1 at depth 3.75 to 3.90 m below surface, at base of peat sequence, resting on late-Glacial sand. Coll. 1969 and subm. by J. I. Chisholm.

IGS-C14/4. (St 3057) Leeds, Yorkshire **4280 ± 100**
2330 B.C.

Wood fragment from 'upper sand and gravel' at Oxbow Opencast Coal site (53° 46′ N Lat, 1° 28′ W Long, Grid Ref. SE 361 300), in Aire Valley. Coll. 1964 and subm. by G. D. Gaunt, Inst. of Geol. Sciences. *Comment*: sample was derived from an horizon containing abundant horizontally disposed tree trunks. Pollen analyses by J. W. Franks, Univ. of Manchester, of silts and clays below and above this horizon suggest correlations with Flandrian Zones VI and VIIb, respectively (Gaunt, Coope, and Franks, in press). Age determination is compatible with these correlations. Pollen of Cerealia and Plantaginaceae was present in the silts and clays above the tree trunks. Abundance of trees at this horizon may possibly reflect forest clearance.

* Published by permission of the Director, Institute of Geological Sciences, Exhibition Road, London S.W.7. The Institute is a contracting agency, not a dating laboratory, yet IGS at London is the "author" when needed for interlaboratory communications.

IGS-C14/5. (St 3071 A, outer fraction) Aberlady, East Lothian **5535 ± 160** **3585 B.C.**

(St 3071 B, inner fraction) Aberlady, East Lothian **5070 ± 180** **3120 B.C.**

Shells from temporary sec. (56° 1′ N Lat, 2° 51′ W Long, Grid Ref. NT 4713 8053) from a fossil life assemblage of *Ostrea edulis* Linn. and *Mya truncata* Linn., respectively, lying on, or burrowed into a platform of till 1.8 m above O.D. Covered by 1 m of estuarine clay. Fauna a little below low water mark. Correlated with a post-Glacial raised beach 8.55 m above O.D. Coll. 1968 and subm. by A. D. McAdam, Inst. of Geol. Sciences. (Descr. by A. D. McAdam and Shelagh M. Smith).

IGS-C14/6. (St 3065) Aberlady, East Lothian **2505 ± 100** **555 B.C.**

Peat from temporary sec. at Luffness Links (56° 1′ N Lat, 2° 51′ W Long, Grid. Ref. NT 4710 8130) in peat wedge underlying 1 m sand, overlying estuarine clay. Probably lies near former high water mark at 6 m above O.D. Coll. 1968 and subm. by A. D. McAdam.

IGS-C14/7. (St 3070) Loch Linnhe area, Argyll **3315 ± 100** **1365 B.C.**

Shells from semi-consolidated plastic clay excavated around screw of sunken ship (56° 29′ N Lat, 5° 25′ W Long). Sample 6 ft below sea floor, probably never above sea level since its formation. Level ca. 100 ft below O.D. Coll. and subm. by R. A. Eden. (Note by D. C. Greig).

IGS-C14/8. (St 3066) Belfast **9130 ± 120** **7180 B.C.**

Peat from borehole in Castle Arcade (54° 36′ N Lat, 5° 56′ W Long, Grid Ref. J 3390 7425). Depth 14.94 m below surface; from layer of peat at base of estuarine clay. Coll. 1968 and subm. by H. E. Wilson, Inst. of Geol. Sciences. *Comment*: in Belfast Lough, Stephens (1968) assigned peat beneath the estuarine clay to Zone VI C, dating to ca. 8200 B.P. New datings place the basal peat at V/VI transition and indicate a much earlier date than has hitherto been suspected. Alternatively, peat deposition in the Belfast area may have been a polyphase event.

IGS-C14/9. (St 3058) Belfast **8715 ± 100** **6765 B.C.**

Wood from same borehole at depth 11.59 m below surface in estuarine clay. Coll. 1968 and subm. by H. E. Wilson. *Comment*: same as for IGS-C14/8.

IGS-C14/10. (St 3067) Birmingham **>40,000**

Plant remains washed from peat bed in core sample between 6.81 m and 6.88 m depth from Quinton No. 1 Borehole (52° 28′ N Lat, 2° 00′ W Long, Grid Ref. SO 9921 8471). Peat from part of sequence of organic sediments sandwiched between glacial deposits. Coll. 1969 and subm. by A. Horton, Inst. of Geol. Sciences. Contained insect fauna and plant remains indicate interglacial age.

IGS-C14/11. (St 3059) West Bromwich **12,165 ± 160**
10,215 B.C.

Wood fragments from basal 150 mm of 1.77 m thick peat in floor of small tributary of R. Tame. Peat rests upon glacial gravels (52° 32′ N Lat, 1° 58′ W Long, Grid Ref. SP 0213 9331). Coll. 1969 and subm. by A. Horton.

IGS-C14/12. (St 3060) West Bromwich **9970 ± 110**
8020 B.C.

Wood fragments from peat bed 0.51 to 0.61 m above base of peat described above. Coll. and subm. by A. Horton.

IGS-C14/13. (St 3068) Wittersham, Kent **3560 ± 100**
1610 B.C.

Peat from depth 4.27 m below surface in a borehole (50° 0′ N Lat, 0° 41′ E Long, Grid Ref. TQ 885 258) at Blackwall Bridge in the Rother Valley. Drift deposits, 31.4 m thick, included a bed of peat from 3.66 to 6.7 m below surface. Pollen analysis made by Charles Turner of peat at 3.81 m yielded a pollen spectrum referable to Zone VII b, and at 6.25 m a spectrum suggesting Zone VII a (pre-elm decline). Coll. 1968 and subm. by E. R. Shephard-Thorn, Inst. of Geol. Sciences. *Comment*: dates agree with palynologic evidence and also with previous dates from the older near-surface peats of Romney Marsh. IGS-C14/14 (see below) is one of the oldest dates so far obtained and suggests that peat may have started to accumulate in this part of the Rother Valley prior to its general accumulation in Romney Marsh.

IGS-C14/14. (St 3069) Wittersham, Kent **4845 ± 100**
2895 B.C.

Peat from same borehole at depth 5.89 to 5.97 m below surface. Coll. 1968 and subm. by E. R. Shephard-Thorn. *Comment*: see IGS-C14/13.

IGS-C14/15. (St 3061) Arlington, Sussex **9435 ± 120**
7485 B.C.

Wood fragments from peaty layer forming floor to the buried channel of R. Cuckmere at ca. O.D. (25 ft below surface). Coll. 1969 and subm. by R. D. Lake, Inst. of Geol. Sciences, from excavations for E sec. of Arlington Reservoir dam (50° 50′ N Lat, 0° 11′ E Long, Grid Ref. TQ 538 074).

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[RADIOCARBON, VOL. 13, No. 1, 1971, P. 29-31]

INSTITUT ROYAL DU PATRIMOINE ARTISTIQUE RADIOCARBON DATES II

M. DAUCHOT-DEHON and J. HEYLEN

INTRODUCTION

The method used was described in R., 1968, v. 10, p. 29-35. The counter is the same (M.B.L.E. Houtermans and Oeschger) but the electronic apparatus is new; all is transistorized and the installation operates in preset time. The counter is filled at a pressure of 600 to 1000 mm Hg; sample, modern reference, and background are counted at the same pressure and reduced to standard conditions: 760 mm Hg, 20°C. Atmospheric pressure and temperature are measured at each filling. Samples are counted for 20 hours at one month intervals and a third time if measurements do not agree within two standard deviations. Age calculations are based on a contemporary value equal to 0.95 of activity of NBS oxalic acid standard and 5570 yr for the half-life of C^{14}, 1950 used as reference year. Errors quoted include the standard deviations of the count rates for unknown sample, modern and background; no corrections are made for isotopic fractionation.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

IRPA-39. Wenduine — **11,349 ± 364**, **9399 B.C.**

Marine shells from E coastal area of Belgium (51° 18′ 30″ N Lat, 3° 5′ 52″ W Long), at –8.5 m alt, in the Wenduine formation. Coll. 1968 by W. De Breuck, Lab. of Geol., Univ. of Ghent, Belgium. *Comment*: pretreated with HCl 1 N until 15% weight loss.

IRPA-40. Varsenare — **11,647 ± 391**, **9697 B.C.**

Marine shells from E coastal area of Belgium (51° 12′ 49″ N Lat, 3° 7′ 47″ W Long), at –4 m alt, probably in the Meetkerke formation of undetermined age. Coll. 1964 by W. De Breuck. *Comment*: see IRPA-39.

IRPA-41. Varsenare — **5068 ± 216**, **3118 B.C.**

Peat from E coastal area of Belgium (51° 13′ 1″ N Lat, 3° 7′ 16″ W Long), at 0 m alt, in peat of Nieuwmunster in age range of late Atlantic to Sub-Boreal. Coll. 1967 by G. De Moor, Lab. of Geol., Univ. of Ghent, Belgium; subm. by W. De Breuck. *Comment*: refluxing hot HCl 1% for 1 hr, no NaOH pretreatment.

IRPA-42. Uitkerke — **5064 ± 229**, **3114 B.C.**

Peat from E coastal area of Belgium (51° 17′ 35″ N Lat, 3° 7′ 14″ W Long), at –0.5 m alt, in peat of Nieuwmunster. Coll. 1966 by W. De Breuck. *Comment*: see IRPA-41.

General Comment (W.DeB.): field work by Center of Hydrogeological Research at the State Univ. of Ghent has provided new data about relief of Tertiary substratum and lithostratigraphy of Pleistocene and Holocene sediments of E coastal area. A SN sec. indicates existence, on buried surface of Tertiary substratum, of 2 degradation levels (between –17 and –22 m and between –8 and –6 m). Date of IRPA-39 comes from –8.5 m level. IRPA-41 and -42, which are the same age, come from levels 0 and –0.5 m. These results agree with stratigraphic position of deposits.

II. ARCHAEOLOGIC SAMPLES

IRPA-27. Suse (Bar-e-Mechandeh) — **1921 ± 100**, **A.D. 29**

Wood (cedar), Ber-e-Mechandeh, Khuzistan (31° 11′ N Lat, 48° 17′ E Long), found 1968 on site of Royal Town, at 50 cm depth on floor of room by H. Gascher, Nekkersberglaan, Ghent. *Comment*: date given in R., 1968, v. 10, p. 29 is wrong: new value agrees with archaeologic date: 1st century B.C.

IRPA-28. Herresbach St. Vith — **677 ± 81**, **A.D. 1273**

Wood (linden) of statue "Vierge à l'Enfant" Herresbach St. Vith, Liège, Belgium (50° 16′ N Lat, 6° 6′ E Long). Coll. 1967 by A. Ballestrem, IRPA. *Comment* (R. Didier): from historic study of "Vierge à l'Enfant"; this statue seems to be imitation of a French statue from 14th century A.D., made at the end of 19th century. Date does not conform with this study; possibly, wood that was used was older, or part of statue is original.

IRPA-30. Brugge — **1089 ± 72**, **A.D. 861**

Wood from St. Donatien Church, Brugge, W Flanders, Belgium. Used to draw church perimeter. Coll. 1955 by J. Mertens, Service Nat. des Fouilles, Brussels, Belgium. *Comment* (J.M.): agrees with archaeol. date: 9th century A.D. Sample is proof that our dates are corrected and our installation is in order.

Alba series

Samples of charcoal found in Alba excavations, Aquila, Italy (42° 05′ N Lat, 13° 12′ E Long), alt 992 m. Coll. 1966 by G. De Boe; subm. by J. Mertens.

IRPA-31. Trench 66 IV — **1728 ± 98**, **A.D. 222**

IRPA-32. Trench 66 IV — **2290 ± 110**, **340 B.C.**

IRPA-33. Trench 66 VI — **2210 ± 146**, **260 B.C.**

General Comment (J.M.): IRPA-31 was found with imperial coins of 3rd century A.D. in Roman house. Date agrees with archaeol. data. IRPA-32 and -33 were found in Roman house of 2nd century B.C. Thus, results seem too old; archaeol. date: 1st century A.D.

Florenville series

Two pieces of charcoal found in archaeologic layer on Roman site, Chameleux, Florenville, Luxembourg, Belgium (49° 40′ N Lat, 5° 18′ E Long), alt 265 m. Coll. 1962 by J. Mertens.

IRPA-35. **1126 ± 87**
A.D. 724

IRPA-36. **1631 ± 98**
A.D. 319

General Comment (J.M.): Service Nat. de Fouilles began excavations of Roman Site of Chameleux in 1954. Site existed from 1st century A.D. to 5th century A.D. Date for IRPA-35 is too young but contamination by roots is possible. IRPA-36 agrees with archaeol. data: 4th century A.D.

IRPA-54. Dendermonde **4169 ± 198**
2119 B.C.

Wood from layer of Holocene peat, Dendermonde, E Flanders, Belgium; St. Arnolphe excavations. Subm. 1969 by Prof. Vanhoorne, Antwerp Univ., Centre Dept. of Sci. *Comment*: date agrees with pollen analysis: ca. 3000 B.C.

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[RADIOCARBON, VOL. 13, NO. 1, 1971, P. 32-44]

INSTITUTO VENEZOLANO DE INVESTIGACIONES CIENTIFICAS NATURAL RADIOCARBON MEASUREMENTS VI

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The I.V.I.C. laboratory continues operation using liquid scintillation spectrometry with synthesized benzene. A plastic-glass counting vessel contains 3 ml benzene, 1 ml commercial toluene, and concentrations of 0.4% PPO and 0.01% POPOP as scintillators. Background is 6.9 cpm and activity of the modern standard, 95% of the activity of the NBS oxalic acid, is 21.4 cpm. In the age calculations, 5568 years is taken for the half-life of C^{14} and quoted errors are one standard deviation arising from the random nature of the radioactive disintegration process. Uncertainties in the half-life are not included nor are variations in the deposition rate of stratospheric radiocarbon and dilution by industrial use of fossil fuels. A.D. 1950 is employed as the reference year in the B.P. (before present) notation of ages.

ACKNOWLEDGMENTS

Close collaboration is maintained with the I.V.I.C. Dept. of Anthropol., J. M. Cruxent, head. V. García and F. Machado carry out the benzene syntheses and routine chemical analyses. A. Russo maintains the liquid scintillation counter.

SAMPLE DESCRIPTIONS

I. GROUND WATER SAMPLES

Considerable portions of Venezuela, including several of its principal cities, lie in semi-arid regions. Traditionally, fresh water in these areas has depended on subterranean aquifers. However, recent introduction of large bore deep wells and electric pumps, necessary for increasing living standards, developing industry, and irrigation, have resulted in lowering ground water levels. A study of the recharge characteristics of the water tables is a *sine qua non* for future planning in these areas.

The principal ground water aquifers of Venezuela have been investigated by radiocarbon dating of dissolved carbonate species. The results have been presented in previous date lists. Two aquifers are sampled annually in a program to observe changes caused by contamination of the atmosphere by nuclear weapons. The wells on the N and S sides of the Lake of Valencia and the Bosque Macuto municipal wells of Barquisimeto are producing modern water. The technique of sequential sampling, initiated in these cases in 1966, allows a fitting of the limestone-corrected radiocarbon dates with the fallout curve (Tamers and Scharpenseel, 1970). The method works well for Barquisimeto, but the Lake of Valencia modern waters are apparently being over-exploited and are no longer reaching the lake. This is accelerating the natural desiccation of the large continental body of water.

Wells of Valencia Lake Basin

	Collection (day/month/yr)	C^{14} (% of modern)
IVIC-685. Mariara 1 (10° 15′ N Lat, 67° 43′ W Long)	14/1/70	88.8 ± 0.7
IVIC-686. Mariara 2 (10° 13′ N Lat, 67° 43′ W Long)	14/1/70	99.7 ± 0.8
IVIC-687. El Trompillo (10° 4′ N Lat, 67° 48′ W Long)	14/1/70	98.8 ± 0.8
IVIC-688. Güigüe 1 (10° 5′ N Lat, 67° 47′ W Long)	14/1/70	91.5 ± 1.0
IVIC-689. Güigüe 3 (10° 5′ N Lat, 67° 47′ W Long)	14/1/70	91.8 ± 0.8

Barquisimeto Wells

IVIC-768. Macuto 1 (10° 3′ N Lat, 69° 19′ W Long)	12/5/70	91.3 ± 0.8
IVIC-769. Macuto 2 (10° 3′ N Lat, 69° 19′ W Long)	12/5/70	92.8 ± 0.7
IVIC-770. Macuto 3 (10° 3′ N Lat, 69° 19′ W Long)	12/5/70	86.5 ± 0.7
IVIC-771. Macuto 5 (10° 3′ N Lat, 69° 19′ W Long)	12/5/70	87.1 ± 0.8
IVIC-772. Macuto 6 (10° 3′ N Lat, 69° 19′ W Long)	12/5/70	85.5 ± 0.7
IVIC-773. Macuto 7 (10° 3′ N Lat, 69° 19′ W Long)	12/5/70	91.4 ± 0.7
IVIC-774. Macuto 8 (10° 3′ N Lat, 69° 19′ W Long)	12/5/70	85.1 ± 0.7

II. ARCHAEOLOGIC SAMPLES

A. Venezuela

IVIC-723. Misteque **850 ± 60**
A.D. 1100

Charcoal obtained from mortar of piled stones, ca. 6 km SE Chachopo, state of Mérida, Venezuela (8° 56.0′ N Lat, 70° 46.7′ W Long). Assoc. with simple pottery, trade pottery, stones, manos, animal bones, ashes. This is 1st date for region of Chachopo. Other dates for Venezuelan Andes discussed previously (Wagner, 1967). Coll. 1970 and subm. by E. Wagner, I.V.I.C., who estimated age to be 500 to 1000 B.P. *Comment* (E.W.): date confirms age estimation from artifacts.

IVIC-724. Ensillada de Mucuyupú **200 ± 60**
A.D. 1750

Small charcoal sample from cave NW of Timotes, on boundary between states of Mérida and Trujillo, Venezuela (9° 1.1′ N Lat, 70° 44.9′ W Long). Assoc. with simple pottery and pieces of shell necklace. Coll.

1970 and subm. by E. Wagner. This is 1st date from cave in elevated zone in Venezuelan Andes. Estimated age, 400 to 1000 B.P. *Comment* (E.W.): probably intrusive charcoal.

Taima-taima series

This paleo-indian kill site W of Vela de Coro, state of Falcón, Venezuela (11° 30′ N Lat, 69° 30′ W Long) has been under intensive investigation by the I.V.I.C. Anthropol. Dept. for past 10 yr (Cruxent, 1967). Pleistocene animal bones have been dated at 13,010 ± 280 and 14,440 ± 435 B.P. (IVIC-191-1 and IVIC-191-2, R., 1966, v. 8, p. 206) for non-carbonate fractions and 7590 ± 100 B.P. (IVIC-191-B, R., 1969, v. 11, p. 407) for carbonates. The fluorine content was 1.0% (Tamers, 1969b). A wood sample, presumably preserved by high sulfur content of soil, provided date of 11,860 ± 130 B.P. (IVIC-655, R., 1970, v. 12, p. 516). Evidence for man is based on numerous cutting scars on bones and stone points (Cruxent, pers. commun.).

9650 ± 80
IVIC-657. Taima-taima A, 0.65 to 0.75 m **7700 B.C.**

Black clay, Profile A, Sec. 38, NE corner. 1.5% non-rootlet, non-carbonate carbon content.

9650 ± 110
IVIC-658. Taima-taima A, 0.75 to 0.85 m **7700 B.C.**

Black clay, Profile A, Sec. 38, NE corner. 2.9% non-rootlet, non-carbonate carbon content.

10,140 ± 90
IVIC-659. Taima-taima A, 0.85 to 0.95 m **8190 B.C.**

Black clay, Profile A, Sec. 38, NE corner. 3.9% non-rootlet, non-carbonate carbon content.

12,660 ± 120
IVIC-660. Taima-taima A, 1.50 to 1.65 m **10,710 B.C.**

Gray sand, Profile A, Sec. 38, NE corner. 0.25% non-rootlet, non-carbonate carbon content.

12,620 ± 120
IVIC-661. Taima-taima A, 1.65 to 1.80 m **10,670 B.C.**

Gray sand, Profile A, Sec. 38, NE corner. 0.35% non-rootlet, non-carbonate carbon content.

13,390 ± 130
IVIC-662. Taima-taima A, 1.80 to 1.95 m **11,440 B.C.**

Gray sand, Profile A, Sec. 38, NE corner. 0.54% non-rootlet, non-carbonate carbon content.

13,130 ± 130
IVIC-663. Taima-taima A, 1.95 to 2.10 m **11,180 B.C.**

Gray sand, Profile A, Sec. 38, NE corner. 0.67% non-rootlet, non-carbonate carbon content.

12,730 ± 120
IVIC-664. Taima-taima A, 2.10 to 2.25 m 10,780 B.C.

Gray sand, Profile A, Sec. 38, NE corner. 0.78% non-rootlet, non-carbonate carbon content. Soil samples coll. 1969 and subm. by J. M. Cruxent and M. A. Tamers. Black clay layer is overlain by ca. 65 cm impermeable yellow clay. From ca. 95 to 150 cm is another deposit of almost carbon-free clay. The kill site bones are located in the gray sand layer, which is in the phreatic zone. Surface vegetation is sparse and xerophytic. At ca. 225 cm begins rock strata of tertiary period. *Comment*: see General Comment after Taima-taima B series.

9860 ± 110
IVIC-665. Taima-taima B, 0.65 to 0.75 m 7910 B.C.

Black clay, Profile B, Sec. 38, SE corner. 1.6% non-rootlet, non-carbonate carbon content.

10,030 ± 90
IVIC-666. Taima-taima B, 0.75 to 0.85 m 8080 B.C.

Black clay, Profile B, Sec. 38, SE corner. 3.6% non-rootlet, non-carbonate carbon content.

10,290 ± 90
IVIC-667. Taima-taima B, 0.85 to 0.95 m 8340 B.C.

Black clay, Profile B, Sec. 38, SE corner. 4.8% non-rootlet, non-carbonate carbon content.

13,390 ± 130
IVIC-668. Taima-taima B, 1.50 to 1.65 m 11,440 B.C.

Gray sand, Profile B, Sec. 38, SE corner. 0.30% non-rootlet, non-carbonate carbon content.

12,770 ± 120
IVIC-669. Taima-taima B, 1.65 to 1.80 m 10,820 B.C.

Gray sand, Profile B, Sec. 38, SE corner. 0.37% non-rootlet, non-carbonate carbon content.

12,990 ± 260
IVIC-670. Taima-taima B, 1.80 to 1.95 m 11,040 B.C.

Gray sand, Profile B, Sec. 38, SE corner. 0.59% non-rootlet, non-carbonate carbon content.

13,180 ± 130
IVIC-671. Taima-taima B, 1.95 to 2.10 m 11,230 B.C.

Gray sand, Profile B, Sec. 38, SE corner. 0.62% non-rootlet, non-carbonate carbon content.

14,010 ± 140
IVIC-672. Taima-taima B, 2.10 to 2.25 m 12,060 B.C.

Gray sand, Profile B, Sec. 38, SE corner. 1.2% non-rootlet, non-carbonate carbon content. Soil samples coll. same time as those of Profile A and soil strata are similar. Previous soil sample date on Taima-taima gray sand was 12,580 ± 150 B.P. (IVIC-627, R., 1970, v. 12, p. 516), from an adjacent area of site; agrees with these dates.

General Comment (M.A.T.): black clay layer overlies and underlies impermeable strata and can be used to give minimum possible age of 10,290 ± 90 B.P. to artifacts located in gray sand. Radiocarbon dates in the gray sand are practically indistinguishable, except for IVIC-672, which is a little older. There is definite increase of carbon content with depth, contrary to other cases of soil profiles studied in Venezuela (see Sec. III). Possibly, carbon originates from a deposit at ca. 2.10 m depth and was partially transported upward by seasonal fluctuations of ground water level. Therefore, 14,010 ± 140 B.P. could be taken as oldest date for the bones. The impermeability of upper strata minimizes the possibility of a large amount of more recent carbon infiltration causing falsely young ages, as observed in work of Bonn lab. (Scharpenseel and Pietig, 1969). The age of Taima-taima kill site must lie between 11,000 and 15,000 B.P. This is oldest dated archaeologic site in South America.

IVIC-704. Taima-taima organic material **$36{,}690 {}^{+2310}_{-1790}$** **34,740 B.C.**

Carbonaceous material, probably lignite, from 2.00 m depth in part of Taima-taima site with few bones. Coll. 1970 and subm. by J. M. Cruxent. Material not typical of site nor of area and must have been introduced artificially from a considerable distance. Previous date on similar sample from Taima-taima was >41,000 B.P. (Y-1199, R., 1969, v. 11, p. 634), which is within 2σ of IVIC date. *Comment* (J.M.C.): material cannot be considered to date Taima-taima artifacts.

B. Chile

Caleta Abtao series

Samples of loco (*Concholepas concholepas*) shells from 3rd marine terrace mound on Mejillones Peninsula, prov. of Antofagasta, Chile (23° 20′ S Lat, 70° 31′ W Long). Coll. 1969 and subm. by G. Boisset and A. Llagostera, Univ. del Norte, Antofagasta, Chile.

IVIC-679. Caleta Abtao 1 **5030 ± 70** **3080 B.C.**

From Site 2, Pit 2, 2.20 m below surface. First occupation level. Assoc. with shell fish hooks, bone and lithic instruments, plant origin cord, guano.

IVIC-680. Caleta Abtao 4 **4820 ± 70** **2870 B.C.**

From Site 2, Pit 1, 2.40 m below surface. First occupation level. Assoc. with 2 shell fish hooks and 1 cactus spine fish hook.

IVIC-681. Caleta Abtao 7 **5100 ± 130** **3150 B.C.**

From Site 1, Sq. 01, 0.10 m below surface. Seventh (last) occupation level. Assoc. with stone points and fragments and tubular bone beads.

5090 ± 80
IVIC-682. Caleta Abtao 8 **3140 B.C.**

From Site 1, Sq. 01, 0.90 m below surface. First occupation level. Assoc. with shell, bone, and cactus spine fish hooks; lithic, bone, and wood instruments; and cord.

4800 ± 70
IVIC-683. Caleta Abtao 11 **2850 B.C.**

From Site 1, Sq. 01, 0.40 m below surface. Fifth occupation level. Assoc. with shell, bone, and cactus spine fish hooks; lithic, bone, and wood instruments; and cord. *Comment* (M.A.T.): the 5 dates are statistically indistinguishable.

General Comment (G.B.): dates agree perfectly with archaeologic evidence. Previous date for shell fish hook culture of Quiani, Arica site was 6170 ± 220 B.P. (I-1348, R., 1969, v. 11, p. 102). Date for cactus spine fish hooks from same site was 5630 ± 145 B.P. (I-1349, R., 1969, v. 11, p. 102). In Caleta Abtao both cultures appear in all occupation levels. Since IVIC dates are close to but less than I-1349, we could say that immigrants from N came to Caleta Abtao at period of beginning of use of cactus spine fish hooks. Shell fish hook use persisted in Caleta Abtao longer than in N, e.g., in Quiani.

Alero Rocoso de San Pedro Viejo series

Charcoal samples from Hortado R. valley, N side, Ovalle Dept., Coquimbo prov., Chile (30° 23′ S Lat, 70° 53′ W Long). Coll. 1968 and 1970 and subm. by G. Ampuero B. and M. A. Rivera, Univ. de Concepción, Concepción, Chile.

7050 ± 80
IVIC-727. Pichasca 1 **5100 B.C.**

From Sq. D-2, Level II, 1 m below surface. Located in simple burial pocket without furnishings. Level occupied by hunters with knowledge of agriculture and possibly in contact with the El Molle ceramic culture. Sample date contact between Levels I and II.

9890 ± 80
IVIC-728. Pichasca 2 **7940 B.C.**

From Sq. D-3, Level III. Assoc. with projectile points, bone and wood tools, and food debris. Existence of basketry. Level occupied by hunters with probable beginnings of agriculture, preceramic, and before El Molle culture. Sample dated twice on separate batches of charcoal with results: 9920 ± 110 and 9860 ± 110 B.P.

4700 ± 80
IVIC-729. Pichasca 3 **2750 B.C.**

From NW wall Sq. A-1, base of Level II. Assoc. with projectile points, basketry, and objects of wood and bone. Sample corresponds to contact between Levels II and III. Occupation by hunters with probable beginnings of agriculture. Ceramics absent.

General Comment (M.A.R.): 1st impression is that dates agree with other evidence of the 2 excavations.

III. SOIL SAMPLES

Radiocarbon dating of soil associations in various regions of Venezuela is one major project of the lab. Pretreatment is similar to that developed in Bonn (Scharpenseel, Tamers, and Pietig, 1968). Sample first passed through gross screen to remove large roots and stones. A slurry is then produced with distilled water and a high torque stirrer. A fine screen removes small rootlets from this suspension. Hydrochloric acid is added to eliminate carbonates and slurries centrifuged to permit decantation of supernatent liquids. After drying at 110°C, soils are burned in usual combustion tubes and CO_2 collected in ammonia bubblers. Precipitation with strontium chloride permits gravimetric analysis of non-carbonate, non-rootlet carbon content and provides material for benzene synthesis.

Maracay series

Soil association on NE bank of Lake of Valencia, in orchard of Fac. de Agron., Univ. Central in Maracay, state of Aragua, Venezuela (10° 17′ N Lat, 67° 36′ W Long). Surface layer of alluvial loam ca. 60 cm separated by ca. 135 cm almost carbon-free sand from fossil horizon. Coll. 1970 and subm. by R. Herrera and M. A. Tamers.

IVIC-690. Maracay A-1 **123.4 ± 0.9 % modern**

Gray-black clayey soil, 0 to 0.15 m below surface. 1.6% non-carbonate, non-rootlet carbon content.

IVIC-691. Maracay A-2 **103.4 ± 0.8 % modern**

Gray-black clayey soil, 0.15 to 0.30 m below surface. 1.2% non-carbonate, non-rootlet carbon content.

IVIC-692. Maracay A-3 **104.6 ± 0.8 % modern**

Gray-black clayey soil, 0.30 to 0.45 m below surface. 0.52% non-carbonate, non-rootlet carbon content.

IVIC-693. Maracay A-4 **103.3 ± 0.9 % modern**

Gray-black clayey soil, limit of this horizon, 0.45 to 0.60 m below surface. Mixed with yellow sand. 0.42% non-carbonate, non-rootlet carbon content.

1260 ± 70
IVIC-700. Maracay A-11 **A.D. 690**

Gray-black friable soil, beginning of fossil horizon. 0.50% non-carbonate, non-rootlet carbon content. 1.35 to 1.50 m below surface.

1650 ± 80
IVIC-701. Maracay A-12 **A.D. 300**

Gray-black soil, 1.50 to 1.65 m below surface. Second half of fossil horizon. 0.24% non-carbonate, non-rootlet carbon content.

General Comment: it was not expected that all upper horizon samples would be modern. Inorganic fertilizer was employed here and soil has not been recently ploughed, and certainly to no more than 30 cm. Modern dates of IVIC-692 and IVIC-693 must be due to infiltration of recent material from upper layers, a phenomenon described elsewhere (Benzler and Geyh, 1966; Scharpenseel and Pietig, 1969). Since sand separating these layers from fossil horizon is permeable, it must be concluded that IVIC-700 and IVIC-701 are also falsely young. Values indicate only minimum ages. It is not clear to us why surface carbon infiltration is so pronounced in this particular soil.

Tierra Pipe series

Clay soil samples, brown earth of A-C horizon type in Altos de Pipe, state of Miranda, Venezuela (10° 23′ N Lat, 66° 58′ W Long), on steep side of Pipe hill. Previous profile gave dates of 2230 ± 60, 4220 ± 90, and 5720 ± 80 B.P. for 15 cm fractions from 0.15 to 0.60 m (IVIC-652, IVIC-653, IVIC-654, R., 1970, v. 12, p. 524). Profiles reported here continue study, Pipe 3 being ca. 50 m below previous samples, Pipe 4 ca. 100 m below, Pipe 2 ca. 50 m above, and Pipe 5 on hill top, slightly on opposite side with gentle slope. Coll. 1970 and subm. by R. Herrera and M. A. Tamers.

890 ± 60
IVIC-756. Pipe 5, 0.25 to 0.35 m **A.D. 1060**

2.3% non-rootlet, non-carbonate carbon content.

1400 ± 70
IVIC-757. Pipe 5, 0.35 to 0.45 m **A.D. 550**

2.1% non-rootlet, non-carbonate carbon content.

2150 ± 70
IVIC-758. Pipe 5, 0.45 to 0.55 m **200 B.C.**

0.91% non-rootlet, non-carbonate carbon content.

2050 ± 70
IVIC-759. Pipe 5, 0.55 to 0.65 m **100 B.C.**

0.56% non-rootlet, non-carbonate carbon content.

2460 ± 70
IVIC-760. Pipe 5, 0.65 to 0.75 m **510 B.C.**

0.53% non-rootlet, non-carbonate carbon content.

2480 ± 80
IVIC-761. Pipe 5, 0.75 to 0.85 m **530 B.C.**

0.26% non-rootlet, non-carbonate carbon content.

2830 ± 80
IVIC-730. Pipe 2, 0.15 to 0.30 m **880 B.C.**

0.42% non-rootlet, non-carbonate carbon content.

5620 ± 100
IVIC-731. Pipe 2, 0.30 to 0.45 m **3670 B.C.**

0.34% non-rootlet, non-carbonate carbon content.

IVIC-732. Pipe 2, 0.45 to 0.60 m **6000 ± 100**
4050 B.C.

0.36% non-rootlet, non-carbonate carbon content.

IVIC-733. Pipe 2, 0.60 to 0.75 m **6820 ± 90**
4870 B.C.

0.34% non-rootlet, non-carbonate carbon content.

IVIC-734. Pipe 2, 0.75 to 0.90 m **6840 ± 100**
4890 B.C.

0.27% non-rootlet, non-carbonate carbon content.

IVIC-735. Pipe 3, 0.15 to 0.30 m **390 ± 60**
A.D. 1560

2.9% non-rootlet, non-carbonate carbon content.

IVIC-736. Pipe 3, 0.30 to 0.45 m **1030 ± 60**
A.D. 920

2.0% non-rootlet, non-carbonate carbon content.

IVIC-737. Pipe 3, 0.45 to 0.60 m **1670 ± 70**
A.D. 280

1.4% non-rootlet, non-carbonate carbon content.

IVIC-738. Pipe 3, 0.60 to 0.75 m **2330 ± 70**
420 B.C.

1.1% non-rootlet, non-carbonate carbon content.

IVIC-739. Pipe 3, 0.75 to 0.90 m **2610 ± 80**
660 B.C.

0.98% non-rootlet, non-carbonate carbon content.

IVIC-740. Pipe 4, 0.15 to 0.30 m **570 ± 60**
A.D. 980

1.7% non-rootlet, non-carbonate carbon content.

IVIC-741. Pipe 4, 0.30 to 0.45 m **1050 ± 60**
A.D. 900

1.8% non-rootlet, non-carbonate carbon content.

IVIC-742. Pipe 4, 0.45 to 0.60 m **1250 ± 70**
A.D. 700

1.4% non-rootlet, non-carbonate carbon content.

IVIC-743. Pipe 4, 0.60 to 0.75 m **1710 ± 70**
A.D. 240

0.96% non-rootlet, non-carbonate carbon content.

IVIC-744. Pipe 4, 0.75 to 0.90 m **2180 ± 70**
230 B.C.

0.47% non-rootlet, non-carbonate carbon content.

IVIC-745. Pipe 4, 0.90 to 1.05 m **2220 ± 70**
270 B.C.

0.31% non-rootlet, non-carbonate carbon content.

General Comment: samples all show correct date sequences with respect to stratigraphy. Ages and carbon contents increase with distance down slope. Previous profile dates in agreement with these tendencies. This study is being continued with more samples and various chemical analyses on the soils.

Club de Campo series

Soil samples on opposite side of Pipe Hill, in direction of settlement Club de Campo (10° 23′ N Lat, 66° 58′ W Long). Pipe 5 dates could be given with this series. Club de Campo 1 is ca. 50 m from hill top and Club de Campo 2 is ca. 100 m down hill. Coll. 1970 and subm. by R. Herrera and M. A. Tamers.

IVIC-748. Club de Campo 1, 0.15 to 0.30 m **100.4 ± 0.8 % modern**

1.3% non-rootlet, non-carbonate carbon content.

340 ± 60
IVIC-749. Club de Campo 1, 0.30 to 0.45 m **A.D. 1610**

0.82% non-rootlet, non-carbonate carbon content.

490 ± 60
IVIC-750. Club de Campo 1, 0.45 to 0.60 m **A.D. 1460**

0.17% non-rootlet, non-carbonate carbon content.

1330 ± 70
IVIC-752. Club de Campo 2, 0.25 to 0.35 m **A.D. 620**

1.1% non-rootlet, non-carbonate carbon content.

1790 ± 70
IVIC-753. Club de Campo 2, 0.35 to 0.45 m **A.D. 160**

0.65% non-rootlet, non-carbonate carbon content.

1650 ± 70
IVIC-754. Club de Campo 2, 0.45 to 0.55 m **A.D. 300**

0.37% non-rootlet, non-carbonate carbon content.

General Comment: dates increase and carbon contents decrease regularly with depth. Relatively recent dates were unexpected. Rather, we expected that this small slope would produce older soils than other side of hill, with its steep gradient. Club de Campo investigations are continuing.

Boconó series

Sandy alluvial soil profile, in pasture 2 km from M.O.P. (Ministerio de Obras Publicas) sta., 100 m from Boconó (Boconoito)—Puerto Nutrias rd., state of Barinas, Venezuela (8° 42′ N Lat, 69° 52′ W Long), W Llanos Altos region. Sediments formed from overflowing of Boconó R., which has since changed course. It was thought that this soil might date previous to those of next 2 series. Coll. 1970 by R. Herrera and J. García and subm. by R. Herrera and M. A. Tamers.

IVIC-706. Boconó, 0 to 0.10 m **104.8 ± 0.8 % modern**

From A horizon, 2.1% non-rootlet non-carbonate carbon content.

IVIC-707. Boconó, 0.10 to 0.25 m **30 ± 70**
A.D. 1920

From A horizon, 1.3% non-rootlet, non-carbonate carbon content.

IVIC-708. Boconó, 0.25 to 0.50 m **1160 ± 70**
A.D. 790

From C horizon, 0.14% non-rootlet, non-carbonate carbon content.

IVIC-709. Boconó, 0.50 to 0.75 m **2670 ± 70**
720 B.C.

From C horizon, 0.09% non-rootlet, non-carbonate carbon content. *General Comment*: ages increase and carbon contents decrease regularly with depth. This series was from bank of previous position of Boconó R. Soil is very permeable and recent carbon infiltration into deeper levels should be at maximum here. Nevertheless, deepest sample, IVIC-709, is still quite old.

Fanfurria series

Sandy loam, alluvial, soil samples from M.O.P. sta. on Boconó (Boconoito)—Puerto Nutrias rd., state of Barinas, Venezuela (8° 42′ N Lat, 69° 56′ W Long). Deposits from overflowing of Boconó R., while in earlier position. Intermediate between Boconó series and Méndez series. Coll. 1970 by R. Herrera and J. García and subm. by R. Herrera and M. A. Tamers.

IVIC-710. Fanfurria, 0 to 0.15 m **106.9 ± 0.8 % modern**

1.4% non-rootlet, non-carbonate carbon content.

IVIC-711. Fanfurria, 0.15 to 0.30 m **106.6 ± 0.8 % modern**

0.70% non-rootlet, non-carbonate carbon content.

IVIC-712. Fanfurria, 0.30 to 0.45 m **1190 ± 70**
A.D. 760

0.58% non-rootlet- non-carbonate carbon content.

IVIC-713. Fanfurria, 0.45 to 0.60 m **1610 ± 70**
A.D. 340

0.52% non-rootlet, non-carbonate carbon content. *General Comment*: ages and carbon contents tendencies are the same as in the Boconó series.

Méndez series

Clayey alluvial soil from M.O.P. sta. on Boconó (Boconoito)—Puerto Nutrias rd., state of Barinas, Venezuela (8° 41′ N Lat, 69° 56′ W Long). Deposits in furthest position from bed of previous Boconó R. Downhill from Boconó and Fanfurria series. Coll. 1970 by R. Herrera and J. García and subm. by R. Herrera and M. A. Tamers.

IVIC-714. Méndez, 0 to 0.12 m **109.8 ± 0.8 % modern**

2.0% non-rootlet, non-carbonate carbon content.

IVIC-715. Méndez, 0.12 to 0.25 m **460 ± 70**
A.D. 1490

0.79% non-rootlet, non-carbonate carbon content.

IVIC-716. Méndez, 0.25 to 0.40 m **940 ± 60**
A.D. 1010

0.58% non-rootlet, non-carbonate carbon content.

IVIC-717. Méndez, 0.40 to 0.55 m **1690 ± 60**
A.D. 260

0.35% non-rootlet, non-carbonate carbon content.

IVIC-718. Méndez, 0.55 to 0.70 m **2540 ± 80**
590 B.C.

0.21% non-rootlet, non-carbonate carbon content.

IVIC-719. Méndez, 0.70 to 0.85 m **2530 ± 80**
580 B.C.

0.16% non-rootlet, non-carbonate carbon content.

General Comment: ages increasing and carbon contents decreasing regularly with depth. At equivalent levels, dates for these three series are similar, suggesting simultaneous formation. Distribution of particle sizes is due to smaller particles, *i.e.*, clay, being transported more easily and thus further by the flooding of previous Boconó river. Assumption that Boconó series would be oldest is rejected.

IV. GEOLOGIC SAMPLE

IVIC-722. Morrena Victoria **5470 ± 80**
3520 B.C.

Soil sample (CS-24) from fluvial terrace, 1 m below surface, ca. 2.7 m E Alto de Santo Domingo (Mucubají), state of Mérida, Venezuela (8° 48.7′ N Lat. 70° 48.3′ W Long). Ca. 1 km S Laguna Victoria. Assoc. with gravel and sand of glacial origin (Schubert and Sifontes, 1970). Coll. 1970 and subm. by C. Schubert. I.V.I.C. First date related to last glaciation in Venezuelan Andes. Soil contained 2.9% non-carbonate, non-rootlet carbon, which was used for radiocarbon determination. *Comment* (C.S.): date very reasonable.

V. EXTRATERRESTRIAL SAMPLE

IVIC-702. Caserio Ucera Meteorite **34.4 ± 2.2 dpm/kg**

Thoroughly metamorphosed chondrite, Type H-6, fell 7:00 p.m., 16 Jan. 1970 near Caserio Ucera, state of Falcón, Venezuela (11° 2′ N Lat, 69° 48′ W Long). Stony meteorite weighed 4.95 kg, had thoroughly rounded edges and typical chemical composition for chondrites (Vaz, 1970). Fall heard by village inhabitants, who coll. meteorite while still warm. Obtained by E. Vaz, I.V.I.C., a few days later. Sample for radiocarbon analysis was taken from surface and heated at ca. 1000°C for 48 hr in oxygen stream. Polyethylene plastic used as carrier. *Comment* (M.A.T.): radiocarbon content is ca. ½ that of other "fall" stone meteorites we have measured, average value: 85 dpm/kg. It is also low in comparison with accelerator measured cross section data for $O^{16}(p,3p)C^{14}$ (Tamers, 1963). There was no indication that Caserio Ucera had recently been transferred from a larger body, which would have meant that it had been irradiated only on one side. Other stone meteorite "Falls" showed average radiocarbon contents of 65 dpm/kg (Goel and Kohman, 1962) and 48 dpm/kg (Suess and Wänke, 1962). Caserio Ucera has lowest value so far observed.

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LOUVAIN NATURAL RADIOCARBON MEASUREMENTS X

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The following list comprises measurements made during 1969-70. The method is essentially the same as previously described, using a 0.6 L proportional gas-counter at 3 atm CH_4 pressure. Ages are calculated with a half-life of 5570 yr and quoted with 1σ experimental error. Descriptions and comments are based on information supplied by the submitters.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Holsbeek series

Samples from Holsbeek, Marrant (50° 55′ 52″ N Lat, 4° 45′ 30″ E Long), Prov. of Brabant, Belgium, alt 15 m. A continuous layer, 1 to 2 m thick, of silty clay Sub-Atlantic alluvium, at bottom of which is a peaty clay horizon with scattered charcoal and potsherds, overlies several peaty or silty horizons, one of which contains Mesolithic industry (Vermeersch, 1971). These horizons are locally overturned by uprooted trees. Coll. 1967 and subm. by P. Vermeersch, Univ. of Louvain.

4820 ± 230
Lv-376. Holsbeek, charcoal **2870 B.C.**

Charcoal from the thin charcoal horizon at 1 m depth. At same level, potsherds of Neolithic appearance and a few Wommerson sandstone-quartzite and flint splinters. *Comment*: very small sample measured at only 1000 mm Hg pressure. Date is probably too old because of contamination by wood pieces from underlying Atlantic peat.

5850 ± 120
Lv-472. Holsbeek I **3900 B.C.**

Peat from Trench 3, N Wall, Sq. 1 G, from top of Layer 3, 212.5 to 215 cm below ground surface. Pollen analysis, by W. Mullenders, indicates a Middle Atlantic phase before 3rd maximum of *Corylus* (C.X), generally dated ca. 3000 B.C.

5550 ± 80
Lv-472 H. Holsbeek I **3600 B.C.**

NaOH-soluble humic matter from above sample. Date shows no contamination originating from upper layers.

8200 ± 160
Lv-473. Holsbeek I **6250 B.C.**

Humified peat from bottom of Layer 8, Trench 3, N Wall, Sq. 1G, 241 to 245 cm depth. Pollen curve shows beginning of Boreal period at this level with 1st maximum of *Corylus* (C.Ia). Mesolithic artifacts were found 10 cm below sample, at level palynologically dated as Piottino oscillation. *Comment*: C^{14} date with soluble humic matter. Date closely agrees with palynology.

11,330 ± 180
Lv-474. Holsbeek I **9380 B.C.**

Humified peat from bottom of Layer 7, Trench 3, N Wall, Sq. 1G, 280 to 285 cm depth. Pollen curve shows Alleröd period with 1st phase characterized by *Betula* preponderance. *Comment*: humic matter used for dating. Result as expected.

4290 ± 90
Lv-378. Holsbeek F **2340 B.C.**

Wood from uprooted Tree F, 110 cm depth, Trench 3, N Wall, Sq. 3G, imbedded in peat layer, palynologically dated as Alleröd to Atlantic. Falling trees disturbed underlying Pre-Boreal Mesolithic layer. *Comment* (P.V.): uprooting seems contemporaneous with 1st Neolithic cultivation.

3900 ± 140
Lv-381. Holsbeek B **1950 B.C.**

Wood from Tree B, Trench 2, S Wall, depth 100 cm.

3880 ± 85
Lv-380. Holsbeek C **1930 B.C.**

Wood from Tree C, Trench 2, S Wall, depth 90 cm.

7900 ± 150
Lv-377. Holsbeek E **5950 B.C.**

Wood from Tree E, Trench 3, N Wall, Sq. 3G, depth 140 cm.

7580 ± 110
Lv-379. Holsbeek D **5630 B.C.**

Wood from Tree D, Trench 3, N Wall, Sq. 3G, depth 130 cm. *Comment*: C^{14} dates show 2 uprooting periods after Mesolithic settlement.

4260 ± 85
Lv-475. Holsbeek II **2310 B.C.**

Peat from top of Layer 13, 224 to 230 cm depth, Trench 3, N Wall, Sq. 3G. Level probably disturbed.

8110 ± 140
Lv-476. Holsbeek II **6160 B.C.**

Peat from 290 to 295 cm, middle part of Layer 13, Trench 3, N Wall, Sq. 3G. By pollen analysis, this level is attributed to Boreal-Atlantic transition. But profile is overturned between 220 and 290 cm, where it contains Boreal and Atlantic mixed sediments.

Maisières series

Humic matter from calcareous clay from Maisières (50° 29′ N Lat, 3° 57′ E Long), Prov. of Hainaut, Belgium, alt 40 m, depth 10 m. Samples related to a lithic industry attrib. to Perigordian V culture, and to an Arcy-Kesselt (Stillfried B) interstadial horizon (Bastin, 1970). Coll. 1966 and subm. by B. Bastin, Univ. of Louvain. According to Groningen date lists, Upper Perigordian IV to VI is generally dated 26,000 B.C. to 21,000 B.C. and Arcy-Kesselt interstadial 30,500 B.C. to 26,500 B.C.

Lv-304. Maisières 1

(1) 31,080 +2040 −1640
29,130 B.C.

(2) 30,150 +1890 −1540
28,200 B.C.

From Sq. J-K 10, archaeol. horizon overlying Arcy-Kesselt interstadial. Sample from same horizon is dated 26,015 B.C. ± 260 (GrN-5523).

Lv-305. Maisières 2

(1) 35,970 +3140 −2250
34,020 B.C.

(2) 24,100 +650 −610
22,150 B.C.

From archaeol. horizon at 12 cm over Lv-304. *Comment*: this excessive discrepancy is unexplained.

Lv-306. Maisières 3 **24,400 +700 −640**
22,450 B.C.

From Sq. J-K 15-16, Arcy-Kesselt interstadial horizon below archaeol. layer. Next sample is dated 28,830 B.C. ± 400 (GrN-5690). *Comment*: NaOH soluble humic matter concentration is very low in this level.

Lv-307. Maisières 4 **23,160 +550 −510**
21,220 B.C.

From same layer, 12 cm overlying Lv-306.

Lv-353. Maisières 5 **25,280 +1040 −920**
23,330 B.C.

From Sq. K-11, clay layer including several "nuclei."

General Comment: relative chronologic position of above C^{14} dates is incompatible with stratigraphic evidence. Lv-306 and -307, poor in organic matter, give C^{14} dates too young compared to archaeol. layer dates. On the other hand, Lv-305 is too old and differs to a fault from Lv-305/2. These anomalies are attributed to problems often encountered with dating calcareous soil. We have no satisfactory explanation.

Entre-Sambre-et-Meuse series

Wood pieces from Entre-Sambre-et-Meuse region, Prov. of Namur, Belgium. From lignitic sands in detrital formations (age unknown, presumed Tertiary) occupying dissolution pockets in Carboniferous Limestones. Coll. 1969 and subm. by J. Soyer, Univ. of Louvain.
General Comment: antiquity of lignitic material doubtful because digging removed presumed overlying sands and clays; it is also possible that wood was recent (e.g., supports for subterranean workings). C^{14} dates support Tertiary age and show that most karst evolution was completed before or during Tertiary.

Lv-477. Bioul A **>32,500**

Wood from Rouchat sandpit near Bioul (50° 20′ 40″ N Lat, 4° 48′ 00″ E Long), alt 220 m. From lignitic sand mound, depth 5 m, center of sandpit.

Lv-478. Bioul B **>32,500**

As above, depth 6 m.

Lv-479. Freyr **>32,500**

Wood from sandpit of Freyr, from Sté. Sambre-et-Dyle (50° 14′ 30″ N Lat, 4° 51′ 30″ E Long) at Waulsort, alt 215 m. From bottom of sandpit, depth 10 m, underlying thin red clay.

2670 ± 100
Lv-434. Geistingen, B1 **720 B.C.**

Wood from Geistingen (51° 07′ 33″ N Lat, 5° 48′ 56″ E Long), Prov. of Limburg, Belgium, alt 27.5 m. From a layer with wood between alluvium and gravels at 2 m depth in alluvial plain of Meuse R. Coll. 1969 and subm. by E. Paulissen, Univ. of Louvain. *Comment* (E.P.): this date, with others from same series (R., 1970, v. 12, p. 557), confirms that, contrary to previously published opinion, clayey alluvium of Meuse R. is recent (Paulissen, 1970).

Opgrimbie series

Samples from a sand hill at Opgrimbie (50° 57′ 17″ N Lat, 5° 39′ 10″ E Long), Prov. of Limburg, Belgium, alt 55 m. Coll. 1968 by A. V. Munaut and E. Paulissen; subm. by A. V. Munaut, Univ. of Louvain.

11,910 ± 170
Lv-457. Opgrimbie I, 200 cm **9960 B.C.**

Peat from 200 cm depth, from a peat layer imbedded in whitish layer with charcoal, between Sand Layers 3 and 2. Pollen analysis, by A. V. Munaut, gives Alleröd age to peat layer. C^{14} date agrees with expectation.

Lv-456. Opgrimbie, 275 cm **12,640 ± 190**
10,690 B.C.

Humic matter from a dark to whitish sand horizon at 275 cm depth, between Sand Layers 2 and 1. Bölling age, ascertained by pollen analysis, is confirmed by carbon dating. A whitish Bölling horizon is proved for the first time; the name "Opgrimbie soil" is proposed (Paulissen and Munaut, 1970).

II. ARCHAEOLOGIC SAMPLES

Baie Diana series, Canada

Samples from Diana I. (60° 57′ N Lat, 70° 00′ W Long), New Quebec, Canada. Coll. 1969 and subm. by P. Plumet, Quebec Univ., Montreal.

Lv-468. Baie Diana I **2070 ± 140**
120 B.C.

Charcoal from a lengthened house with 2 hemicycles and inside partitions. From Level IV belonging to a former camping hearth. *Comment* (P.P.): at Pamiok, a late reoccupation in a similar site is dated 1050 A.D. The 2 dates are 1st chronologic limits for this kind of house uncommon in Arctic (Plumet, 1969).

Lv-469. Baie Diana II **1360 ± 90**
A.D. 590

Charred fat on an upturned slab used to support a fat or oil lamp.

Lv-470. Baie Diana II bis **1510 ± 65**
A.D. 440

Charred fat under a sloped slab, near Lv-469, in lobby of a Dorset semi-underground house.

Lv-471. Baie Diana III **1300 ± 75**
A.D. 650

Charred fat on a slab *in situ* used as support of lamp. *Comment* (P.P.): 3 dates agree with each other and with another sample from this site dated A.D. 500 ± 90 in Gif-sur-Yvette laboratory. They also agree with lithic industry, but not with type of building. Till now, this Dorset house type was estimated to be related to arrival of Thule tradition ca. A.D. 1000 (Plumet, 1968).

Lv-483. Peu, New Caledonia **270 ± 120**
A.D. 1680

Human skeleton from Peu (27° 31′ 40″ S Lat, 167° 59′ 10″ E Long) in Mare I., Royalty Archipelago, New Caledonia. From cave used as ossuary in Rawa forest. Skeleton is insulated from ossuary by a small wall. Coll. 1946 and subm. by M. J. Dubois, Mus. de l'Homme, Paris. *Comment* (M.J.D.): according to tradition, the man belongs to Si Peu people diminishing in 18th century. However, skeleton shows very marked archaïc aspect (Hartweg, 1948). C^{14} date confirms that very archaïc type has been preserved till recently.

1090 ± 80
Lv-367. Mont Noir, France **A.D. 860**

Charcoal from Mont Noir at St. Jans Cappel (50° 45′ N Lat, 2° 45′ E Long), Dept. of Nord, France, alt 150 m. From Level 4, 1.20 to 2.40 m depth, dark sand filling layer of Neolithic pit near a dwelling house. Coll. 1967 by G. Tieghem; subm. by P. Moisin, Recherches Prehist. en Hainaut Soc. *Comment* (G.T.): assoc. lithic and ceramic industries are only Middle Neolithic. C^{14} date is still unexplained.

2040 ± 120
Lv-510. Russeignies **90 B.C.**

Charcoal from Russeignies (50° 45′ N Lat, 3° 39′ E Long), Prov. of Hainaut, Belgium, alt 30 m. Imbedded at 80 cm depth in a sandy clay layer with Roman tiles. Coll. 1970 by J. M. Vlieghe; subm. by R. Vandenhaute, Univ. of Louvain. *Comment*: C^{14} date confirms Gallo-Roman age of site.

560 ± 110
Lv-496. Gomery **A.D. 1390**

Charcoal (*Quercus*) id. by J. Heim, from Bleid-Gomery (49° 34′ 15″ N Lat, 5° 34′ 54″ E Long), Prov. of Luxembourg, Belgium, alt 240 m. From hearth 70 cm below ground surface. Coll. 1969 by M. Seret; subm. by J. Heim, Univ. of Louvain. *Comment* (J.H.): hearth, within a few m from "dolmen" of Gomery, was assumed of Mesolithic Seine-Oise-Marne culture (1600 to 1900 B.C.). Soil profile taken below a big stone of dolmen, pollen analyzed by J. Heim, shows a Sub-Atlantic pollen curve (40% *Carpinus*). Palynology and carbon dating agree with each other, and disprove Mesolithic assumption.

840 ± 65
Lv-485. Haltinne **A.D. 1100**

Charcoal from Haltinne (50° 27′ N Lat, 5° 04′ E Long), Prov. of Namur, Belgium. Exhumed from 35 cm below tillable layer, during preliminary excavating to determine questionable disappearance of a Middle age village during 15th century. Coll. 1969; subm. by L. F. Genicot, Centre Belge d'Histoire Rurale, Louvain. *Comment* (L.F.G.): C^{14} date agrees with analysis of potsherds and is consistent with historical data of the country.

195 ± 75
Lv-442. Wuustwezel **A.D. 1755**

Collagen from human bones from H. Willibrord chapel (51° 23′ N Lat, 4° 33′ E Long) at Westdoorn near Wuustwezel, Prov. of Antwerp, Belgium. Skeleton found at 1 m depth below tile floor of chapel. Coll. 1967; subm. by K. C. Peeters, Univ. of Louvain. *Comment* (K.C.P.): historical date would be A.D. 1500 to A.D. 1660.

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LYON NATURAL RADIOCARBON MEASUREMENTS II

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INTRODUCTION

The Radiocarbon Dating Laboratory of the Department of Geology, University of Lyon, is going on with work since its foundation in 1965, in the basement of the Nuclear Physics Institute.

The present list includes geologic and archaeologic samples measured from 1968 to 1970, most of the water samples measured since 1966 and a range of bone samples measured to try a new collagen preparation method which the abstract is given below.

The wood and shell samples preparation method and the counting technique (CO_2 in 0.5 L proportional counter) have not been really modified and were already described in Lyon I (R., 1969, v. 11, p. 112-117). The background of the two counters has been lowered and better stabilized by a new setting of discriminators. The new backgrounds are respectively 3.20 ± 0.05 and 2.20 ± 0.05 cpm.

Two new detectors will be set up. One is a proportional counter of large effective volume ca. 40,000 yr limit ages; the other one is a Packard liquid scintillation spectrometer Model 3320 Tricarb. The characteristics of these two detectors and a description of the chemical bench for benzene preparation will be given in the next date list. The Radiocarbon Laboratory has, since May 1970, a mass spectrometer Model A.E.I., MS 20 Isotopic, which will ensure C^{13} measurements for all the samples.

Ages are calculated using the half-life value 5570 with A.D. 1950 as reference year. The statistical errors, corresponding to one standard deviation, include the contribution of the contemporary standard, background, and sample counting.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Rhône Alpes region

Ly-113. Rouelbeau, Canton de Genève **7950 ± 180**
6000 B.C.

Wood from peaty layer with volcanic ash, interbedded in lacustrine chalk, at Rouelbeau, near Jussy, canton of Genève (46° 14′ N Lat, 6° 14′

E Long). Coll. 1964 and subm. 1967 by A. Jayet, Chemin du Pré Catellier 9, Genève. *Comment*: much younger than expected by assoc. volcanic ash which supposedly were from Laachersee (Eifel) of Allerød age (Martini and Duret, 1965).

Ly-116. Veigy, Haute-Savoie **9180 ± 200**
7230 B.C.

Pinus sylvestris cone included in lacustrine chalk 10 cm below volcanic ash at Veigy, Haute-Savoie (46° 16′ N Lat, 6° 15′ E Long). Coll. 1964 by J. Martini and J. J. Duret; subm. 1967 by A. Jayet. Before subm. sample was kept in glycerin. *Comment*: ash suggested Allerød age. Date is too young but may be due to defective elimination of the glycerin.

Ly-277. Cuculianne, Hautes-Alpes **11,250 ± 250**
9300 B.C.

Fragment of tree trunk from a thick detrital deposit in Le Buech torrent bed at Cuculianne near Eyguians, Hautes-Alpes (44° 21′ N Lat, 5° 46′ E Long). Coll. and subm. by G. Montjuvent, Inst. Dolomieu, Grenoble. *Comment* (G.M.): agrees with Postglacial or Allerød age of the main alluviation phase of Le Buech torrent.

Ly-237. Quaix, Isère **⩾31,500**

Fragment of larch trunk inbedded in a clayey, sandy layer during Würm retreat at Peteysset near Quaix, Isère (45° 15′ N Lat, 5° 44′ E Long). Coll. by M. Collardel and subm. 1968 by A. Bocquet, Grenoble. *Comment*: date older than expected; implies earlier Würm glacier retreat or redeposition of old wood.

Ly-114. Saint Jean, Genève **⩾31,000**

Fragment of tree-trunk inbedded in an interglacial deposit –40 m below Saint-Jean dist., Genève, Switzerland (45° 14′ N Lat, 6° 07′ E Long). Coll. 1964 by J. Duret and subm. 1967 by A. Jayet. *Comment*: as expected, (Jayet, 1966) date seems to exclude Würm IV age for overlying glacial deposits.

Chevillys series, Haute-Savoie

Samples from clayey, sandy interglacial sediment 15 m thick at Chevillys near Lathuile, Haute-Savoie (45° 48′ N Lat, 6° 12′ E Long). Coll. and subm. 1967 by A. Brun, Lab. de Géol. Dynam., Fac. Sci., Paris.

Ly-139. Chevillys I **⩾34,000**

Wood from a lignitic layer in upper part of interglacial series (alt 510 m).

Ly-140. Chevillys 3C **⩾33,000**

Fine lignitic debris from the lower part of the series (alt 500 m).
General Comment: interglacial series is overlain by a supposed Würm moraine (Bourdier, 1963). Minimum age eliminates attribution of series to interstadial found at Armoy, Haute-Savoie (Blavoux and Brun, 1966) and dated Gif-333: 23,500 ± 1200.

B. Other regions

Ly-281. La Maxe, Moselle **8660 ± 160**
6710 B.C.

Wood from alluvions in Moselle R. lower terrace at La Maxe, Moselle (48° 51′ N Lat, 6° 12′ E Long). Coll. and subm. 1969 by R. Haghighate, Bur. Recherches Géol. et Min., Metz. *Comment*: agrees with expected Postglacial age of terrace.

Ly-243. Vik, Cameroun **⩾30,000**

Oyster shells from −20 m depth in a well dug in a clayey, sandy Quaternary series at Vik, Dept. de Logone et Chari, N Cameroun (12° 31′ N Lat, 14° 36′ E Long). Coll. and subm. 1969 by R. Biscaldi, Bur. de Recherches Géol. et Min., Montpellier.

Golfe de Gascogne series

Unbroken marine shells assoc. with sand and gravel, from continental plateau of Gascogne Gulf between Ré I. and Rochebonne Plateau. Coll. 1968 and subm. 1969 by J. P. Barusseau, Centre de Recherches de Séd. Marine, Perpignan.

Ly-168. T H E 22 **6080 ± 200**
4130 B.C.

(46° 25′ N Lat, 1° 59′ W Long) −32 m

Ly-171. T H E 146 **⩾6280 ± 200**
4330 B.C.

(46° 20′ N Lat, 2° 05′ W Long) −53 m
Comment: value calculated only after 20 hr counting before elimination of eventual Radon activity.

Ly-169. T H E 128 **8240 ± 220**
6290 B.C.

(46° 12′ N Lat, 2° 08′ W Long) −46 m

Ly-170. T H E 139 **19,960 ± 400**
18,010 B.C.

(46° 13′ N Lat, 1° 59′ W Long) −41 m
General Comment (J.P.B.): all measured shell species are shallow-water or littoral. Their fragility excludes any important transport. Dates make evident several ancient shores between 6000 and 20,000 B.P. (Barusseau, 1969). Ly-168 and Ly-171 should be contemporary with Salpausselkä episode.

II. ARCHAEOLOGIC SAMPLES

A. Historic and Bronze-age periods

Ly-272. Doué la Fontaine, Maine et Loire **1210 ± 100**
A.D. 740

Charcoal from a building inside a feudal clod at La Motte de la Chapelle near Doué la Fontaine, Maine et Loire (47° 11′ N Lat, 0° 18′ W Long). Coll. and subm. 1969 by M. de Boüard, Centre de Recherche Archéol., Univ. de Caen. *Comment* (M.deB.): a little older than supposed destruction of building (ca. A.D. 900); but measurement was performed in order to invalidate ca. A.D. 1120, which was also possible.

1645 ± 80
Ly-267. Les Kéllia Qouçour 'Isā, Sud I 5.50 W A.D. 315

Charcoal from kitchen of coptic monastery Les Kéllia near Markaz de Dilingat, Egypt (30° 45′ N Lat, 30° 22′ E Long). Coll. 1967 and subm. 1968 by D. Weidmann, Lausanne, Switzerland. *Comment* (D.W.): kitchen was occupied till A.D. 600, date seems to prove that woods from an old building was burnt later in kitchen. Compare with B-988: 1530 ± 100 (R., 1970, v. 12, p. 381).

1690 ± 100
Ly-152. Saint Romain en Gal, Rhone A.D. 260

Charcoal from a timber, burned at destruction time (ca. A.D. 250) of Gallo-Roman town at Saint-Romain en Gal, Rhône (45° 32′ N Lat, 4° 51′ E Long). Coll. and subm. by R. Chalavoux, Lyon.

2450 ± 200
Ly-72. Magny sur Tille, Cote d'Or 500 B.C.

Charcoal from refuse pit assoc. with Hallstatt industry at Le Marais near Magny sur Tille, Côte d'Or (47° 12′ N Lat, 5° 11′ E Long). Coll. and subm. 1966 by R. Ratel, Lab. de Géol., Fac. Sci., Dijon. *Comment*: agrees with expected age and assoc. industry.

Chaumes les Baigneux series, Cote d'Or

Charcoal from supposed Late Bronze tumulus at La Forêt near Chaumes les Baigneux, Côte d'Or (47° 38′ N Lat, 4° 35′ E Long). Coll. and subm. 1966 by R. Ratel.

370 ± 150
Ly-80. Chaumes les Baigneux, Central hearth A.D. 1580

Sample from hearth found in middle of tumulus, no assoc. industry.

2320 ± 100
Ly-94. Chaumes les Baigneux, Basal hearth 370 B.C.

Samples from hearth found at bottom of tumulus.

General Comment: Ly-80 is obviously wrong, Ly-94 seems too young for expected Late Bronze age, but agrees with Gif-1109 (550 B.C.) measured on the same sample.

2880 ± 220
Ly-135. Chène de la Balme, Savoie 930 B.C.

Fragment of branch of oak tree found in alluvions of Rhône bed at La Balme, Savoie (45° 43′ N Lat, 5° 43′ E Long). Coll. 1883 and subm. by L. Lagier-Bruno Yenne, Savoie (Lagier-Bruno, 1970). *Comment*: compare with Gif-386: 2870 ± 200 (R., 1969, v. 11, p. 332).

Les Sarrasins series, Isère

Charcoal from grotto Les Sarrasins near Seyssinet-Pariset, Isère (45° 10′ N Lat, 5° 41′ E Long). Coll. and subm. 1969 by A. Bocquet, Grenoble.

Ly-238. Les Sarrasins, Level 4C **2940 ± 170**
990 B.C.

Assoc. with Late Bronze II industry.

Ly-239. Les Sarrasins, Level 5 **3240 ± 120**
1290 B.C.

Assoc. with industry of beginning of Late Bronze age.

General Comment: both dates confirm that Grenoble region Late Bronze age is contemporaneous and not delayed with respect to other French regions (Bocquet and Papet, 1966).

Ly-84. Lithaire, Manche **2030 ± 150**
80 B.C.

Charcoal lying on flagging of an "Allée Couverte" at Le Plessis near Lithaire, Manche (49° 17′ N Lat, 1° 36′ W Long). Coll. and subm. 1967 by B. Edeine, Caen. *Comment* (B.E.): date proves that "Allée Couverte" was reoccupied much later than erection.

Ly-83. Flamanville, Manche **2660 ± 220**
710 B.C.

Charcoal from −60 cm level in hearth at Le Castel, near Flamanville, Manche (49° 32′ N Lat, 1° 44′ W Long). Coll. and subm. by B. Edeine. *Comment* (B.E.): agrees with assoc. Bronze industry.

Ly-233. Sous-Sac, Ain **3260 ± 100**
1310 B.C.

Calcareous tuffa from rock-shelter Sous-Sac, near Craz de Michaille, Ain (46° 02′ N Lat, 5° 46′ E Long). Coll. 1962 by G. Sanlaville and subm. 1967 by R. Vilain, Lab. de Géol., Fac. Sci. Lyon. *Comment*: tuffa contained fragment of Middle Bronze age pottery with which the date agrees well despite fact that a calcareous tuffa theoretically contains some dead carbon.

B. Pile dwellings of French alpine lake

The following samples come from several coastal stations submerged in French alpine lakes. They were coll. and subm. in 1967 or 1968 by R. Laurent, Centre de Recherche Archeol. Lacustre, Tréserves, Savoie.

Ly-189. Aiguebelette, 145 B2, Savoie **1860 ± 70**
A.D. 90

Fragment of wood submerged near island La Tour de Beauphare, S part of Aiguebelette Lake near Lepin, Savoie (45° 33′ N Lat, 5° 48′ E Long). *Comment*: object was found close to, but outside, a Chalcolithic settlement. Date suggests occupation of Tour de Beauphare I. in Roman times.

Meymart series, Savoie

Samples from settlement, central part of Le Bourget Lake near Brisson-Saint-Innocent, Savoie (45° 42′ N Lat, 5° 53′ E Long). This site is complex and presents several successive occupations.

4060 ± 120
2110 B.C.

Ly-190. Meymart, 59 C1

Fragment of wooden cup from supposed Chalcolithic part of site. *Comment* (R.L.): date confirms Chalcolithic attribution and agrees with Ly-20: 4150 ± 180 (R., 1969, v. 11, p. 115) from coastal sta. in Aiguebelette Lake.

2140 ± 110
240 B.C.

Ly-276. Meymart, 59 C2

Wood from pile foundation from S part of site. *Comment* (R.L.): this unexpected young pile might have been fixed by Gallo-Roman fishermen.

Chatillon series, Savoie

Samples from coastal sta. at Chatillon underlying ca. 5 m in N part of Le Bourget Lake near Chindrieux, Savoie (45° 46′ N Lat, 5° 50′ E Long).

2670 ± 110
720 B.C.

Ly-274. Chatillon, 85 A4

Wood from pile fixed in central part of sta. *Comment* (R.L.): same value as Ly-17: 2700 ± 110 (R., 1969, v. 11, p. 115) which confirms expected Late Bronze age.

2380 ± 100
430 B.C.

Ly-275. Chatillon, A5

Wood from isolated settlement outside sta. *Comment* (R.L.): settlement was built after destruction of main village, supposedly ca. 700 B.C.

Sévrier series, Haute-Savoie

Sample from coastal sta. submerged in Annecy Lake near Sévrier, Haute-Savoie (45° 39′ N Lat, 6° 9′ E Long).

2760 ± 150
810 B.C.

Ly-191. Sévrier, 267 A 3

Wood from inner part of pile foundation.

3030 ± 150
1080 B.C.

Ly-192. Sévrier, 267 A 4

Wood from top of another pile.

General Comment: Ly-191 and Ly-192, respectively, agree with Ly-17: 2700 ± 100 and Ly-9: 3060 ± 100 from coastal sta. Chatillon in Le Bourget Lake. Thus, occupation length of these 2 Late Bronze settlements seems the same.

C. Neolithic and Mesolithic periods

Tureng Tepe series, Iran

Charcoal from 2 levels of Tell Tureng Tepe near Gorgan, Iran (36° 55′ N Lat, 54° 35′ E Long). Coll. 1963 and subm. 1968 by J. Deshayes, Fresnes, Hauts-de-Seine.

4550 ± 140
Ly-97. Tureng Tepe, No. 3 **2600 B.C.**
Sample from Level 12.

4400 ± 130
Ly-96. Tureng Tepe, No. 1 **2450 B.C.**
Sample from Level 15.

General Comment: allowing for statistical errors, both dates may agree with Gif-301: 4325 ± 250, from Level 14 and with Gif-302: 4090 ± 250 from Level 18, and these 4 values with stratigraphic order of levels.

5700 ± 100
Ly-229. Les Romains, Ain **3750 B.C.**

Charcoal from Level E14 N. Part of site La Grotte des Romains near Virignien, Ain (45° 41′ N Lat, 5° 21′ E Long). Coll. and subm. by R. Desbrosse, Blanzy, Saône et Loire. *Comment* (R.D.): agrees well with assoc. Neolithic industry.

5950 ± 340
Ly-264. Les Hotteaux, Ain **4000 B.C.**

Small fragments of charcoal extracted from calcareous tuffa from grotto Les Hotteaux near Rossillon, Ain (45° 41′ N Lat, 5° 35′ E Long). Coll. 1963 and subm. 1968 by R. Vilain. *Comment* (R.V.): expected age was Magdalenian or Azilian but stratigraphic relationship between tuffa and industries is not established.

Culoz Sous Balme series, Ain

Charcoal from several levels in rock-shelter Sous-Balme near Culoz, Ain (45° 51′ N Lat, 5° 47′ E Long). Coll. and subm. 1968 by R. Vilain (1966).

4600 ± 480
Ly-288. Culoz Sous Balme, W site, Level 3 **2650 B.C.**

Comment (R.V.): may be little too young but agrees with Neolithic assoc. industry.

7360 ± 1080
Ly-289. Culoz Sous Balme, W site, Level 1 **5410 B.C.**

Comment (R.V.): despite large statistical error due to small sample, date fits with assoc. Sauveterrian industry.

9150 ± 160
Ly-286. Culoz Sous Balme, E shelter, Level 1E **7200 B.C.**

Comment (R.V.): in good agreement with age expected by assoc. Sauveterrian triangles and microburins.

4790 ± 140
Ly-287. Culoz Sous Balme, E shelter, Level 3E **2640 B.C.**

Comment (R.V.): Level 3E underlying Level 1E, Ly-287 confirms contamination from overlying levels as suspected during excavation.

La Brèche au Diable and Longrais series, Calvados

Charcoal from several levels at Chasséan settlement, La Brèche au

Diable and Rubané Récent site (Danubian) Les Longrais. Both sites near Soumont-Saint-Quentin, Calvados (48° 39′ N Lat, 0° 13′ W Long). Coll. 1966 and subm. 1967 by B. Edeine.

4560 ± 120
Ly-134. La Brèche au Diable, Layer m, Level-97 2610 B.C.

4940 ± 200
Ly-135. La Brèche au Diable, Layer n, Level-102 2990 B.C.

4540 ± 140
Ly-148. La Brèche au Diable, Layer p, Level-110 2590 B.C.

5140 ± 140
Ly-149. La Brèche au Diable, Layer q, Level-116 3190 B.C.

Comment (B.E.): these 4 values confirm relatively old age attributed to Chasséan of Normandie by Gsy-39: 4790 ± 150 (R., 1966, v. 8, p. 131). They prove settlement was occupied for at least ca. 500 yr.

5290 ± 180
Ly-150. Les Longrais, Hole X 7, Layer a 3340 B.C.

Comment (B.E.): this age for Rubané Récent (Danubian) seems to correspond with Neuvy en Dunnois incinerations (Gif-785: 5250 ± 140 B.P.) which might be also Danubian (Masset, 1968).

General Comment (B.E.): comparing Ly-150 and Ly-149, there is no interruption between Rubané Récent and Chasséan in Normandie; dates "Cerny" civilization underlying Chasséan at La Brèche au Diable (Edeine, 1970).

3670 ± 130
Ly-164. La Baume Loire 2, Haute Loire 1720 B.C.

Charcoal from overlying level in rock-shelter La Baume Loire, near Solignac, Haute Loire (44° 56′ N Lat, 3° 54′ E Long). Coll. and subm. 1968 by A. Crémilleux, Le Monastier sur Gazeille, Haute Loire. *Comment* (A.C.): agrees well with assoc. Late Neolithic industry; comparison with Ly-50: 4230 ± 300 (R., 1969, v. 11, p. 116) shows occupation time of site for Middle and Late Neolithic.

Le Rond du Lévrier séries, Haute Loire

Charcoal from levels at rock-shelter Le Rond du Lévrier, near Salette, Haute Loire (44° 51′ N Lat, 3° 58′ E Long). Coll. and subm. 1968 by J. P. Daugas and A. Crémilleaux.

3370 ± 210
Ly-194. Le Rond du Lévrier, Level III 1420 B.C.

3570 ± 130
Ly-195. Le Rond du Lévrier, Level IIb 1620 B.C.

4380 ± 280
Ly-196. Le Rond du Lévrier, Level I 2430 B.C.

General Comment (A.C.): Ly-196 comes from same Middle Neolithic level as Ly-82: 4750 ± 300 (R., 1969, v. 11, p. 115). Comparison between

Ly-196 and Ly-194, assoc. with metallic remains, shows a site occupation > 1000 yr long. Ly-195 comes from another part of the site; its assoc. Late Neolithic industry shows Mediterranean influences.

Prélétang series, Isère

Charcoal from several sectors of upper layers in long cave, Prélétang, near Presle, Isère (45° 05′ N Lat, 5° 25′ E Long). Coll. and subm. by P. Lequatre, Saint-Marcellin, Isère. Lower layers of site contain a large *Ursuslic. Spelaeus* fauna assoc. with Mousterian industry (Lequatre, 1966). See Ly-167, this list.

Ly-118. Prélétang No. 4, Sector XIII **Modern**

Comment: charcoal from upper stalagmitic floor in which branch traces demonstrate a temporary occupation.

10,400 ± 300
Ly-81. Prélétang No. 1, Sector XVIII **8450 B.C.**

11,730 ± 260
Ly-93 Prélétang No. 3, Sector XIX **9780 B.C.**

Comment on Ly-81 and Ly-93: both samples come from bellow stalagmitic floor overlying *Ursuslic. Spelaeus* fauna. As expected, similar dates show that formation of stalagmitic floor began at end of Glacial time.

III. ARCHAEOLOGIC CHECK SAMPLES FOR A NEW BONE COLLAGEN PREPARATION METHOD

The following samples were measured to test a new method of bone treatment for their dating. Many studies were made to find methods of preparation, e.g., Haynes (1966), Berger, Horney, and Libby (1964), and Kruegger (1965) that would eliminate, by different chemical processes, many contaminants which can change results. These methods have disadvantages—either treatment is too strong (contaminants are well eliminated, but very often much collagen is destroyed), or contaminants are not fully eliminated.

The method perfected and described by R. Longin (1970) consists in extracting bone collagen selectively by using one of its specific physicochemical properties—its solubility in water at a very determined temperature and pH, after an acid pretreatment of bones. Bones, after crushing, are attacked with a solution of HCl 8% to eliminate the most important part of mineral substances (especially carbonates) and one of the main contaminants of fossil bones; pretreatment time is limited for not rendering soluble collagen. Extraction of collagen is obtained by heating and mixing the acidification residue with water at pH 3.0, for many hours. Only collagen goes through the solution and the impurities stay in the residue. Then, collagen is recovered by drying of the solution in an oven.

The number of bones to be treated is determined by a Kjedhal dosage. The yield of the total extraction is about 65 to 70%; it especially depends on crushing, acid pretreatment time, and dissolution time in water. Then, the pure gelatin obtained is burnt.

This method has the following advantages: rapidity of preparation (ca. 2 hr), simplicity of operations and employed substances, full elimination of contaminants, and an important yield. The technical process is fully described in the thesis and an abstract of this method will be published elsewhere.

To check the validity of dates obtained by this method (and elimination of any impurity), samples were chosen from different types of archaeologic sites (rock shelter or open air sites and calcareous or sandy layers) and the dated bones were assoc. with charcoals or burned bones on which the classical method of preparation had been made.

All measurements below show a perfect agreement between the obtained dates with bones and charcoals, and also with archaeologic data. The following table shows an easy comparison between the obtained results.

Sites	Collagen	Charcoal residue	Humic fraction
La Couronne Martigues	3970 ± 130	4060 ± 220	
Montclus layer 4	6140 ± 140	6300 ± 140	
Montclus layer 21	7780 ± 250	7890 ± 170	
Montclus layer 22	7750 ± 340	7770 ± 410	
St Remèze 378	11,500 ± 380	11,750 ± 300	12,080 ± 310
Les 2 Avens	12,350 ± 200	12,320 ± 600	
Solutré 9b, 8b	17,150 ± 300	16,740 ± 300	10,900 ± 400
St Martin sous Montaigu	22,900 ± 600	24,150 ± 550	21,100 ± 1300

La Couronne, Bouches du Rhone series

Samples from Layer 3D, Habitat 1 of the late Neolithic (Couronnien) village of Le Collet Redon at La Couronne, Bouches du Rhône (43° 21′ N Lat, 5° 4′ E Long). Coll. 1968 and subm. 1969 by M. Escalon de Fonton, Marseille (Escalon de Fonton, 1956). Samples coll. 80 cm below a permeable calcareous soil, were subject to rain water leaching for a long time.

Ly-301. La Couronne, I/3D, charcoal **4060 ± 220**

Pretreatment with HCl 2% and twice 15 h with NaOH 2% at 80°C.

Ly-303. La Couronne, I/3D, bone **3970 ± 130**

In spite of bone leaching, 300 g were sufficient to get 4.6 g of collagen. Average of Ly-301 and Ly-302: 4000 ± 110 B.P. = 2050 B.C. *General Comment* (M.E. deF.): agrees with expected age which corresponds to desertion of village and not to its foundation.

Montclus, Gard series

Samples from several levels of Rock-shelter La Baume de Monclus, Gard (44° 16′ N Lat, 4° 26′ E Long). Coll. 1960 and subm. 1969 by M. Escalon de Fonton. Layers contain Sauveterrian (Middle Mesolithic), Castelnovian (Late Mesolithic), Cardial and Epicardial (Late Neolithic) industries (Escalon de Fonton, 1967). Rock shelter is near La Cèze R. and deposits often overflowed.

Ly-303. Montclus, No. 3a, Layer 4, charcoal 6300 ± 140

Ly-304. Montclus, No. 3b, Layer 4, bone 6140 ± 140

4.35 g; collagen from 320 g bone. Average of Ly-303 and Ly-304: 6220 ± 100 B.P. = 4270 B.C. *Comment* (M.E.F.): this layer contains a late Cardial industry with which date agrees well.

Ly-305. Montclus, No. 25a, Layer 21 F, charcoal 7890 ± 170

Ly-306. Montclus, No. 25b, Layer 21 F, bone 7780 ± 250

1.8 g; collagen from ca. 200 g bone. Average of Ly-303 and Ly-306: 7780 ± 140 B.P. = 5830 B.C.

Ly-307. Montclus, No. 27a, Layer 22, charcoal 7770 ± 410

Ly-308. Montclus, No. 27b, Layer 22, bone 7750 ± 340

1.5 g collagen from 190 g bone. Large statistical errors are due to small size of sample. Average of Ly-307 and Ly-308: 7760 ± 260 B.P. = 5810 B.C. *Comment on Ly-307 and Ly-308* (M.E.F.): Layers 21 F and 22 contain a regional Sauveterrian (Montclusian) industry. Dates may be compared with Kn-58: 8130 ± 240 from the same Layer 22. They are a little younger than Upper Sauveterrian dates at Rouffignac, Dordogne, GrN-2913: 8370 ± 100 (R., 1963, v. 5, p. 175).

Saint Remèze, Ardèche series

Samples from Layer D at Rock-shelter le Saut du Loup (or Abri Dumas) near Saint Remèze, Ardèche (44° 20′ N Lat, 4° 32′ E Long). Coll. and subm. 1969 by J. Combier Romanèche-Thorins, Saône et Loire. Layer contains a large rabbit fauna assoc. with Azilian industry (Combier, 1963). Samples come from 1.07 m below calcareous pebbles without any water circulation.

Ly-318. Saint-Remèze, a) charcoal 11,750 ± 300

Ly-319. Saint Remèze, b) humus fraction 12,080 ± 310

Ly-320. Saint Remèze, c) bone 11,500 ± 380

155 g bone treated in several parts gave 2.1 g collagen. Average of Ly-318 and Ly-320: 11,650 ± 240 B.P. = 9700 B.C. *Comment* (J.C.): date a little older than expected with respect to regional Late Magdalenian dates (e.g., Ly-321, 322, this list). It seems very possible because this old Azilian industry might succeed to Late Magdalenian at end of Allerød period.

Les Deux Avens, Ardèche series

Samples from Level C in Les Deux Avens grotto near Vallon-Pont-d'Arc, Ardèche (44° 23′ N Lat, 4° 24′ E Long). Coll. and subm. 1969 by J. Combier. Assoc. with industry precisely dated Late Magdalenian VI² and certainly before Allerød period (Combier, 1963). Level is inside a deep calcareous cave; it is sandy with recrystallized calcite.

Ly-321. Les Deux Avens, a) charcoal **12,320 ± 600**

Very small sample.

Ly-322. Les Deux Avens, b) bone **12,350 ± 200**

5.0 g collagen from 545 g bone. Average of Ly-321 and Ly-322: 12,340 ± 200 B.P. = 10,390 B.C. *Comment* (J.C.): agrees with other Late Magdalenian dates, as expected, just before Allerød period (ca. 12,000 to 11,000 B.P.) Compare with Layer 2 at La Grotte de la Vache near Alliat, Ariège, GrN-2025: 12,540 ± 105 (R., 1963, v. 5, p. 168).

Solutré series, Saone et Loire

Samples from several places and levels of the site Solutré, Saōne et Loire (46° 18′ N Lat, 4° 43′ E Long). Coll. and subm. 1969 by J. Combier. Site is mainly composed of a thick mass of horse bones in a large rock-rubble at foot of a limestone cliff. Some layers below a few thicknesses of soil were subject to rain-water leaching. Settlement was occupied from Mousterian to Late Magdalenian.

Ly-314. Solutré No. 8 b1) burned bone, residue **16,740 ± 300**

Ly-315. Solutré No. 8 b2) burned bone humic fraction **10,900 ± 400**

Ly-316. Solutré No. 9 b) Unburned bone **17,150 ± 300**

Average of Ly-314 and Ly-316: 16,950 ± 220 B.P. = 15,000 B.C. Comparison between Ly-315 and Ly-316 proves that humic fraction is fully eliminated in bone collagen. *Comment* (J.C.): samples come from upper part of layer containing a Middle Solutrean industry. Date, 2000 yr younger than Middle Solutrean at Laugerie-Haute Dordogne (GrN-4442: 19,600 ± 140, R., 1967, v. 9, p. 116). Date needs confirmation, but late age is possible in region.

Ly-317. Solutré No. 11, Sondage C, unburned bone **24,050 ± 600**
22,100 B.C.

Comment (J.C.): expected age was Aurignacian, but those bones may belong to Upper Perigordian layers called "Magma de Cheval". This date agrees with Dordogne, e.g., Perigordian VI at Abri Pataud, GrN-4721: 23,010 ± 170 (R., 1967, v. 9, p. 114) and agrees also with Saint-Martin Sous Montaigu, Ly-309-311.

Ly-12. Solutré No. 4, Layer 6, small unburned broken bones **28,650 ± 1100** **26,700 B.C.**

3.4 g collagen from 300 g bone.

Ly-313. Solutré No. 5, Layer 6, unburned bone **22,650 ± 500**

3.5 g collagen from 300 g bone. *Comment* (J.C.): both samples from Upper Perigordian "Magma de Cheval" level. Ly-313 agrees with Ly-317. Ly-312 is too old but these small bones come from a place in site where they might be mixed with older small bones (may be Aurignacian).

Saint Martin Sous Montaigu series, Saone et Loire

Samples from hearth at Les Vignes du Chateau Beau, near Saint Martin sous Montaigu, Saône et Loire (46° 49′ N Lat, 4° 42′ E Long). Coll. and subm. by J. Combier. Site is similar and close to Solutré. Samples were from level resembling "Magma de Cheval" of Solutré and assoc. with Upper Perigordian Pointe de Font-Robert faciès (Combier, 1962).

Ly-309. Saint Martin Sous Montaigu, a) burned bone residue **24,150 ± 550**

Ly-310. Saint Martin Sous Montaigu, b) burned bone humic fraction **21,100 ± 1300**

Ly-311. Saint Martin Sous Montaigu, c) unburned bone **22,900 ± 600**

Average of Ly-309 and Ly-311: 23,550 ± 400 B.P. = 21,600 B.C. Comparison between Ly-310 and Ly-311 proves full elimination of humic fraction by bone collagen preparation. *Comment* (J.C.): agrees with expected age and confirms similarity with "Magma de Cheval" level of Solutré. Compare with Ly-317 and with Layer 3, Lens 2a, Abri Pataud, GrN-4721: 23,010 ± 170 (R., 1967, v. 9, p. 114).

Abri Pataud series, Dordogne

Unburned bone from Layer 5 (Perigordian IV) at Abri Pataud, near Les Eyzies, Dordogne (44° 56′ N Lat, 1° 0′ E Long). Coll. by H. L. Movius and subm. 1968 by J. C. Lerman, Radiocarbon Lab., Groningen. That sample previously measured, GrN-4631: 21,780 ± 215 (R., 1967, v. 9, p. 114) was estimated too young with respect to other measurements 5000 yr older from same Level 5.

Ly-100. Abri Pataud, Layer 5, No. 1 **23,800 ± 800** **21,850 B.C.**

Collagen extracted by H_2SO_4 and Na_2SO_4.

Ly-300. Abri Pataud, Layer 5, No. 2 **22,000 ± 1000** **20,050 B.C.**

Collagen extracted by method described above. *Comment*: Ly-300 agrees better than Ly-100 with GrN-4631. Both new values confirm younger than expected age of that sample.

Prélétang series, Isère

Very calcified bones, from Mousterian *Ursuslic. Spelaeus* level in Grotte de Prélétang near Presle, Isère (45° 04′ N Lat, 5° 25′ E Long). Coll. and subm. 1969 by P. Lequatre, Saint-Marcellin, Isère.

Ly-167. Prélétang, Layer 9, bone collagen fraction ⩾32,000

Ca. 2 g collagen from 100 g bone.

Ly-167 bis. Prélétang, Layer 9, bone carbonate fraction 3810 ± 160

Comment: amount of collagen shows that calcification by recent water (Ly-167 bis) did not affect bone organic fraction. Null activity of Ly-167 proves that bone collagen extraction method eliminates carbonate fraction completely.

IV. WATER SAMPLES

Le Chêne series, Vaucluse

The following samples were pumped from a well at Le Chêne near Apt, Vaucluse (43° 41′ N Lat, 5° 20′ E Long) in 1968 and 1969 to practice a periodical C^{14} and T^3 surveillance. This well, bored at the end of 1967, gives water from the old-water reserve which contributes to the feeding of the huge intermittent spring, Fontaine de Vaucluse, at the low-water period (Margrita *et al.*, 1970). δC^{13} was measured by R. Letolle, Lab. de Géol. Dynamique, Fac. Sci., Paris. Results are given as % of modern without any correction.

Sample	Collection date (mo/day/yr)	C^{13}	C^{14} (% of modern)
Ly-98. Le Chêne I	4/17/68		35.5% ± 1.0
Ly-99. Le Chêne II	4/17/68	−8.80‰	48.5% ± 1.1
Ly-136. Le Chêne III	11/13/68		39.9% ± 0.9
Ly-137. Le Chêne IV	11/13/68		49.3% ± 1.2
Ly-184. Le Chêne V	03/05/69	−9.19‰	48.8% ± 1.3
Ly-230. Le Chêne VI	04/30/69		44.1% ± 0.8
Ly-231. Le Chêne VII	07/09/69		43.7% ± 0.8
Ly-244. Le Chêne VIII	10/28/69		46.8% ± 1.7
Ly-245. Le Chêne IX	11/17/69		45.1% ± 0.8

General Comment: first values (Le Chêne I to Le Chêne IV) show perturbations caused by boring the well. Afterwards, C^{14} content of the water remains constant (ca. 45% of modern), but T^3 values show mixing with ca. 20% of modern water in the well.

Ly-138. Fontaine de Vaucluse 93.8 ± 1.6% of modern

Water from the spring Fontaine de Vaucluse (43° 44′ N Lat, 5° 07′ E Long) coll. 1968 by J. Evin. *Comment*: may be compared to Ly-29:

91.5 ± 3.0% and Ly-30: 93.7 ± 3.0%, both samples coll. in 1967 (R., 1969, v. 11, p. 116).

Ground water of the Albien in the Paris Bassin series

Measurements listed here were made in 1966-1970 in a hydrogeologic study of confined ground water of the Albien in the Paris Bassin. This study, set up by the Bureau de Recherches Géol. et Min., (which assumed financial support), was made to test the use of C^{14} in a wide (several hundred km^2) and sandy aquifer.

Selection of sampling points, samplings, supervision of chemical preparations and hydrogeologic and chemical studies were made by Y. Vuillaume, of the Bureau La Source-Orléans, Loiret.

Most samples were treated classically by metallic tank to precipitate $BaCO_3$ at the sampling place. But for Ly-224/249-247/250-223/248, the CO_2 was extracted from the water by acidification in the radiocarbon lab. to test the tank for pollution which could be sensitive in case of low activity. Almost all the samples come from the Albien aquifer, except Ly-66, 67, 188, 221, and 203 which come from an underlying aquifer, and Ly-225 and 227, from an overlying one.

Radiocarbon content is reported as % of modern without correction from the δC^{13} measured by R. Letolle.

SE region: Bourgogne

Sample	Collection date	C^{13}	C^{14} % of modern
Ly-21. Parly-Chenons Alb2 (47° 46′ N Lat, 3° 21′ E Long)	10/66		94.7 ± 0.7
Ly-32. Parly-Bernier Alb4 (47° 46′ N Lat, 3° 21′ E Long)	10/66		86.7 ± 0.7
Ly-22. Poilly S/Thollon Alb3 (47° 52′ N Lat, 3° 23′ E Long)	10/66		91.7 ± 1.0
Ly-226. Dracy 401 (47° 45′ N Lat, 3° 15′ E Long)	7/69	−13.9‰	66.7 ± 1.0
Ly-213. Chichery 397 (47° 54′ N Lat, 3° 31′ E Long)	4/66	−17.7‰	53.2 ± 1.8
Ly-208. Chichery 391/395 (47° 54′ N Lat, 3° 31′ E Long)	7/69	−13.0‰	58.0 ± 1.1
Ly-85. Migennes 263 (47° 58′ N Lat, 3° 31′ E Long)	10/67		46.6 ± 1.0
Ly-210. Migennes 392 (47° 58′ N Lat, 3° 21′ E Long)	7/69		67.3 ± 0.9

Sample	Collection date	C^{13}	C^{14} % of modern
Ly-108. Montbouy 262/269 (47° 52′ N Lat, 2° 49′ E Long)	10/67		28.9 ± 0.5
Ly-186. Neuilly 371/374 (48° 04′ N Lat, 3° 25′ E Long)	3/69	−15.0‰	15.9 ± 0.6
Ly-109. Fleury 268 (47° 52′ N Lat, 3° 26′ E Long)	11/67		14.9 ± 0.7
Ly-187. Champvallon 375/376 (47° 56′ N Lat, 3° 20′ E Long)	3/69	−12.8‰	13.6 ± 0.7
Ly-66. Appoigny 264 A (47° 53′ N Lat, 3° 31′ E Long)	10/67		12.7 ± 1.0
Ly-67. Appoigny 264 B (47° 53′ N Lat, 3° 31′ E Long)	10/67		11.6 ± 0.8
Ly-188. Appoigny 377/378 (47° 53′ N Lat, 3° 31′ E Long)	3/69	−18.3‰	0.6 ± 0.4
Ly-86. Grande Paroisse 258 (48° 23′ N Lat, 2° 35′ E Long)	10/67		10.6 ± 0.6
Ly-125. Grande Paroisse 304/305 (48° 23′ N Lat, 2° 35′ E Long)	3/68		9.5 ± 0.8
Ly-228. Grande Paroisse 403 (48° 23′ N Lat, 2° 35′ E Long)	7/69	−10.2‰	3.2 ± 0.5
Ly-209. Bussy en Othe 393 (48° 01′ N Lat, 3° 30′ E Long)	7/69	−10.2‰	4.5 ± 0.4
Ly-225. Grand-Chaumont 402 (47° 51′ N Lat, 3° 19′ E Long)	7/69	−13.2‰	95.6 ± 1.1
Ly-227. Froville 400 (47° 51′ N Lat, 3° 16′ E Long)	7/69	−12.7‰	72.5 ± 0.9
E region: Champagne			
Ly-219. Nuisement 387 (48° 35′ N Lat, 4° 44′ E Long)	6/69	−11.7‰	84.3 ± 1.1
Ly-218. Humbécourt 386 (48° 35′ N Lat, 4° 54′ E Long)	6/69	−12.1‰	76.9 ± 0.8
Ly-222. Chaudefontaine 390 (49° 66′ N Lat, 4° 52′ E Long)	6/69	−13.3‰	74.8 ± 0.9
Ly-220. Voilecomte 388 (48° 41′ N Lat, 4° 51′ E Long)	6/69	−14.8‰	66.3 ± 1.0

Sample	Collection date	C^{13}	C^{14} % of modern
Ly-217. Montier en Der 385 (48° 29′ N Lat, 4° 46′ E Long)	6/69		52.8 ± 0.8
Ly-216. Dompremy 384 (48° 44′ N Lat, 4° 43′ E Long)	6/69	−9.0‰	17.9 ± 0.9
Ly-221. Sainte Menehould 389 (49° 06′ N Lat, 4° 53′ E Long)	6/69		1.4 ± 0.4
S and W regions: Orléannais and Normandie			
Ly-71. Barlieu 266 (47° 30′ N Lat, 2° 38′ E Long)	10/67		82.1 ± 1.3
Ly-205. Bemecourt 381 (48° 51′ N Lat, 0° 53′ E Long)	5/69	−13.7‰	75.5 ± 1.0
Ly-204. Thiberville 380 (49° 08′ N Lat, 0° 27′ E Long)	5/69	−13.0‰	65.3 ± 0.8
Ly-206. Brou 382 (48° 13′ N Lat, 1° 10′ E Long)	5/69	−9.0‰	52.0 ± 0.8
Ly-207. Chateaudun 383 (48° 03′ N Lat, 1° 24′ E Long)	5/69	−5.7‰	40.9 ± 0.8
Ly-74. Blancafort 267 (47° 32′ N Lat, 2° 32′ E Long)	10/67		42.2 ± 1.2
Ly-111. La Chapelle d'Angillon 274 (47° 22′ N Lat, 2° 26′ E Long)	11/67		34.2 ± 0.9
NW regions: Haute-Normandie			
Ly-146. Gauciel 318 (49° 02′ N Lat, 1° 14′ E Long)	7/68	−9.9‰	37.5 ± 0.8
Ly-141. Le Marais Vernier 326 (49° 26′ N Lat, 0° 28′ E Long)	7/68	−14.3‰	36.9 ± 0.9
Ly-147. Vernon 317 (49° 06′ N Lat, 1° 26′ E Long)	7/68	−8.3‰	21.7 ± 0.6
Ly-144. Les Loges 322 (49° 42′ N Lat, 0° 17′ E Long)	7/68	−9.6‰	15.9 ± 0.4
Ly-143. Saint Pierre en Port 323 (49° 48′ N Lat, 0° 29′ E Long)	8/68	−11.4‰	16.0 ± 2.0
Ly-145. Le Trait 319 (49° 28′ N Lat, 0° 49′ E Long)	7/68	−10.9‰	12.4 ± 0.7

Sample	Collection date	C^{13}	C^{14} % of modern
Ly-215. Mantes 399 (48° 59′ N Lat, 1° 40′ E Long)	3/69		11.8 ± 1.4
Ly-110. Pont de l'Arche 272 (49° 18′ N Lat, 1° 09′ E Long)	11/67		7.2 ± 0.7
Ly-181. Honfleur 325 (49° 25′ N Lat, 0° 14′ E Long)	7/68	−13.3‰	78.6 ± 1.4
Ly-142. Le Crotoy 324 (50° 13′ N Lat, 3° 04′ E Long)	7/68	−17.1‰	31.7 ± 0.9
Ly-203. Incarville 379 (49° 14′ N Lat, 1° 10′ E Long)	5/69	+2.9‰	1.4 ± 0.4
Central region: Ile de France			
Ly-121. Epinay 298 (48° 57′ N Lat, 2° 19′ E Long)	3/68	−14.2‰	9.7 ± 1.4
Ly-40. Villeneuve La Garenne 236 (48° 56′ N Lat, 2° 20′ E Long)	6/67		9.1 ± 0.5
Ly-124. Achères 302 (48° 58′ N Lat, 1° 53′ E Long)	3/68	−16.3‰	8.9 ± 0.2
Ly-119. Ivry (48° 49′ N Lat, 2° 23′ E Long)	1/68	−13.3‰	8.5 ± 0.1
Ly-120. Orsay 284 (48° 43′ N Lat, 2° 10′ E Long)	1/68	−10.7‰	7.8 ± 0.8
Ly-126. Le Pecq 303 (48° 53′ N Lat, 2° 06′ E Long)	3/68	−14.3‰	7.3 ± 1.3
Ly-37. Pantin 214/226 (48° 54′ N Lat, 2° 15′ E Long)	12/66	−15.3‰	6.4 ± 0.1
Ly-211. Issy 394 (48° 50′ N Lat, 2° 16′ E Long)	7/69	−15.0‰	3.7 ± 0.4
Ly-122. Noisy le Grand 299 (48° 48′ N Lat, 2° 32′ E Long)	3/68	−14.1‰	3.5 ± 0.5
Ly-224/249. Noisy le Grand L. 310 (48° 48′ N Lat, 2° 32′ E Long)	8/69		3.7 ± 0.4
Ly-23. Paris O.R.T.F. Alb1 (48° 52′ N Lat, 2° 18′ E Long)	10/66		8.8 ± 0.3
Ly-214. Paris O.R.T.F. 398 (48° 52′ N Lat, 2° 18′ E Long)	2/67	−12.2‰	3.2 ± 0.5

Sample	Collection date	C^{13}	C^{14} % of modern
Ly-123. Aulnay Sous Bois 300 (48° 57′ N Lat, 2° 30′ E Long)	3/68	−16.4‰	2.7 ± 0.1
Ly-212. Aulnay Sous Bois 396 (48° 57′ N Lat, 2° 30′ E Long)	7/69	−9.5‰	1.0 ± 0.4
Ly-247/250. Aulnay Sous Bois L. 382 (48° 57′ N Lat, 2° 30′ E Long)	10/69	−10.6‰	2.6 ± 0.3
Ly-223/248. Viry Chatillon L. 309 (48° 40′ N Lat, 2° 23′ E Long)	8/69	−12.8‰	2.1 ± 0.5

General Comment (J.E. and Y.V.): a map of these results in isorad curves shows the feeding zones along the entire periphery of the bassin and the general flow in the direction of the central or the NW regions. In the SE region, great differences of radioactivity along short distances show that feeding of the reservoir occurs through clay overlying the aquifer (Evin and Vuillaume, 1970).

Ground water of the Calcaires de Champigny series, Seine et Marne

The following samples measured in 1967-1969 were sent by the Dept. d'Hydrogéol. du Bur. de Recherches Géol. et Min. All come from free ground water in the limestone Calcaire de Champigny, ca. 20 km SE of Paris. Y. Vuillaume assumed sampling and chemical treatment.

Sample	Collection date	C^{14} % of modern
Ly-78. Brie Comte Robert 292 (48° 41′ N Lat, 2° 26′ E Long)	3/68	126.8 ± 1.2
Ly-172. Brie Comte Robert 339 (48° 41′ N Lat, 2° 26′ E Long)	1/69	139.2 ± 2.0
Ly-102. Presles en Brie 286 (48° 43′ N Lat, 2° 44′ E Long)	3/68	97.6 ± 1.5
Ly-179. Presles en Brie 330 (48° 43′ N Lat, 2° 44′ E Long)	1/69	102.6 ± 1.6
Ly-175. Mardilly 336 (48° 39′ N Lat, 2° 38′ E Long)	1/69	94.7 ± 1.5
Ly-174. Saint Hillier 337 (48° 38′ N Lat, 3° 15′ E Long)	1/69	93.0 ± 1.4
Ly-107. Combe la Ville 291 (48° 40′ N Lat, 2° 33′ E Long)	3/68	84.7 ± 1.5
Ly-176. Pont du Diable 335 (48° 39′ N Lat, 2° 38′ E Long)	1/69	83.2 ± 1.4

Sample	Collection date	C^{14} % of modern
Ly-104. Rouilly 288 (48° 36′ N Lat, 3° 17′ E Long)	3/68	70.1 ± 1.1
Ly-173. Rouilly 338 (48° 36′ N Lat, 3° 17′ E Long)	1/69	77.5 ± 1.5
Ly-103. Neufmoutier 287 (48° 46′ N Lat, 2° 50′ E Long)	3/68	72.5 ± 1.1
Ly-178. Neufmoutier 332 (48° 46′ N Lat, 2° 50′ E Long)	1/69	52 ± 6
Ly-46. Nangis 242/243 (48° 33′ N Lat, 3° 01′ E Long)	9/67	58.6 ± 1.4
Ly-44. Nangis 249 (48° 33′ N Lat, 3° 01′ E Long)	9/67	66.7 ± 0.5
Ly-105. Nangis 289 (48° 33′ N Lat, 3° 01′ E Long)	3/68	64.4 ± 1.1
Ly-101. Chevry Cossigny 285 (48° 43′ N Lat, 2° 41′ E Long)	3/68	45.6 ± 0.9
Ly-177. Chevry Cossigny 333 (48° 43′ N Lat, 2° 41′ E Long)	1/69	43.0 ± 1.0

Samples from the same well at La Ferté Alais (48° 29′ N Lat, 2° 21′ E Long).

Ly-56. La Ferté 250	9/67	12.5 ± 0.5
Ly-57. La Ferté 251	9/67	9.6 ± 0.7
Ly-58. La Ferté 253	9/67	6.0 ± 0.9
Ly-59. La Ferté 255	9/67	7.7 ± 0.6
Ly-79. La Ferté 293	3/68	8.2 ± 1.6
Ly-106. La Ferté 290	3/68	9.1 ± 0.1
Ly-161. La Ferté 348	1/69	4.4 ± 0.6
Ly-162. La Ferté 347	1/69	3.4 ± 0.7
Ly-163. La Ferté 346	1/69	8.2 ± 0.6

General Comment: most of these values are rather high. This fits with the fact that the ground water is free and with rather quick renewal except at La Ferté Alais, where radioactivity is low and ground water is confined without flow.

Villeneuve La Garenne series, Hauts de Seine

Samples from Lutetien and Sparnacien aquifer at Villeneuve La Garenne (48° 56′ N Lat, 2° 20′ E Long).

	Sample	Collection date	C^{14} % of modern
Ly-45.	Villeneuve-Lutetien 235	9/67	58.9 ± 1.0
Ly-39.	Villeneuve-Sparnacien 234	9/67	56.4 ± 1.1
Ly-127.	Villeneuve-Lutetien 297	3/68	61.2 ± 2.2
Ly-128.	Villeneuve-Sparnacien 296	3/68	56.9 ± 2.1
Ly-183.	Villeneuve-Lutetien 341	1/69	63.3 ± 1.2
Ly-180.	Villeneuve-Sparnacien 340	1/69	62.8 ± 1.0

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[RADIOCARBON, VOL. 13, NO. 1, 1971, P. 74-77]

RADIOCARBON, LTD.
NATURAL RADIOCARBON MEASUREMENTS I

CHARLES S. TUCEK

Radiocarbon, Ltd., Spring Valley, New York

Radiocarbon, Ltd. is a privately owned laboratory designed to provide quality service to the archaeologic and geologic communities. Operations began in 1969 using standard techniques for preparation, conversion to CO_2, and purification of samples prior to counting. A sample is counted as CO_2 in each of two identical proportional counters of volume 2.2 L, built on the design of Östlund and Engstrand (1963); each counter has its own multi-anode guard ring, and is housed in a common shield of iron 8 in. thick.

CO_2 from anthracite is used to monitor the background count rate, and the NBS oxalic acid standard is used (0.95 A_{OX}) as the contemporary count rate reference. Statistical counting variations are quoted to one sigma standard deviation, and the radiocarbon age is based on the C^{14} half-life of 5570 ± 30 yr.

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I would like to thank Wallace S. Broecker of the Lamont-Doherty Geological Observatory and Paul E. Damon of the University of Arizona for supplying interlaboratory check samples, and for giving timely encouragement. L-607-B, reported as 11,790 ± 100 (Broecker and Farrand, 1963) was dated at 11,560 ± 260 (RL-10); and A-773, reported as 5010 ± 60 (Damon, written commun.) was dated at 4990 ± 150 (RL-12).

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Western United States

Lincoln County (Site 26LN126) series, Nevada

Charcoal and charred wood samples from Site 26LN126 (37° 30′ N Lat, 114° 30′ W Long), 5 mi S of Caliente, Nevada. Coll. 1969 and subm. by D. D. Fowler, Desert Research Inst., Univ. of Nevada, Reno.

230 ± 100
RL-36. 26LN126, FS-6 **A.D. 1720**

Charcoal from hearth in Level I, depth 50 cm. *Comment* (D.D.F.): stratum from which sample was taken contained Shoshonean ceramics and Desert Side-Notched points.

1050 ± 100
RL-37. 26LN126, FS-64 **A.D.900**

Charred wood from hearth in Level II, depth 1.35 m. *Comment* (D.D.F.): sample assoc. with Fremont ceramics.

940 ± 100
RL-38. 26LN126, FS-91 **A.D. 1010**

Charcoal from hearth area in Level III, depth 2.5 m. *Comment* (D.D.F.): sample assoc. with Fremont ceramics.

2050 ± 110
RL-39. 26LN126, FS-155 **100 B.C.**

Charcoal from hearth area in Level IV, depth 3.0 m. *Comment* (D.D.F.): sample assoc. with late Desert Archaic points.

2090 ± 100
RL-40. 26LN126, FS-154 **140 B.C.**

Charcoal from hearth area in Level V, depth 3.5 m. *Comment* (D.D.F.): sample assoc. with Elko series Desert Archaic point types.

1980 ± 110
RL-41. 26LN126, FS-163 **30 B.C.**

Charcoal from hearth area in Level V, depth 3.5 m. *Comment* same comment as for RL-40, for which this sample appears to be a duplicate.

970 ± 120
RL-47. Lincoln County (Site 26LN407), Nevada **A.D. 980**

Charcoal from midden deposit, depth 70 cm, at Site 26LN407 (37° 34′ N Lat, 114° 33′ W Long), 22 mi ENE of Caliente, Nevada (Sample FS-57). Coll. 1969 and subm. by D. D. Fowler. *Comment* (D.D.F.): sample from open site at 7000 ft elev. assoc. with Fremont ceramics.

B. Eastern United States

3660 ± 110
RL-32. Bluffton-1, Florida **1710 B.C.**

Celt (*strombus gigas*) (made from lip of shell) from Bluffton site on St. Johns R., Florida (20° 5′ 0″ N Lat, 81° 30′ 2″ W Long), in bottom of fiber-tempered ceramic zone in 14 ft sec. Coll. 1955 and subm. by R. P. Bullen, Florida State Mus., Gainesville. *Comment* (R.P.B.): should date beginning of plain fiber-tempered ceramic period of Florida, earliest phase of the Orange period. Date is earliest demonstrably assoc. ceramic date for Florida (Bullen, 1958).

C. West Indies

710 ± 100
RL-26. Lavoutte-1, St. Lucia **A.D. 1240**

Shell (*strombus gigas*) from shore of Anse Lavoutte at extreme NE side of St. Lucia, Windward Is. (Lesser Antilles) (14° 24′ 0″ N Lat, 60° 55′ 30″ W Long), in buried Amerindian shell midden ca. 8 in. thick. Coll. 1968 and subm. by R. P. Bullen. *Comment* (R.P.B.): dates Suazey ceramic complex and Cap Estate figurine; Suazey is latest known pre-Columbian complex of Lesser Antilles (Bullen and Bullen, 1970).

RL-27. Banana Bay-1, Baliceaux Island **720 ± 100**
A.D. 1230

Shell (*strombus gigas*) from Banana Bay on W side of Baliceaux I., Grenadines (Lesser Antilles) (12° 57′ 0″ N Lat, 61° 9′ 10″ W Long), in buried Amerindian midden, 8 to 10 in. thick. Coll. 1969 and subm. by R. P. Bullen. *Comment* (R.P.B.): dates Suazey ceramic complex, proves midden not that of Black Caribs coll. at Baliceaux by British in 1797 before they were taken to Honduras; checks RL-26 with similar ceramic complex.

RL-28. Kingstown Post Office-1, St. Vincent **1790 ± 100**
A.D. 160

Shell (*strombus gigas*) from behind Kingstown post office on St. Vincent, Windward Is. (Lesser Antilles) (13° 9′ 10″ N Lat, 61° 13′ 35″ W Long), in midden deposit buried by volcanic ash, assoc. with Saladoid-like pottery. Coll. 1969 by Earle Kirby, Dept. of Agric., St. Vincent and subm. by R. P. Bullen. *Comment* (R.P.B.): dates early phase of Lesser Antillean Modified Saladoid period. As this is not the earliest ceramic complex, it implies pottery was introduced into Lesser Antilles well before instead of ca. time of Christ.

RL-29. Sabazan-1, Carriacou Island **940 ± 100**
A.D. 1010

Charcoal from Sabazan Amerindian site at extreme E end of Great Breteche Bay (E of Breteche) on S shore of Carriacou I., Grenadines (Lesser Antilles) (12° 28′ 0″ N Lat, 61° 26′ 20″ W Long), in higher level of a 3 to 4 ft thick stratigraphic sec. exposed by ocean erosion. Coll. 1969 and subm. by R. P. Bullen. *Comment* (R.P.B.): dates Terminal Saladoid pottery of Lesser Antilles; is a pre-Suazey complex date but may apply to Calviny complex intermediate between Terminal Saladoid (of the Lesser Antilles) and Suazey complexes.

General Comment (R.P.B.): data regarding RL-27-29 will be published in Wm. L. Bryant Foundation, Am. Studies, no. 8 (ms. in preparation).

Giraudy series, St. Lucia

Shells from Giraudy site at N side of Beane Field in S St. Lucia, Windward Is. (Lesser Antilles) (13° 44′ 0″ N Lat, 60° 56′ 30″ W Long). Coll. 1969 by A. K. Bullen and R. P. Bullen, Florida State Mus., and Eric Branford, St. Lucia Archaeol. and Hist. Soc.; subm. by R. P. Bullen.

RL-30. Giraudy-1 **1240 ± 100**
A.D. 710

Shell (*strombus gigas*) from disturbed upper zone of deposit, Trench 1. *Comment* (R.P.B.): in disturbed zone so that cultural identification not demonstrable, but it obviously applies to earlier phase at site, *i.e.*, pre-Suazey complex. See RL-31.

RL-31. Giraudy-2 **1120 ± 110**
A.D. 830

Shell (*strombus costatus*) from lower undisturbed part of deposit, Trench 1. *Comment* (R.P.B.): dates earlier occupation of site with a late Modified Saladoid or early Terminal Saladoid ceramic inventory. Is comfortably 100 yr earlier than RL-30 which was from a higher zone of the same trench.

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[RADIOCARBON, VOL. 13, No. 1, 1971, P. 78-83]

TARTU RADIOCARBON DATES V

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The following list includes samples dated in 1968 and 1969. Wood dating from A.D. 1850 ± 10 yr is used as contemporary reference standard. Background sample is synthesized from anthracite or shungite. All radiocarbon dates were calculated with C^{14} half-life of 5568 ± 30 yr. All dates are calculated from the year 1950.

I. GEOLOGIC SAMPLES

Remmeski series

Bog Remmeski 2 km SE of settlement Vastseliina, Võru Dist., Estonian SSR, formed under conditions of monticulate-morainic landscape of S Estonia. Bog with 118 ha area is composed of fen peat with average thickness 2.2 m (Veber *et al.*, 1961), at ca. +165 m. Sapropelite underlying peat indicates lacustrine origin of bog.

Samples coll. 1967 by E. Ilves, A. Sarv, Geol. Inst., Acad. Sci. of Estonian SSR and R. Pirrus, Geol. Inst., Acad. Sci. of Estonian SSR. Pollen analyses, after T. Nilsson (1961) by A. Sarv; botanical analyses by H. and J. Allikvee, Geol. Board, Estonian SSR.

TABLE 1
Stratigraphy of structure

Depth (cm)	Sediment type	Degree of decomposition (%)
0 to 95	wood and reed peat	55
95 to 105	wood and *Sphagnum* peat	45
105 to 135	wood and reed peat	50
135 to 215	reed peat	40
215 to 235	reed and *Bryales* peat	40
235 to 240	sedge peat	50
240 to 260	peat sapropel	—
260 to 283	sapropel, brown compact	—
283 to 285	sapropel, olive green, with plant remains	—
285 to 293	sapropel, brown compact	—
293 to 307	sapropel, olive green, containing aleurite with plant remains	—
307 to 355	aleurite, containing 4 to 6% carbon of organic origin	—

TA-205. Remmeski **2560 ± 90**
610 B.C.

Wood and reed peat at depth 20 to 25 cm. Pollen Zone SA_2.

TA-206. Remmeski **4550 ± 60**
2600 B.C.

Wood and reed peat at depth 55 to 60 cm. Boundary of Pollen Zones SB_2 and SB_1.

TA-207. Remmeski **5280 ± 60**
3330 B.C.

Wood and reed peat at depth 75 to 80 cm. Pollen Zone SB_2.

TA-208. Remmeski **5420 ± 70**
3470 B.C.

Wood and *Sphagnum* peat at depth 95 to 100 cm, Atlantic/Sub-Boreal contact.

TA-209. Remmeski **6180 ± 70**
4230 B.C.

Reed peat at depth 135 to 140 cm, Pollen Zone AT_2.

TA-210. Remmeski **6760 ± 70**
4810 B.C.

Reed peat at depth 180 to 185 cm. Boundary of Pollen Zones AT_1 and AT_2.

TA-211. Remmeski **7690 ± 70**
5740 B.C.

Sedge peat at depth 255 to 260 cm. Beginning of Pollen Zone AT_1 (transition of lacustrine stage to bog stage, empirical boundary of alder and spruce pollen, culmination of hazel pollen).

TA-212. Remmeski **8090 ± 80**
6140 B.C.

Sapropel at depth 260 to 265 cm, Boreal/Atlantic contact.

TA-213. Remmeski **8380 ± 80**
6430 B.C.

Sapropel at depth 265 to 270 cm. Boreal maximum of pine pollen.

TA-214. Remmeski **9610 ± 190**
7660 B.C.

Sapropel with plant remains at depth 300 to 305 cm, overlying contact of DR_3 and PB.

TA-215. Remmeski **10,740 ± 130**
8790 B.C.

Aleurite containing 6% of organic carbon at depth of 305 to 310 cm, lying immediately below contact of DR_3 and PB.

TA-216. Remmeski **10,770 ± 130**
8820 B.C.

Aleurite containing 4% of organic carbon at depth 340 to 350 cm. Pollen Zone DR_3.

TA-248. Kirbla **6860 ± 60**
4910 B.C.

Fragments of pine stump from Kirbla, 10 km NE of settlement Lihula, W Estonia. Structure of sec.: fine-grained yellowish-gray sand 122 cm thick, pine stump, varved clay. Pollen analysis by H. Kessel refers sample to Pollen Zone V, Nilsson system. Coll. 1968 by H. Kessel, Geol. Inst., Acad. Sci. of Estonian SSR, subm. by G. Eltermann, Geol. Board, Estonian SSR.

TA-249. Vitosha **2550 ± 60**
600 B.C.

Fragment of juniper buried by inter-morainic (?) bog on Vitosha Mt. near Sofia, Bulgaria. Depth of sample 0.6 m below ground surface. Coll. 1968 by A. V. Shnitnikov and K. Janakiev, Limnol. Lab., Leningrad State Univ.; subm. 1968 by A. V. Shnitnikov.

Shalkar series

Submerged wood remains near Lake Shalkar, Volodar Dist., Kokcheta Reg., Kazakh SSR. Samples coll. 1965 to 1968 and subm. by A. V. Shnitnikov, Limnol. Lab., Leningrad State Univ.

TA-250. Shalkar-1 **1095 ± 60**
A.D. 855

Submerged root from SW bank of lake, depth 140 cm above lake, overlain by lacustrine sand.

TA-257. Shalkar-2 **700 ± 65**
A.D. 1250

Stump from bank of NE inlet, in silt beneath sand.

TA-256. Shalkar-3 **960 ± 60**
A.D. 990

Tree trunk from head of SE inlet, beneath lacustrine sand.

TA-267. Shalkar-4 **430 ± 60**
A.D. 1520

Submerged pine stump from NE bank, depth of 3 m, overlain by lake sediment.

TA-268. Shalkar-5 **895 ± 65**
A.D. 1055

Buried tree trunk from Peninsula at S end. Sample lying at depth 180 cm is attributed to 6th submerged layer.

TA-264. Shalkar-13 **845 ± 60**
A.D. 1105

Tree trunk from NE bank, depth 175 to 183 cm.

TA-251. Sista **7470 ± 90**
5520 B.C.

Wood from right bank of Sista R. 300 m upstream from highway bridge in Leningrad Region. Structure of sec., according to H. Viiding: sand grains of various sizes 270 cm; peat with plant remains

45 cm; bluish-gray clay 60 cm; gravel moraine 100 cm; Cambrian deposits. Coll. 1968 and subm. by H. Viiding, Geol. Inst., Acad. Sci. of Estonian SSR.

39,700 ± 850
TA-254. Peedu **37,750 B.C.**

Woody peat from intermorainic bed near town Elva on NW elev. of Otepää, depth 760 to 780 cm. Coll. from borehole 1968 by J. M. Punning and E. Liivrand, Geol. Inst., Estonian SSR. *Comment*: dates of wood yielded 39,180 ± 1960 yr (TA-136, R., 1968, v. 10, p. 380).

31,200 ± 800
TA-254A. Peedu **29,250 B.C.**

Same as TA-254, age determined from extracted humic substances.

4900 ± 60
TA-259. Epu **2950 B.C.**

Peat from borehole 0.5 km N of Lake Tulisilla, Paide Dist., Estonian SSR. Depth 530 to 540 cm, from lower horizon of peat. Coll. 1968 by G. Kolmer and subm. by H. Elvre, Geol. Board.

6480 ± 60
TA-261. Eina **4530 B.C.**

Valves of *Cyprina islandica* from S shore of Eina Bay, Rõbachij Peninsula, Kola Peninsula. Stratigraphy of sec., according to B. I. Koshetchkin: pebble and gravel 280 cm; fine-grained sand 80 cm; fine sand with abundant mollusk valves; greenish-gray clay. Coll. 1968 and subm. by B. I. Koshetchkin, Geol. Inst., Kola branch of Acad. Sci. of SSSR.

8440 ± 70
TA-262. Joelähtme **6490 B.C.**

Woody peat from vicinity of village Jõelähtme, 35 km E of Tallinn, N Estonia. Structure of sec., according to H. Kessel: humified soil 50 cm; wood peat 16 cm; bluish-gray clay 8 cm; moraine. Sample depth 0 to 5 cm from roof of organic layer. Pollen analysis by H. Kessel. Coll. 1968 and subm. by H. Kessel. Sample attributed to Pollen Zone VIII.

8745 ± 75
TA-263. Joelähtme **6795 B.C.**

Woody peat from locality Jõelähtme (see TA-262). Sample lying at depth 11 to 16 cm (from roof of organic layer) is referred to Pollen Zone VIII.

34,500 ± 450
TA-270. Tchapoma **32,550 B.C.**

Shells from 35 km upstream from mouth of Tchapoma R., Kola Peninsula. Stratigraphy of sec., according to V. T. Evzerov; soil and plant layer 10 cm; thick-grained sand with gravel and pebble 580 cm; loam 335 cm; inequigranular sand 60 cm; pebble and rubble layer 180 cm; aleurite 220 cm; greenish-gray aleurite with shell fragments and intact valves 185 cm; down to river level 120 cm. At distance of 100 m upstream aleurite can be seen overlying reddish-brown loamy moraine. Coll. 1968 and subm. by V. J. Evzerov, Geol. Inst., Kola branch of Acad. of SSSR.

TA-271. Ponoi **33,650 ± 400**
31,700 B.C.

Shells from left bank of Ponoi R., Kola Peninsula. Coll. 1968 and subm. by V. J. Evzerov.

II. ARCHAEOLOGIC SAMPLES

TA-252. Daugmale **1700 ± 60**
A.D. 250

Charcoal from outer defense works of township Daugmale, Riga Dist. on left bank of Daugerva R., 22 km SE of city Riga, Latvian SSR. Sample from upper part of 12th layer of rampart, Putative archaeologic age: Bronze age, ca. 1000 yr. B.C. or more recent. Coll. 1967 and subm. by V. Urtan, Latvian State Mus. of Hist.

TA-253. Daugmale **1770 ± 80**
A.D. 180

Charcoal from township Daugmale (see TA-252) from lower part of 12th layer of rampart. Coll. 1967 and subm. by V. Urtan.

TA-265. Sarnate **4630 ± 70**
2680 B.C.

Wood from remains of dwelling in peat cutting settlement Sarnate, Ventspils Dist., 40 km S of town Ventspils, Latvian SSR. Probable age: Neolithic (middle or 2nd half of 3rd millennium B.C.; see TA-24, TA-26, R., 1966, v. 8, p. 434). Coll. 1959 by L. Vamcina, Latvian State Mus. of Hist.

TA-238. Tamula **890 ± 60**
A.D. 1060

Peat from upper horizon containing finds of Late Neolithic settlement Tamula (see TA-10, TA-28, R., 1966, v. 8, p. 433), 16 to 20 cm below surface. *Comment*: archaeologic age of settlement: 1st half of 2nd millennium. Date confirms formation of given layer by late reprecipitation. Coll. 1968 by A. Liiva; subm. by L. Jaanits, Inst. of Hist., Acad. Sci. of ESSR.

TA-237. Tamula **4300 ± 70**
2350 B.C.

Peat from lowest horizon of cultural layer of Late Neolithic settlement Tamula (See TA-238). Putative age: boundary of 3rd to 2nd millennium B.C. Coll. 1968 by A. Liiva; subm. by L. Jaanits.

TA-245. Sindi **9600 ± 120**
7650 B.C.

Wood from Mesolithic settlement Sindi (Pulli) near Sindi RR bridge, on right bank of town Pärnu (See TA-175, TA-176, R., 1968, v. 10,

p. 382). Sample from depth 320 cm below ground surface, from layer containing archaeologic finds. Coll. 1968 and subm. by L. Jaanits.

4830 ± 80
TA-242. Usvyata **2880 B.C.**

Wood from 4th horizon of cultural Layer B of Neolithic settlement Usvyata IV, Usvyata Dist., Pskov Region, RSFSR, on S outskirts of settlement Usvyata. Coll. 1964 and subm. by A. Miklyayev, State Hermitage of SSSR.

4510 ± 70
TA-244. Usvyta **2560 B.C.**

Wood from 3rd horizon of cultural Layer B of settlement Usvyata B. Sample taken from depth 125 cm below ground surface and belongs to same horizon as TA-105 which yielded age 4570 ± 70 (R., 1968, v. 10, p. 125). Coll. 1967 and subm. by A. Miklyayev.

4310 ± 80
TA-243. Usvyata **2360 B.C.**

Wood from 1st horizon of cultural Layer B of Neolithic settlement Usvyata IV, depth 70 cm below surface. Coll. 1967 and subm. by A. Miklyayev.

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TATA INSTITUTE RADIOCARBON DATE LIST VIII

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Given below are the dates of archaeologic and Quaternary samples measured by the proportional counting of methane gas. Details of the techniques used were published earlier (Agrawal *et al.*, 1965).

The half-life used is 5568 yr; the base year for converting dates on A.D./B.C. scale is 1950. Ninety-five per cent activity of the NBS oxalic acid is used as the modern standard.

*General Comment:** for the first time, the crucial Pre-Harappa site of Amri (Period IB) (Casal, 1964) has been dated to ca. 2900 B.C. (TF-864). Nindovari damb, a site of Kulli affiliation, gives ca. 2050 B.C. (TF-862). Bagor, a newly discovered Neolithic site of Rajasthan, has given a very early date of ca. 3800 B.C. (TF-1007). The material used was charred bones. More samples from this site are under processing. Inamgaon, a Chalcolithic site, has been placed ca. 1350 B.C. (TF-922 and -924). A few samples from the old workings of copper and gold mines too have been dated for the first time. Summaries of excavations appear in Lal (1967-69).

In connection with our Quaternary Project, a large number of samples from raised beaches, borings from the swamps (Singh, 1967) and the continental shelf of the Arabian coast have been dated. Samples were collected in collaboration with Birbal Sahni Inst. of Palaeobotany, Lucknow, Deccan College, Poona and Natl. Inst. of Oceanog., Goa. As a result of this program, a number of Late Quaternary eustatic events on the west coast have been dated. Climatic and ecologic reconstructions based on pollen also have been dated for Rajasthan and Bengal.

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

Amri series, West Pakistan

Amri (26° N Lat, 68° E Long), Dist. Dadu, was excavated by J. M. Casal, Mus. Guimet, Paris, who subm. the samples. Rootlets were handpicked and NaOH pretreatment was given in both samples.

4485 ± 110
TF-863. Amri culture **2535 B.C.**

Charcoal, Field Id. Ai A, Layer 19.

4710 ± 110
TF-864. Amri culture **2760 B.C.**

Charcoal, Field Id. Ai A10, Layer 28c.

* Dates based on half-life, 5730 yr.

5620 ± 125
TF-1007. Bagor, India, Neolithic deposits **3670 B.C.**

Charred bones from Bagor (25° 22′ N Lat, 74° 23′ E Long), Dist. Bhilwara, Trench EI, depth 1 m, Sample 4, Field No. BGR 1968-9/EI-4. Sample subm. by V. N. Mishra, Deccan College, Poona-6.

Bandlamottu Hill series, Andhra Pradesh

Bandlamottu Hill (16° 13′ N Lat, 79° 40′ E Long), Dist. Guntur, from old mine workings. Samples subm. by D. B. Sikka, Agnigundala Copper-Lead Project, Bollapalli. NaOH pretreatment given to both samples.

875 ± 80
TF-805. Old copper workings **A.D. 1075**

Burnt wood, Sample Ag/B/W/02.

635 ± 90
TF-806. Old copper workings **A.D. 1315**

Wood, Sample Ag/B/W/1.

Inamgaon series, Maharashtra

Inamgaon (18° 35′ N Lat, 74° 32′ E Long), Dist. Poona. The site was excavated by H. D. Sankalia, Deccan College, Poona, who subm. the samples.

2890 ± 170
TF-923. Chalcolithic culture **940 B.C.**

Charcoal from Mound 1, Trench C2, Layer 5, depth 1.8 m, Field No. 133. NaOH pretreatment was given.

3225 ± 200
TF-924. Chalcolithic culture **1275 B.C.**

Charcoal from section-scrappings from 1st and 2nd floors, Layer 2, Field No. 139. NaOH pretreatment was given.

3205 ± 100
TF-922. Chalcolithic culture **1255 B.C.**

Charcoal from Mound 1, Trench C3, Layer 5, depth 1.3 m, Field No. 63.

Kalibangan series, Rajasthan

The site of Kalibangan (29° 25′ N Lat, 74° 05′ E Long), Dist. Sri Ganganagar, has yielded remains of Pre-Harappa and Harappa cultures. Excavations are being jointly conducted by B. B. Lal and B. K. Thapar. Samples subm. by B. B. Lal, Dir. Gen. Archaeol., New Delhi-11. All samples were pretreated with NaOH.

4055 ± 110
TF-942. Harappa culture **2105 B.C.**

Charcoal from Trench KLB-2, Loc. XAI-QD4, Layer 12, depth 3.45 m, Field No. 1967-68/4/KLB-2.

TF-946. Harappa culture **3605 ± 100**
1655 B.C.

Wood charcoal from Trench KLB-2, Loc. ZNI, Qd1, Layer 7, depth 2.25 m, Field No. 1967-68/18/KLB-2.

TF-947. Harappa culture **3765 ± 85**
1815 B.C.

Wood charcoal from Trench KLB-2, Loc. G5, Qd3, Layer 34, depth 5.2 m, Field No. 1967-68/21/KLB-2.

TF-948. Harappa culture **3815 ± 100**
1865 B.C.

Wood charcoal from Trench KLB-2, Loc. C5, Qd3, Layer 22, depth 3.11 m, Field No. 1967-68/22/KLB-2.

TF-396. Kayatha, India, Chalcolithic culture **3575 ± 105**
1625 B.C.

Charcoal from Kayatha (23° 30′ N Lat, 76° E Long), Dist. Ujjain, Trench KTH-1, Layer 32, depth 8 m, Field No. 5. NaOH pretreatment was given. Sample subm. by V. S. Wakankar, Vikram Univ., Ujjain.

TF-879. Kolar Mine, India **1460 ± 110**
A.D. 490

Wood from Kolar mine (12° 57′ N Lat, 78° 16′ E Long), Dist. Kolar, No. 2 Shaft area. Subm. by M.G.A. Mine Champion Reefs, P.O., KGF-3, Mysore.

TF-759. Kotia, India, Late Quaternary **39.63 ± 1.6%**
Modern

Caliche from Kotia (21° 50′ N Lat, 73° 15′ E Long), Dist. Broach, from height 24.5 m, from freshly exposed sec. of Narmada R. Subm. by K. T. M. Hegde to date river terraces. *Comment*: geochemistry of caliche not understood, hence "dates" expressed in percentage terms.

TF-966. Kulur, India, River sediments **37,355 +5980 −3390**
35,405 B.C.

Root of tree from Gurpur R. sediments, Dist. Mangalore, depth 13.7 m, Sample 2, Field 2. Sample subm. by E. Nielson. *Comment*: NaOH pretreatment was given. Sample dates a river bed sediment.

TF-822. Meja Dam, India **125 ± 90**
A.D. 1825

Wood from Meja Dam (24° 52′ N Lat, 80° 24′ E Long), Dist. Mirzapur, depth 2 m, Field No. MEJA/4. Subm. by V. S. Krishnaswamy, Geol. Survey of India, Lucknow. NaOH pretreatment was given.

TF-862. Nindowari damb, West Pakistan, Kulli culture **3900 ± 105**
1950 B.C.

Charcoal from Nindowari (27° N Lat, 66° 30′ E Long), Dist. Khuzdar, from Trench ND, Layer 3, Field Id. ND. B1-XXIV. Site was excavated by J. M. Casal who subm. the sample. NaOH pretreatment was given.

Paiyampalli series, Madras

Paiyampalli (12° 33′ N Lat, 78° 25′ E Long), Dist. North Arcot; samples subm. by B. B. Lal.

2515 ± 100
TF-823. Megalithic **565 B.C.**

Charred grains and charcoal pieces in a pit on Floor 3, Trench B1, Loc. Qd2, Layer 4, depth 1.7 m, Field No. PMP/4. NaOH pretreatment was given.

785 ± 90
TF-824. Megalithic (?) **A.D. 1165**

Charcoal from Trench A2, Pit 6 sealed by Layer 4, depth 1.21 m, Field No. PMP/8. NaOH pretreatment was given.

695 ± 95
TF-825. Megalithic (?) **A.D. 1255**

Charcoal from Trench A2, Pit 1 sealed by Layer 5, depth 0.9 m, Field No. PMP/8. NaOH pretreatment was given.

3570 ± 105
TF-827. Neolithic (?) **1620 B.C.**

Charcoal from Trench A1, Pit 3 sealed by Layer 6A, depth 2 m. Field No. PMP/8. NaOH pretreatment was given.

2100 ± 95
TF-828. Megalithic **150 B.C.**

Charcoal from Trench A1, Layer 6A, depth 1.7 m, Field No. PMP/8. NaOH pretreatment was given.

985 ± 105
TF-829. Neolithic (?) **A.D. 965**

Charcoal from Trench A2, Pit 9 sealed by Layer 7, depth 1.3 m, Field No. PMP/8. NaOH pretreatment was given.

770 ± 100
TF-832. Neolithic (?) **A.D. 1180**

Charcoal from Trench A1, Layer 8, depth 1.9 m, Field No. PMP/8.

3215 ± 210
TF-833. Neolithic (?) **1265 B.C.**

Charcoal from Tr. XF1, Qdt. 2, Layer 8, depth 1.9 m, Field No. PMP/8. *Comment*: as the sample was small, anthracite was mixed for counting.

General Comment: considerable scatter shown by the C^{14} dates cannot be explained by contamination. A more controlled sampling of the site is indicated.

Palavoy series, Andhra Pradesh

Palavoy (14° 31′ N Lat, 77° 09′ E Long), Dist. Ananthpur. Samples subm. by H. D. Sankalia.

TF-699. Ashmound **Modern**

Carbonaceous clay from Layer 2. *Comment*: iron slag was found with sample.

3390 ± 95
TF-700. Neolithic **1440 B.C.**

Carbonaceous ash (dung) from Layer 7, depth 2.1 m, sample No. 2.

2660 ± 100
TF-861. Pirak, West Pakistan, Pirak Ware complex **710 B.C.**

Charcoal from Pirak (29° 30′ N Lat, 67° 54′ E Long), Dist. Kanchi, Layer 12, depth 1 m, Field PK.A. Site excavated by J. M. Casal who subm. sample. *Comment*: date agrees with Casal's estimate. NaOH pretreatment was given.

1975 ± 95
TF-921. Sonkh, India, Early historic deposits **25 B.C.**

Charcoal, Prob. I, Qdt. E/19, depth 11.6 m. Sample subm. by B. K. Thapar from Haertel's excavations of 1966/67.

10,095 ± 300
TF-803. Spirit Cave, Thailand, Mesolithic deposits **8145 B.C.**

Wood from Spirit Cave (20° N Lat, 98° E Long), Dist. Prov. Hongson, Loc. B3, Layer 3, depth 0.3 m, Field B3 (3). Sample subm. by C. F. Gorman, Archaeol. Lab., Hawaii, Honolulu.

II. QUATERNARY SAMPLES

+1300
27,050
−1100
TF-907. Aramra, Late Quaternary **25,100 B.C.**

Dead coral from surface near village of Aramra (22° 26′ N Lat, 69° 05′ E Long), Dist. Jamnagar, Field 24. Coll. by S. K. Gupta.

14,565 ± 185
TF-905(a). Bardia village, India, Late Quaternary **12,615 B.C.**

Shells from Bardia village (22° 11′ N Lat, 69° 02′ E Long). Dist. Jamnagar, from depth 2 m, Field Loc. 29. Coll. by S. K. Gupta.

5275 ± 105
TF-908. Bhimrana village, Late Quaternary **3325 B.C.**

Shells from Bhimrana village (22° 23′ N Lat, 69° 02′ E Long), Dist. Jamnagar, from raised beach, depth 1.25 m, Field Loc. 23. Coll. by S. K. Gupta.

General Comment: samples date eustatic changes as recorded by Kathiawar peninsula.

140 ± 90
TF-969. Off Bombay, India, continental shelf **A.D. 1810**

Coral from continental shelf off Bombay (18° 36′ N Lat, 70° 59′ E Long), depth 96 m, Field 42(b). Sample subm. by R. R. Nair, Natl.

Inst. Oceanog., Panaji, Goa. *Comment*: for studying Quaternary sea-level changes.

TF-814. Coondapoor town, India **>40,000**

Submerged mangrove plants from Coondapoor (13° 30′ N Lat, 74° 4′ E Long), Dist. S Kanara. Subm. by K. S. Karanth, Puttur, S Kanara. NaOH pretreatment was given. *Comment*: sample dates a marine transgression.

12,280 ± 165
TF-897(b). Dhrubya Hill, India Late Quaternary **10,330 B.C.**

Miliola tests from Dhrubya Hill, Dist. Kutch, from surface, Field 11/78. Coll. and subm. by S. K. Biswas, Oil Nat. Gas. Comm., Baroda.

Erangal—Bhatti series, Maharashtra

Erangal-Bhatti (18° 36′ N Lat, 70° 39′ E Long), Dist. Bombay. Samples coll. by D. P. Agrawal from raised beach.

4925 ± 100
TF-981. Late Quaternary **2975 B.C.**

Shells from depth 2.9 m, Sample 6, Field Pit 1.

2655 ± 90
TF-972. Late Quaternary **705 B.C.**

Shells from depth 0.6 m, Sample 2, Field 2/Pit 1.

1715 ± 95
TF-938. Late Quaternary **A.D. 235**

Shells from depth 0.8 m, Sample 3, Field Madh/2.

General Comment: above samples consist of consolidated comminuted shells from raised beach, which represents a Holocene transgression. TF-972 and -938 indicate some stratigraphic disturbance.

6640 ± 125
TF-915. Jhinjunvada, India, Late Quaternary **4690 B.C.**

Shells from Jhinjunvada (23° 24′ N Lat, 71° 32′ E Long), Dist. Surendra Nagar, from a brine well, depth 5.1 to 5.5 m. Sample coll. by S. K. Gupta. *Comment*: sample dates a Holocene regression in Little Rann of Kutch.

$$24,760 \begin{matrix} +1000 \\ -885 \end{matrix}$$
TF-898. Jura Hill, India, Late Quaternary **22,810 B.C.**

Miliola tests from surface of Jura Hill, Dist. Kutch, Field 11/61. Coll. and subm. by S. K. Biswas. *Comment*: sample dates miliolite formations of Gujarat.

8880 ± 125
TF-983. Continental shelf, off Karwar, India **6930 B.C.**

Mollusc shells from continental shelf off Karwar (10° 33′ N Lat, 73° 13′ E Long), depth below water surface 58.5 m, Sample 653. Sample subm. by R. R. Nair. *Comment*: sample dates a eustatic event.

Katral Hill series, Gujarat

Katral Hill, Dist. Kutch. Samples subm. by S. K. Biswas to date Kutch miliolite formations.

TF-893. Late Quaternary **28,595 $^{+1600}_{-1345}$**
26,645 B.C.

Miliola shells from surface, Field 11/26.

TF-892. Late Quaternary **32,530 $^{+2710}_{-2025}$**
30,580 B.C.

Miliola shells from depth 7.6 m, Field 11/92.

Kharagodha series, India

Kharagodha (23° 10′ N Lat, 71° 39′ E Long), Dist. Surendra Nagar. Samples coll. by S. K. Gupta from a brine well. Samples date Holocene marine regressions in Little Rann of Kutch.

TF-917. Late Quaternary **6835 ± 110**
4885 B.C.

Wood from Damod, depth 5.4 to 6.1 m, Loc. 2. NaOH pretreatment was given.

TF-919. Late Quaternary **5900 ± 105**
3950 B.C.

Shells from depth 2.6 to 2.9 m, Loc. 2.

TF-920. Late Quaternary **6860 ± 110**
4910 B.C.

Wood from depth 2.4 to 3.5 m, Loc. 1. NaOH pretreatment was given.

Kuda series, Gujarat

Kuda (23° 13′ N Lat, 71° 23′ E Long), Dist. Surendra Nagar. Samples coll. from brine well by S. K. Gupta to date marine regressions in Little Rann of Kutch.

TF-913. Late Quaternary **6315 ± 95**
4365 B.C.

Shells from depth 5.7 m, Loc. 17.

TF-914. Late Quaternary **5925 ± 105**
3975 B.C.

Shells from depth 7.9 to 8.2 m, Loc. 16.

Minicoy Island series

Minicoy I. (8° 18′ N Lat, 73° E Long). Samples coll. by S. G. Patil, Tata Inst. of Fundamental Research, Bombay, to date exposed coral reefs.

TF-1017. Exposed corals **1575 ± 85**
A.D. 375

Coral, pure aragonite, from depth 3 m. Sample 2, Field A5.

TF-1022. Exposed corals **Modern**

Coral, pure aragonite from depth 0.9 m. Sample 3, Field A11.

Nicora series, Gujarat

Nicora (21° 46′ N Lat, 73° 7′ E Long), Dist. Broach. Samples coll. and subm. by K. T. M. Hegde, M.S. Univ., Baroda, to date river sediments by using caliche deposits. *Comment*: same as for TF-759.

TF-900. Late Quaternary **12.31 ± 0.34%**
Modern

Caliche coll. from Narmada R. bank. Sample 2.

TF-901. Late Quaternary **10.90 ± 0.36%**
Modern

Caliche coll. from Narmada R. bank. Sample 3.

TF-906. Okha, India, Late Quaternary **>39,000**

Coral from Okha (22° 28′ N Lat, 69° 06′ E Long), Dist. Jamnagar, Field 27. Coll. by S. K. Gupta, to date an emerged reef.

TF-891. Paithan, India, Late Quaternary **18,490 ± 650**
16,540 B.C.

Fresh-water shells from Paithan (19° 31′ N Lat, 75° 22′ E Long), Dist. Aurangabad, from an old floodplain of Godavari R., depth 5 m. Subm. by A. Parthasarthy, Indian Inst. of Technol., Powai, Bombay.

TF-911. Salaya, India, Late Quaternary **5075 ± 105**
3125 B.C.

Dead coral from Salaya (22° 22′ N Lat, 69° 39′ E Long), Dist. Jamnagar. Sample coll. from well dug in the sea floor, Loc. 20. Coll. by S. K. Gupta.

Sambhar Lake series, Rajasthan

Sambhar Salt lake (26° 54′ N Lat, 75° 13′ E Long), Dist. Jaipur. Coll. by G. Singh, Birbal Sahni Inst. of Palaeobotany, Lucknow, for pollen analysis and C^{14} dating. NaOH pretreatment given to all samples.

TF-883. Late Quaternary **4385 ± 110**
2435 B.C.

Organic debris from depth 1.3 to 1.5 m, Field S2/135-150, Sample RC-6.

TF-884. Late Quaternary **6060 ± 105**
4110 B.C.

Organic debris from depth 1.9 m, Field S2/185-195. Sample RC-7.

TF-886. Late Quaternary **7165 ± 310**
5215 B.C.

Organic debris from depth 2.9 m, Field S2/285-295. Sample RC-9.

TF-887. Late Quaternary **8990 ± 125**
7040 B.C.

Organic debris from depth 3.2 m, Field S2/315-325. Sample RC-10. *General Comment*: samples date wet and dry phases on the basis of pollen zones which indicate that Sambhar was a fresh water lake before 4000 B.P.

Sankrail series, West Bengal

Sankrail (22° 35′ N Lat, 88° 20′ E Long), Dist. Howrah, coll. and subm. by Vishnu-Mittre and H. P. Gupta, Birbal Sahni Inst. of Palaeobotany, Lucknow.

TF-850. Late Quaternary **2540 ± 100**
590 B.C.

Peaty clay from depth 1.4 m, Sample 1.

TF-851. Late Quaternary **3960 ± 95**
2010 B.C.

Peat from depth 1.8 m, Sample 2.

TF-853. Late Quaternary **4785 ± 105**
2835 B.C.

Wood from depth 1.5 m, Sample 4. NaOH pretreatment was given.

TF-855. Late Quaternary **4590 ± 130**
2640 B.C.

Peat from depth 3 m. Sample 6.

TF-856. Late Quaternary **5645 ± 105**
3695 B.C.

Peat from depth 6 m, Sample 7.

TF-857. Late Quaternary **5285 ± 110**
3335 B.C.

Wood, depth not given. Sample 8.

General Comment: samples date a pollen sequence and thus help ecologic and climatic reconstructions for Holocene in Bengal.

Saurashtra coast series, Gujarat

Saurashtra coast, samples coll. and subm. by M.V.A. Sastry, Geol. Survey of India, Calcutta, to date emerged coral reefs for eustatic studies.

TF-1015. Sub-Recent/Recent **4445 ± 105**
2495 B.C.

Coral, pure aragonite. Sample 2, Field C.R. 2.

TF-1014. Sub-Recent/Recent **6010 ± 110**
4060 B.C.

Coral aragonite. Sample 1, Field C.R. 1.

Surajbari series, Gujarat

Surajbari (23° 8′ N Lat, 70° 42′ E Long), Dist. Malia, in Little Rann of Kutch. Samples coll. and subm. by S. K. Gupta, to date marine regressions.

TF-930. Late Quaternary **3720 ± 100**
1770 B.C.

Shells from depth 4.9 m. Sample 3, Field RH 27(c)/3.

TF-932. Late Quaternary **6600 ± 105**
4650 B.C.

Shells from depth 16 m. Sample 7, Field RH 24/7.

TF-927. Late Quaternary **4685 ± 100**
2735 B.C.

Shells from depth 7 m. Sample 3, Field RH 27(d)/3.

TF-765. Takaopa, Thailand, Late Pleistocene **>40,000**

Lignitic clay, from Takaopa (8° 8′ N Lat, 98° 4′ E Long), alluvial tin-mine area, depth 9 m. Sample coll. by P. Aranyaknon, Royal Dept. of Mines, Bangkok, Thailand.

TF-903. Visavara village, India, Late Quaternary $\mathbf{27{,}710^{+1400}_{-1190}}$
25,760 B.C.

Coral from Visavara village (21° 45′ N Lat, 69° 26′ E Long), Dist. Junagadh, depth 0.3 m, Loc. 32. Coll. by S. K. Gupta to date emerged reef.

TF-889(a). Washtana, India, Late Quaternary **11,130 ± 150**
9,180 B.C.

Miliolite from Washtana (23° 25′ N Lat, 70° 34′ E Long), Dist. Waga, Field 11/132. Subm. by S. K. Biswas to date local miliolite formations.

TF-965. Willington Island, India, Postglacial sediments **8080 ± 120**
6130 B.C.

Root of tree from Willington I., Dist. Cochin, depth 16.75 m. Sample 1, Field 1. Sample subm. by E. Nielson, Cochin Port Trust. *Comment*: sample from postglacial marine or backwater sediments. NaOH pretreatment was given.

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[RADIOCARBON, VOL. 13, NO. 1, 1971, P. 94-96]

UNIVERSITY OF TOKYO RADIOCARBON MEASUREMENTS III

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Radiocarbon measurements in this list were made from Sept. to Dec., 1968. They are based on acetylene counting in an Oeschger-Houtermans-type proportional counter (1 L) at pressure 1 atm. All data are based on duplicated measurements. For calculation of ages, 95% activity of NBS oxalic acid is used as the modern standard and value of 5570 ± 30 years is used for the half-life of C^{14}. Dates are expressed in years B.P. (before A.D. 1950). Error corresponds to 1σ deviation of sample net counting rate as well as modern standard and background. Details of procedures are given in previous reports (R., 1968, v. 10, p. 144-148; 1969, v. 11, p. 509-514).

Descriptions of samples are given by collectors and submitters. We express our thanks to M. Kishi for secretarial assistance.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Japan

6740 ± 400
TK-56. Nakai-machi Sakai **4790 B.C.**

Cone of *Picea bicolor* Mayr, id. by Y. Kimura, Univ. of Tokyo, from black soil under pumice flow, Sakai, Nakai-machi, Kanagawa pref. (35° 21′ N Lat, 139° 12′ E Long). Coll. 1967 and subm. 1968 by N. Katayama, Univ. of Tokyo. *Comment* (N.K.): from paleoclimatic point of view, specimen should be older than 10,000 yr. Contamination by younger carbon may have occurred.

TK-57. Waki-machi **>50,000**

Wood from sand layer, ca. 1.5 m thick, ca. 40 to 50 cm below surface of fan, NW of Waki-machi, Mima-gun, Tokushima Pref. (34° 04′ 07″ N Lat, 134° 08′ 44″ E Long). Coll. 1968 by A. Okada; subm. 1968 by S. Iwatsuka, Univ. of Tokyo.

8760 ± 250
TK-59. Yatate-toge **6810 B.C.**

Charred wood from Ito pyroclastic flow, NW of Yatate-tōge, Mimata-cho, Miyazaki pref. (31° 43′ 45″ N Lat, 131° 15′ 50″ E Long). Coll. and subm. 1968 by S. Aramaki, Univ. of Tokyo.

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TK-60. Iidani **2460 ± 350**
510 B.C.

Charred wood from Ito pyroclastic flow, Iidani, Kobayashi city, Miyazaki pref. (32° 0′ 30″ N Lat, 131° 0′ 40″ E Long). Coll. and subm. 1968 by S. Aramaki.

B. Israel

TK-33b. Amud Cave **4630 ± 470**
2680 B.C.

20% H_2SO_4–leached portion of TK-33, animal bone from Amud Cave, Israel (32° 52′ 30″ N Lat, 35° 30′ 09″ E Long). Coll. 1964 by Univ. of Tokyo Scientific Expedition to W Asia and subm. 1967 by F. Takai, Univ. of Tokyo. *Comment* (F.T.): material was obtained from middle horizon of Bed B of Amud Cave, characterized by occurrence of Neanderthal skeletons and stone implements of transitional type between Levalloiso-Mousterian and Upper Paleolithic. Stratigraphic and paleontologic correlations of Bed B with surrounding Quaternary deposits suggest geologic age is Middle Würm, probably interstadial between Early and Main Würm. Radiocarbon age is remarkably younger than age expected from prehistoric as well as stratigraphic and paleontologic correlations. Bone carbonate of same sample gave 10,500 ± 140 (TK-33 a, R., 1969, v. 11, p. 511). Dating by ionium-growth method for same material of TK-33 shows minimum age of 27,000 ± 5000 yr (Suzuki and Takai, 1970).

II. ARCHAEOLOGIC SAMPLES

A. Japan

TK-61. Onnemoto **2310 ± 90**
360 B.C.

Charred timber on floor of dwelling pit No. 2 at Onnemoto, Nemuro city, Hokkaido (43° 23′ N Lat, 145° 47′ E Long). Excavation 1967 by N. Kokubu, Tokyo Univ. of Educ. Pottery is of Okhotsk type. Coll. 1967 by T. Iwasaki, Tokyo Univ. of Educ., and subm. 1968 by N. Watanabe, Univ. of Tokyo. *Comment* (N.W.): obsidian arrowhead and flake from same dwelling pit yielded fission track dates 1060 ± 160 and 1150 ± 440, respectively (Watanabe and Suzuki, 1969). Comparable dates for Okhotsk type pottery are 1420 ± 170, 990 ± 140, 1310 ± 120 (Gak-189-191, R., 1963, v. 5, p. 117; 1230 ± 100, 1180 ± 100 (TK-2, 9, R., 1968, v. 10, p. 147; and 1240 ± 90 (TK-54, R., 1969, v. 11, p. 513).

B. Korea

TK-55. Oksokni dwelling site **2980 ± 100**
1030 B.C.

Charcoal from floor of pit covered by large flat stone of dolmen at Oksōkni, P'aju, Korea (36° 50′ N Lat, 126° 43′ E Long). Coll. 1967 and subm. 1968 by S. Izumi, Univ. of Tokyo. *Comment* (S.I.): date is acceptable, as this is somewhat earlier than Dolmen period (Kim and Youn, 1967).

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UNIVERSITY OF TOKYO RADIOCARBON MEASUREMENTS IV

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The C^{14} measurements reported here were made in this laboratory between January 1969 and July 1970. Details of our apparatus, sample preparation, and measuring procedure were described in R., 1968, v. 10, p. 144-148. A change has been made since January 1969: strontium carbonate is reduced to strontium carbide with a mixture of 60g of $SrCO_3$ to 40g of Mg-powder (<200 mesh) instead of 60g of $SrCO_3$ to 50g of Mg-powder (<50 mesh).

Counting was made on acetylene gas and was repeated at least twice on the same gas for periods of more than 1000 min. All age calculations are based on a C^{14} half-life of 5570 and 0.95 of the activity of the NBS oxalic acid standard. Ages are quoted in years before 1950. The standard deviation quoted includes only 1σ of the counting statistics of background, sample, and standard counts.

Sample descriptions have been prepared in collaboration with collectors and submitters.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Japan

Hikichi sand dune series

Humic soil from sand layer in sand dune, ca. 10 m below surface (alt ca. 20 m), Hikichi, Fujisawa city, Kanagawa Pref. (35° 21′ N Lat, 139° 28′ E Long). Coll. 1968 by K. Endo and subm. 1968 by S. Iwatsuka, Univ. of Tokyo.

3040 ± 120
TK-49a. Humic soil **1090 B.C.**

Base treatment was omitted.

2560 ± 190
TK-49b. Humic acid **610 B.C.**

KOH-leached portion from the same sample as TK-49a. Sample

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mixed with dead carbon for counting. *Comment* (S.I.): date of charcoal from sand layer thought to be same horizon is 3000 ± 180 yr B.P. (TK-48, R., 1969, v. 11, p. 511).

27,100 ± 410
TK-58. Ikenoura **25,150 B.C.**

Wood from fan, depth ca. 20 m, Ikenoura, Mima-cho, Mima-gun, Tokushima Pref. (34° 03′ 48″ N Lat, 134° 03′ 59″ E Long). This fan surface is dislocated by Mino fault along Median Tectonic Line. Coll. 1968 by A. Okada and subm. by S. Iwatsuka. *Comment* (A.O.): this surface is geomorphically correlated with terrace in vicinity of Awa-Ikeda. Wood from terrace sediments dislocated by Ikeda fault along Median Tectonic Line was dated 27,700 ± 600 (TK-39, R., 1969, v. 11, p. 510).

Fuji Volcano series

Samples from outer part of wood stem from Aokigahara lava flow at NW foot of Mt. Fuji, Narusawa-mura, Yamanashi Pref. (35° 28′ N Lat, 138° 42′ E Long). Coll. 1968 by H. Tsuya *et al.* and subm. 1968 by N. Saito, Univ. of Tokyo. *Comment* (N.S.): flow was interpreted to have erupted in 865 A.D.

910 ± 60
TK-62a. Wood **A.D. 1040**

1040 ± 80
TK-62b. Wood **A.D. 910**

Different part of same sample (TK-62a).

8680 ± 190
TK-65. Chikura-cho, Teraniwa **6730 B.C.**

Wood from marine-terrace sediments at Teraniwa, Chikura-cho, Awa-gun, Chiba Pref. (34° 57′ 30″ N Lat, 139° 57′ 30″ E Long). Coll. 1968 by T. Yoshikawa and subm. 1968 by S. Iwatsuka. *Comment* (T.Y.): sample coll. from thin gravel intercalated in marine silt, of which the marine terraces ca. +20 m are composed. Gravel is ca. 10 m below surface. These terraces were formed by eustatic rise of sea level and crustal uplift during Holocene. For three relevant dates see TK-3, TK-7, and TK-8 (R., 1968, v. 10, p. 144-148).

33,400 ± 1200
TK-66. Lake Shiobara-ko **31,450 B.C.**

Driftwood from upper part of lake sediments, Shiobara-machi, Shioya-gun, Tochigi Pref. (37° 0′ N Lat, 139° 50′ E Long). Coll. 1968 by S. Yamada and subm. 1968 by F. Takai, Univ. of Tokyo. *Comment* (F.T.): Shiobara lake sediments (Akutsu, 1964) have been considered Upper Pleistocene in broad sense, containing well-preserved broad leaf and aquatic plant fossils which indicate cool, moist climate.

Boso Alluvial Terrace deposits series

4070 ± 100
TK-67. Tomiura-cho, Tatara **2120 B.C.**

Shells and barnacles from elevated sea cave fringed by abrasion platform, at +13.5 m, E of Daibusaki, Tatara, Tomiura-cho, Awa-gun, Chiba Pref. (35° 02′ N Lat, 139° 50′ E Long). Coll. 1968 by N. Yonekura and subm. 1969 by S. Iwatsuka.

6880 ± 120
TK-68. Kamogawa-cho, Kaisuka **4930 B.C.**

Shells from alluvial terrace deposits, ca. 4.5 m below surface (alt 10 m), near mouth of Kamo R., Kaisuka, Kamogawa-cho, Awa-gun, Chiba Pref. (35° 05′ N Lat, 140° 05′ E Long). Coll. 1968 by N. Yonekura and subm. 1969 by S. Iwatsuka.

5910 ± 100
TK-69. Misaki-cho, Shinoki **3960 B.C.**

Shells from alluvial terrace sediments, 120 cm below surface (alt 10 m), lower part of Isumi R., Shīnoki, Misaki-cho, Isumi-gun, Chiba Pref. (35° 19′ N Lat, 140° 23′ E Long). Coll. 1968 by N. Yonekura and subm. 1969 by S. Iwatsuka. *Comment* (N.Y.): age of fill-top surfaces of dated layers (TK-68, 69) correspond to post-glacial climatic optimum. Inferences: 5500 ± 7500 yr B.P.

Ito pyroclastic flow deposit series

Samples are from Ito pyroclastic flow which determine age of formation of Aira caldera in Kyushu.

38,900 ± 2100
TK-75. Hase **36,950 B.C.**

Charcoal from Ito pyroclastic flow, Hase, Kokubu city, Kagoshima Pref. (31° 42′ 30″ N Lat, 130° 52′ 05″ E Long). Coll. and subm. 1969 by S. Aramaki, Univ. of Tokyo.

26,800 ± 500
TK-77. Kibayashiki **24,850 B.C.**

Charcoal from Ito pyroclastic flow, Kibayashiki, N of Suki, Miyazaki Pref. (32° 06′ 30″ N Lat, 131° 04′ 0″ E Long). Coll. and subm. 1969 by S. Aramaki. Cf. Gak-473 and Gak-558, R., 1966, v. 8, p. 57; Gak-211, R., 1963, v. 5, p. 109. *Comment* (S.A.): TK-59, 60, TK-75, 77 (R., this issue), and Gak-473, 558 were taken from Ito pyroclastic flow (ash-flow tuffs), considered to have caused formation of the Aira caldera, which forms N part of Kagoshima Bay, S Kyushu (Aramaki and Ui, 1966). All tuffs from which charcoal samples were taken were carefully correlated by stratigraphic and petrographic methods and are believed to belong to same sheet. Large variance in ages might indicate unknown secondary effects that greatly modified apparent age.

TK-76. Kozushima **1230 ± 80**
A.D. 720

Charcoal from Mt. Tenjo pyroclastic flow, Nagahama, Kozushima, Tokyo (34° 13′ 29″ N Lat, 139° 08′ 29″ E Long). Coll. 1960 by N. Isshiki, Geol. Survey of Japan, and subm. 1969 by S. Aramaki. Previous age determination of same sample gave 1260 ± 80 (Gak-477, unpub.). *Comment* (S.A.): according to Tsuya (1929), deposit was formed during eruption in A.D. 838, recorded in old documents.

TK-79. Murota pumice flow **27,900 ± 600**
25,950 B.C.

Charred wood from Murota pumice flow, which resulted directly in formation of summit caldera of Haruna Volcano, Nakamurota, Haruna-machi, Gunma-gun, Gunma Pref. (36° 23′ 28″ N Lat, 138° 51′ 06″ E Long). Coll. 1969 by O. Oshima and subm. 1969 by F. Takai. Cf. Haruna volcano series TK-31, 32 (R., 1969, v. 11, p. 510). *Comment* (F.T.): date younger than expected. Flow may be contemporaneous with or a little younger than that of TK-31.

II. ARCHAEOLOGIC SAMPLES

A. Japan

Sakaeura II series

Samples from pit houses at Sakaeura II site, Tokoro-machi, Tokoro-gun, Hokkaido (44° 07′ 31″ N Lat, 44° 01′ 21″ E Long). Pottery is late Okhotsk type. Coll. 1968 by Dept. of Archaeol., Univ. of Tokyo and subm. 1969 by T. Sekino, Univ. of Tokyo.

TK-83. Pit House 11 **890 ± 100**
A.D. 1060

Charcoal from pit house, ca. 70 cm below surface. Sample was mixed with dead carbon for counting.

TK-84. Pit House 12 **960 ± 80**
A.D. 990

Charcoal from pit house, ca. 30 cm below surface. *Comment* (T.S.): compared with TK-21 (R., 1968, v. 10, p. 146) and archaeologic point of view, true age of samples is supposedly ca. 1250 A.D. Cf. TK-2, 9 (R., 1968, v. 10, p. 147), TK-54 (R., 1969, v. 11, p. 513), TK-61 (R., this issue) and Gak-190 (R., 1963, v. 5, p. 117).

TK-78. Yamashita-cho Cave 1 **32,100 ± 1000**
30,150 B.C.

Charcoal from Layer 3 of cave at Yamashita-cho, Naha city, Okinawa (26° 11′ 30″ N Lat, 127° 40′ 30″ E Long) excavated 1968 by Research Group for Pleistocene Man in Okinawa, under N. Watanabe, Univ. of Tokyo. Layer 6 beneath Layers 3 to 5, of which Layers 3 and 5 contained charcoal, yielded human skeletons, deer bones, and antlers. Coll. 1968 and subm. 1969 by N. Watanabe. *Comment* (N.W.): human skeletons are of Pleistocene.

B. Egypt

Egyptian mummy series

Wooden coffin and hempen cloth of a mummy of a maiden in service of large temple at Thebes, Egypt, excavated 1884 and presented 1888 to Fac. of Med., Univ. of Tokyo by French Consulate at Yokohama, Japan. Archaeol. age is ca. 800 B.C. Coll. 1969 by T. Kamiya, Fac. of Med., Univ. of Tokyo, and subm. 1969 by N. Watanabe.

2810 ± 80
TK-80. Hempen cloth **860 B.C.**

2670 ± 80
TK-81. Wood of coffin **720 B.C.**

C. Peru

540 ± 80
TK-85. Pasamayo tomb **A.D. 1410**

Wool products with mummy in tomb, No. 15, Area 2, Pasamayo, 56 km N of Lima, Peru (11° 50′ S Lat, 77° 05′ E Long). Pottery is of Chancay Black-on-White type. Coll. 1969 by H. Vidal V., Univ. of San Marcos, Lima, and subm. 1969 by K. Terada, Univ. of Tokyo. *Comment* (K.T.): Chancay Black-on-White is placed at middle phase of Postclassic period of Peruvian archaeology, presumably 12th to 16th centuries. Date supports previous hypothesis on chronologic position of Late Chancay culture.

D. Israel

Amud Cave series

Bones from deposits in Bed B of Amud Cave, Israel (32° 52′ 30″ N Lat, 35° 30′ 09″ E Long) which yielded Neanderthal skeletons. Coll. 1961 by Tokyo Univ. Scientific Expedition to W Asia and subm. 1969 by H. Suzuki, Univ. of Tokyo.

5710 ± 80
TK-86a. Bone, carbonate **3760 B.C.**

Bone carbonate from 2 samples coll. at adjacent localities, 6-9-II and 6-10-II, at same level, 50 cm in average below surface of Bed B.

7030 ± 120
TK-86a′. Bone, carbonate **5080 B.C.**

Bone carbonate from 2 samples coll. at adjacent localities, 6-9-III$_{sup.}$ and 6-10-III$_{sup.}$ at same level, 60 cm in average below surface of Bed B, immediately below 6-9-II and 6-10-II, respectively. *Comment* (H.S.): stratigraphic horizon of TK-86 materials underlies horizon of Neanderthal skeleton Amud-I. Bed B is characterized by occurrences of Neanderthal skeletons and stone implements of Transitional type between Levalloiso-Mousterian and Upper Paleolithic. Stratigraphic and paleontologic correlations of Bed B with surrounding Quaternary deposits suggest Middle Würm, probably Interstadial between Early and Main Würm.

Dates are remarkably younger than age postulated from prehistoric as well as stratigraphic and paleontologic correlations. Dating by ionium growth method for animal bones obtained from horizon ca. 1 m below materials of TK-86a and TK-86a′ shows minimum age of 27,000 ± 5000 B.P.

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BELFAST RADIOCARBON DATES III

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Belfast, Northern Ireland

INTRODUCTION

The dating equipment in the Palaeoecology Laboratory remains essentially as described in R., 1970, v. 12, p. 285-290, and the operating conditions as described in R., 1970, v. 12, p. 291-297. Small samples, however, have been counted at a filling pressure equivalent to 152 cm Hg at 20°C. Charcoal samples pretreated by nitration have been treated as described in R., 1970, v. 12, p. 285-290. Other charcoal samples have been pretreated using the following technique developed by P. Q. Dresser: samples are washed in 5% sodium hydroxide; this is followed by treatment in a solution composed of 8% potassium permanganate and 10% sulphuric acid, at 80°C for 20 mins, to remove residual rootlets and organic matter. Unless specifically stated, the samples have been collected by the authors and other members of the Laboratory: M. G. L. Baillie, P. Q. Dresser, Adelaide Goddard, and I. Goddard. Where a sample has been collected for a specific research project the collector's initials are given. Routine operation of the dating apparatus has been carried out by Mrs. Marilyn Carse and Mrs. Florence Qua to whom we are much indebted.

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I. ARCHAEOLOGIC SAMPLES

Armagh Hill Fort series, Co. Armagh

Samples from excavation of Early Christian site at Castle Street, Armagh, Co. Armagh (54° 21′ N Lat, 6° 39′ W Long; Irish Grid Ref. H 874453). Site excavated by C. Warhurst and A. Harper for Ministry of Finance for Northern Ireland in 1968. Coll. 1968 by C. W. and A.H.; subm. by D. M. Waterman, Archaeol. Survey of Northern Ireland.

1660 ± 80
UB-283. Armagh Hill Fort, Trench 3, 16 **A.D. 290**

Twigs from bottom of ditch. Pretreatment by bleaching and charring.

1845 ± 85
UB-284. Armagh Hill Fort, Trench 3, 13a **A.D. 105**

Charcoal from intermediate layer in ditch fill. Pretreatment by nitration.

UB-285. Armagh Hill Fort, Trench 2, Pit 3 **1430 ± 85 A.D. 520**

Charred twigs from pit dug into filled ditch. Pretreatment by nitration.

General Comment (C.W.): UB-283 came from bottom of defensive ditch encircling hill in centre of Armagh city. There is documentary evidence for founding of city by St. Patrick (*Annals of Ulster,* A.D. 444; *Annals of the Four Masters,* A.D. 457). Date for UB-283 suggests possibility of pre-Christian settlement on hill. UB-284 and UB-285 were stratigraphically later, which suggests that UB-284 was from old wood. Date range fits finds from metal workshop which included clay molds dated by art styles, Warhurst and Harper (1970).

UB-43. Coney Island, F 158, Sample 4 **3350 ± 80 1400 B.C.**

Carbonized wood from prehistoric settlement site on Coney I., SW Lough Neagh, 1 mi from shore, Co. Armagh (54° 31′ N Lat, 6° 33′ W Long; Irish Grid Ref. H 938642). Site excavated by P. V. Addyman, Univ. of Southampton in 1964. Coll. 1964 by A. G. Smith. Ref. Addyman, P. V. 1965. *Comment*: sample came from deposit containing Irish Bowl pottery. Date is somewhat younger than expected. Sample is part of large series to be dated.

Pubble archaeologic series, Co. Londonderry

Samples are from peat-covered round barrow in Loughermore Td., 8 mi SW of Limavady, Co. Londonderry (54° 55′ N Lat, 7° 7′ W Long; Irish Grid Ref. C 585128; alt 600 ft O.D.). Site excavated 1968 by C. Warhurst.

Central mound, of turves and upcast, contained 2 soil horizons (UB-262 and UB-263) above pre-barrow land surface (UB-191) from which had been dug a central pit. Central mound was surrounded by a ditch (UB-193, basal deposit) and bank. Tail of bank was stratified into peat and is bracketed by UB-195 and UB-196. Fraction notation is as for geochemical samples (Sec. IV).

UB-191 E. Pubble, old ground surface 1 **3875 ± 85 1925 B.C.**

Charcoal from old ground surface below central mound.

UB-191 C. (humic acid) 3560 ± 60

Comment: date for Fraction E provides one lower bracket for monument; date for humic acid (Fraction C) probably provides a closer lower bracket than Fraction E, but possibility of downwash of humic acid cannot be excluded.

UB-193 A. Pubble, ditch **3135 ± 90 1185 B.C.**

Basal 5 cm of peat from ditch.

UB-193 C.	(humic acid)	2970 ± 85
UB-193 F.	(fine particulate fraction)	3135 ± 75

Comment: dates give an upper bracket for barrow. Using quoted errors dates are not significantly different. Consideration of Laboratory's dates on fractionated peats will form subject of future publication.

UB-195 F. Pubble, old ground surface 2 **3835 ± 80**
1885 B.C.

Fine particulate fraction from 5 cm of humus and peat sealed beneath S edge of barrow bank.

UB-195 A.	(whole peat)	3220 ± 65
UB-195 C.	(humic acid)	2850 ± 60

Comment: Fraction F provides 2nd lower bracket for monument and is closely comparable with UB-191 E. Fractions A and C present clear evidence of contamination by washed-down humic acid.

UB-196 F. Pubble, basal blanket peat **2775 ± 75**
825 B.C.

Fine particulate fraction from basal 5 cm of peat covering S edge of bank above UB-195.

UB-196 A.	(whole peat)	2745 ± 60
UB-196 C.	(humic acid)	2625 ± 90

Comment: by comparison with UB-193, dates show time lag of several centuries between initiation of peat growth in ditch and over bank. Similarity of dates for fractions indicates no downwash of humic acid.

UB-262 C. Pubble, upper buried soil (B) **535 ± 80**
A.D. 1415

Humic acid from buried soil (B) developed on upcast over original mound surface.

UB-262 F.	(fine fraction)	555 ± 80

Comment: no significant difference between fractions suggesting no movement of humic acid in body of barrow.

UB-263. Pubble, lower buried soil (A) **950 ± 75**
A.D. 1000

Humic acid from buried soil (A), just below UB-262, developed on original mound surface. *Comment*: taken together with dates for UB-262 (this list) date suggests disturbance of barrow in medieval times. Soil humus may, however, be older than burial of soil and date does not measure disturbance of site precisely.

General Comment: monument must have been built after formation of deposits dated to 3875 ± 85 (UB-191 E) and 3835 ± 80 (UB-195 F), and possibly after 3560 ± 60 (UB-191 C), and before 3135 ± 90 (UB-193 A). Any of these possible brackets demonstrates that the barrow is of Bronze age rather than Iron age date.

Ballynagilly Series I, Co. Tyrone

Continuation of series reported in R., 1970, v. 12, p. 285-290, from site known as 'The Corbie' in Ballynagilly Td., Co. Tyrone (54° 42′

N Lat, 6° 51′ W Long; Irish Grid Ref. H 743837) 5 mi NW of Cookstown. Series is from excavations carried out by A. M. ApSimon (Dept. Archaeol., Univ. of Southampton) for Ministry of Finance, Northern Ireland during 1966-69. Samples are from Neolithic and Earlier Bronze age occupations. Coll. 1969 by A. M. ApSimon unless otherwise stated.

UB-199. Ballynagilly, post-hole in Neolithic House F(L)149 **5230 ± 125** **3280 B.C.**

Charcoal from post-hole in Neolithic house (ApSimon, 1969); assoc. with Neolithic pottery. Coll. 1967 by A.M.A. *Comment*: similar to date for material from walling of house (UB-201, 5165 ± 50, R., 1970, v. 12, p. 289) and some early Neolithic dates in this series.

UB-200. Ballynagilly, Beaker Hearth-Pit F(M)32 **3905 ± 120** **1955 B.C.**

Charcoal from hearth-pit in Beaker habitation area. Pit contained much pottery and fragmentary burnt bone. Evidence of burning *in situ*. Coll. 1967 by A. M. ApSimon.

UB-301. Ballynagilly, Pit F(L) 134 **4910 ± 90** **2960 B.C.**

Charcoal from pit containing Neolithic artifacts. Coll. 1967 by A. M. ApSimon. *Comment*: result similar to that from Middle Neolithic hearth (UB-306, 4880 ± 110), this list.

UB-304. Ballynagilly, Pit Complex F(L) 211 **5370 ± 85** **3420 B.C.**

Charcoal from Layer 5b of pit complex. No artifacts found in this layer but it was sealed by layer containing Neolithic artifacts.

UB-305. Ballynagilly, Hearth F(L) 16 **5745 ± 90** **3795 B.C.**

Charcoal from hearth and ash-pit in Neolithic occupation area. Coll. 1967 by A. M. ApSimon.

UB-306. Ballynagilly, Middle Neolithic Hearth F(M) 174 **4880 ± 110** **2930 B.C.**

Charcoal found in close assoc. with Middle Neolithic pottery, stratigraphically pre-Beaker.

UB-307. Ballynagilly, Pit and Gully Complex F(M) 46 **5640 ± 90** **3690 B.C.**

Charcoal from pit containing Early Neolithic pottery in base of gully sealed by sterile sand and overlain by Beaker occupation material. Coll. 1967 by A. M. ApSimon.

UB-309. Ballynagilly, Beaker Pit F(M) 17 **3850 ± 55** **1900 B.C.**

Charcoal from basal Layer F of pit 1.2 × 1.2 × 0.6 m deep containing Beaker pottery: some sherds closely assoc. with sample. Coll. 1968 and 1969 by A. M. ApSimon.

UB-314. Ballynagilly, 'Plainware' Pit F(M) 317 **3455 ± 60** **1505 B.C.**

Charcoal from shallow pit 1.0 × 0.8 × 0.1 m deep with one 'plainware' potsherd and flints.

UB-315. Ballynagilly, 'Plainware' Hearth F(M) 332 **3480 ± 80** **1530 B.C.**

Charcoal from hearth ca. 2 × 1 m with flints and 'plainware' sherds closely assoc.

UB-316. Ballynagilly, Beaker Hearth F(G) 5 **3960 ± 75** **2010 B.C.**

Charcoal from hearth 0.4 × 0.3 m × 5 cm deep in Area G of excavation containing compacted mass of charcoal enclosing sherds of Beaker pottery. Further excavation in this area is planned.

UB-355. Ballynagilly, 'Plainware' Occupation Spread F(M) 335 **3525 ± 75** **1575 B.C.**

Charcoal from 2 m diam. continuous spread of 'plainware' sherds and charcoal. Probable focus of occupation.

UB-356. Ballynagilly, Burnt Area F(M) 334 and 333 **3905 ± 75** **1955 B.C.**

Charcoal from burnt area with Beaker pottery.

General Comment: further samples will be dated after 1970 excavations. Dates obtained so far fall into 2 distinct groups. Those from Neolithic contexts fall before ca. 2700 B.C. and those from Earlier Bronze age contexts fall after ca. 2200 B.C. This is in line with pollen evidence for forest regeneration and lack of agriculture for the period between 2590 ± 65 B.C. (UB-251) and 2390 ± 65 B.C. (UB-250, R., 1970, v. 12, p. 295).

Dates for Neolithic house wall material (UB-201) and house posthole (UB-199) are statistically indistinguishable from dates for early forest clearance shown by pollen analysis (UB-253, R., 1970, v. 12, p. 295) and for charcoal layers in surrounding bog (UB-18, this list and UB-15, R., 1970, v. 12, p. 289). Results strongly suggest that forest clearance at elm decline was carried out by builders of rectangular house. These dates cluster around mean of ca. 3250 B.C. and are closely comparable with other dates for Irish Early Neolithic material (McAulay and Watts, 1961). Dates for 3 Neolithic samples (UB-305, UB-307, and UB-197), however, are earlier than any other dated Neolithic material from Ireland. It may be noted that date for end of pre-landnam forest clearance at Ballyscullion (UB-116) is 5525 ± 60, this list. Single sample (UB-306) for Middle Neolithic falls in later part of forest clearance phase and may be compared with UB-252 (4850 ± 70, R., 1970, v. 12, p. 295).

Samples from Beaker contexts fall ca. 1900 to 2000 B.C. and those from Irish Bowl and 'Plainware' (Early Bronze age) contexts fall ca. 1500 to 1600 B.C. Although individual samples from these 2 contexts may not always be statistically distinct, the 2 groups of dates show a clear separation. Beaker occupation can be correlated with forest clearance indicated by increase of plantain pollen (UB-248, 2005 ± 55 B.C., R., 1970, v. 12, p. 294, emended this list). Subsequent Earlier Bronze age occupation is presumably connected with charcoal layer and clearance of birch (UB-247, 1670 ± 60 B.C., R., 1970, v. 12, p. 294).

General Comment on Archaeologic Samples (A.M.A.): dates are from 4 sites in area 200 × 200 m. Early Neolithic pottery resembles Ballymarlagh style (Case, 1961, p. 176). Further study is necessary to determine whether the group of very early dates (UB-305, -307, -197) is reflected by differences in artifacts. Pot attributed to the Middle Neolithic (UB-306) resembles *Murlough* variety of Sandhills ware (Case, 1961, 1969) with features reminiscent of Carrowkeel ware. Bell Beaker dates are from 3 separate sites, each with differing pottery. This suggests contributions from European Bell and Wessex/Middle Rhine groups and Early Northern British Beaker tradition. Later pottery includes Irish Bowl (UB-198) and, from a separate site, 'plainware' dated by UB-314, -315, -316. Affinities of this plainware require further study.

UB-163. Beaghmore Diagram 4, 33 to 35 cm — **2725 ± 55** / **775 B.C.**

Humic acid from blanket peat from Beaghmore stone circle site (54° 42′ N Lat, 6° 56′ W Long; Irish Grid Ref. H 685843) 9 mi NW of Cookstown, Co. Tyrone. Sample from base of ditch of Cairn 10. Coll. 1966 by Pilcher (1969). *Comment* (J.R.P.): together with UB-11 (R., 1970, v. 12, p. 292, emended this list) result provides date bracket for construction of cairn. Humic acid fraction extracted and dated as contamination by modern roots was suspected. Date may still be younger than earliest organic accumulation in ditch. Date bracket places construction in Middle or Later Bronze age.

UB-320 E. Goodland Neolithic ritual site, Co. Antrim — **4575 ± 135** / **2625 B.C.**

Fine charcoal particles from Neolithic ritual site in Goodland Td., 5 mi E of Ballycastle, Co. Antrim (55° 12′ N Lat, 6° 7′ W Long; Irish Grid Ref. D 200413; alt 750 ft O.D.). Samples separated in lab. by P. Q. Dresser from filling of pit containing Neolithic material. Pit was in till beneath blanket peat. Coll. 1964 by H. Case, Ashmolean Mus., Oxford, in consultation with A. G. Smith.

UB-320 C.	(humic acid)	1710 ± 65
UB-320 G.	(rootlet material)	885 ± 80

Comment: mean of charcoal determination falls near end of Middle Neolithic and beginning of Late Neolithic distinguished by Case (1961, 1969) and provides date for mature Sandhills Ware and for Goodland type of ritual site.

Samples from this site have been dated by the Lamont Lab. (R., 1961, v. 3, p. 172). Downwash of humic acid is shown by young age of Fraction C which is close to that for humic acid from basal peat determined by Lamont Lab., L-472 (humic acid). At least some rootlets (Fraction G) penetrating Neolithic pit deposits clearly much younger than pit and suggest possible cause of unacceptably young age previously determined by Lamont Lab. for charcoal from pit, L-472 A. Charcoal date conforms with that for base of peat at site obtained by Dublin Lab. (D-46, 4150 ± 200; R., 1961, v. 3, p. 33), though both of these are much older than the Lamont determination for basal peat (L-472 B; 1380 ± 150).

UB-317. Kilmagoura bridge, Co. Cork, Republic of Ireland **725 ± 70** **A.D. 1225**

Oak foundation timber of entrance to Kilmagoura moated site, Kilmagoura Td., 0.75 mi SW of Newtown, Co. Cork, Ireland (52° 20′ N Lat, 8° 47′ W Long; Irish Grid Ref. R 467213). Coll. 1967 by R. E. Glasscock, Dept. of Geog., Univ. of Belfast. Ref. Glasscock, 1968. *Comments* (M.G.L.B.): sample of 10 annual rings beginning 20 yr from outside of 160 yr old tree. (R.E.G.): date agrees with late 13th to 14th century date already suggested from excavation evidence. Pretreatment by bleaching and charring.

Mullaghbane Rath series, Co. Tyrone

Fossil soil and charcoal from Mullaghbane Rath, 6 mi SW of Omagh, Co. Tyrone (54° 33′ N Lat, 7° 24′ W Long; Irish Grid Ref. H 385661; alt 300 ft O.D.). Samples composed of old ground surface material containing charcoal from beneath highest part of bank (ca. 6 ft) of ringwork. Site excavated by A. Harper for Ministry of Finance for Northern Ireland. Coll. 1969 by P. Q. Dresser, A. G. Smith, and A. Harper, and pretreated by P. Q. Dresser.

UB-268. Mullaghbane No. 1 **825 ± 85** **A.D. 1125**

Humic acid from upper 2 cm of fossil soil from beneath bank of rath. Charcoal dated as UB-391.

UB-390. Mullaghbane No. 2 **1715 ± 100** **A.D. 235**

Humic acid from lower 4 cm of fossil soil from beneath bank of rath, contiguous with Mullaghbane No. 1. Charcoal dated as UB-391.

UB-391. Mullaghbane No. 3 **2915 ± 115** **965 B.C.**

Charcoal from fossil soil from beneath bank of rath.

General Comment: result for UB-268 lies within limits for acceptable age of ringwork. Contiguous sample UB-390 is appreciably older and may indicate lack of large-scale contamination by downwash of humus, presumably due to great thickness of mineral overburden. Difference between UB-268 and UB-390 suggests a lack of pre-structure ploughing and that UB-268 could indicate maximum age of building. Charcoal (UB-391) is clearly of prehistoric age and not related to ringwork.

II. PALAEOECOLOGIC SAMPLES

Ballyscullion series, Co. Antrim

Samples from monolith, from which detailed pollen diagram has been prepared by Mrs. A. Crowder (Queen's Univ., Kingston, Ontario), through large raised bog in Ballyscullion East Td., 8.5 mi SW of Ballymena, Co. Antrim (54° 58′ N Lat, 6° 27′ W Long; Irish Grid Ref. H 997955; alt 80 ft O.D.). Refs. Jessen (1949); Mitchell (1956). Coll. 1963 by A. G. Smith. All samples received acid pretreatment.

3835 ± 80
UB-109. Ballyscullion monolith, 204 to 208 cm 1885 B.C.

Sphagnum-Eriophorum peat with *Calluna*. Sample from beginning of phase of intense agricultural activity, possibly of pastoralism, some time after 2nd elm decline, indicated by rise of grass and plantain pollen.

3920 ± 85
UB-110. Ballyscullion monolith, 236 to 238 cm 1970 B.C.

Sphagnum-Eriophorum peat. Sample from level of recovery of elm after its 2nd decline.

4200 ± 85
UB-111. Ballyscullion monolith, 250 to 254 cm 2250 B.C.

Sphagnum-Eriophorum peat. Sample from level of 2nd marked elm decline, and final pine decline.

4570 ± 55
UB-112. Ballyscullion monolith, 284 to 286 cm 2620 B.C.

Sphagnum-Eriophorum peat. Sample from end of Stage 3 of landnam phase, where elm curve has fully recovered and where plantain pollen has disappeared. Heath curve begins to rise.

4830 ± 60
UB-294. Ballyscullion monolith, 290 to 294 cm 2880 B.C.

Sphagnum-Eriophorum peat. Sample from middle of Stage 3 of landnam phase, where elm recovery has begun and plantain curve has just fallen. Includes maximum of hazel curve.

4840 ± 60
UB-113. Ballyscullion monolith, 298 to 300 cm 2890 B.C.

Sphagnum-Eriophorum peat. Sample from beginning of Stage 3 of landnam phase, as defined by beginning of rise of hazel curve but includes maxima of grass and plantain pollen.

4990 ± 55
UB-114. Ballyscullion monolith, 304 to 308 cm 3040 B.C.

Sphagnum-Eriophorum peat. Sample from beginning of Stage 2 of landnam phase where elm curve falls markedly and includes rise of grass and plantain curves. Sample at Pollen Zone Boundary VIIa-VIIb of Jessen (1949).

5130 ± 60
UB-115. Ballyscullion monolith, 310 to 314 cm 3180 B.C.

Sphagnum-Eriophorum peat. Sample from beginning of Stage 1 of landnam phase where elm curve begins to decline, grass pollen increases and plaintain pollen re-appears.

5250 ± 85
UB-295. Ballyscullion monolith, 330 to 334 cm 3300 B.C.

Sphagnum-Eriophorum peat.

5530 ± 60
UB-116. Ballyscullion monolith, 340 to 344 cm 3580 B.C.

Sphagnum-Eriophorum peat with *Calluna*. Sample from later part of pre-landnam clearance phase with maxima of grass and plantain pollen just above slight fall of oak curve.

5815 ± 90
UB-296. Ballyscullion monolith, 354 to 356 cm 3865 B.C.

Sphagnum-Eriophorum peat with *Calluna*. Sample ca. 10 cm above decline of pine curve.

6000 ± 85
UB-118. Ballyscullion monolith, 374 to 378 cm 4050 B.C.

Sphagnum-(Eriophorum) peat with *Calluna*.

6430 ± 85
UB-119. Ballyscullion monolith, 398 to 400 cm 4480 B.C.

Sphagnum-(Eriophorum) peat with *Calluna*.

6950 ± 85
UB-120. Ballyscullion monolith, 416 to 418 cm 5000 B.C.

Reedswamp peat. Sample from level of rise of alder curve at Boreal-Atlantic boundary (Pollen Zone Transition VI-VII of Jessen, 1949).

General Comment: samples selected primarily to date horizons of vegetational change, particularly those assoc. with early human activity. UB-116 (5530 ± 60) dates later part of earliest forest clearance episode discovered so far in Ireland. Dates in same range were obtained for Neolithic material from Ballynagilly, Co. Tyrone (UB-197, R., 1970, v. 12, p. 289 and UB-305, UB-307, this list).

UB-115 (5130 ± 60) dates beginning of landnam phase of classical type as distinguished at Fallahogy, Co. Londonderry (Smith and Willis, 1962) and dated by Cambridge Lab. (R., 1962, v. 4, p. 68). End of landnam phase is dated by UB-112 (4570 ± 55). These dates, and consideration of deposition rate as a whole, suggest that total length of landnam phase was some 400 to 600 yr. Phase appears thus to have been more than a temporary clearance for agriculture as was originally supposed. This finding is in line with conclusions drawn for landnam phases at Beaghmore and Ballynagilly, Co. Tyrone (Pilcher, 1970). At level of UB-109 (3835 ± 80) creation of pasture is indicated by pollen diagram and date suggests that this may have been due to activities of Beaker peoples (see general comment on Ballynagilly Series I, this list).

Ballynagilly Series II, Co. Tyrone

Continuation of series reported in Belfast I and II from palaeoecologic work assoc. with excavations of A. M. ApSimon at 'The Corbie', Ballynagilly Td., Co. Tyrone (54° 42′ N Lat, 6° 51′ W Long; Irish Grid Ref. H 743837). All samples received acid pretreatment. Coll. 1967 by J. R. Pilcher and A. G. Smith.

695 ± 80
UB-242. Ballynagilly core, 40 to 44 cm **A.D. 1255**

Blanket peat with *Eriophorum*.

2375 ± 80
UB-244. Ballynagilly core, 120 to 124 cm **425 B.C.**

Blanket peat. Time of high plantain pollen values.

7275 ± 95
UB-257. Ballynagilly core, 310 to 314 cm **5325 B.C.**

Coarse detritus mud. Just after main rise of pine pollen curve and just before Zone VI/VIIa boundary.

8095 ± 80
UB-258. Ballynagilly core, 330 to 334 cm **6145 B.C.**

Coarse detritus mud. First rise of elm and oak curves marking Zone V/VI boundary.

9595 ± 80
UB-260. Ballynagilly core, 380 to 384 cm **7645 B.C.**

Fine detritus mud. Fall of juniper curve and rise of birch curve.

9595 ± 125
UB-297. Ballynagilly core, 400 to 404 cm **7645 B.C.**

Sandy and muddy diatomite. Pollen very scarce, *Myriophyllum* pollen dominant, some *Rumex* and *Empetrum* pollen. Tree pollen forms $< 10\%$ of total. Pollen Zone III. *Comment*: date is indistinguishable from UB-260, 20 cm higher in profile. Contamination by younger humic acids is suspected, but organic content of samples was too small to permit extraction of particulate organic fraction. For comparable situation see UB-298, basal sample of Slieve Gallion series (this list).

5295 ± 90
UB-18. Ballynagilly Monolith E, 29 to 31 cm **3245 B.C.**

Charcoal (hazel, id. by J.R.P.) from layer below iron pan in monolith from blanket peat between prehistoric occupation area and deep bog. *Comment*: date is comformable with those for Early Neolithic material from this site (e.g., UB-201, R., 1970, v. 12, p. 289). Overlying sand suggests soil erosion following forest clearance and burning. Date shows this to have been in Neolithic times.

General Comment: core samples expand previous dating of profile (R., 1970, v. 12, p. 291-297) and complete Post-glacial sequence from site. Date for Zone III is unexpectedly young and is discussed in connection with similar problem at Slieve Gallion (this list).

Slieve Gallion Monolith series, Co. Tyrone

Samples from monolith from which pollen diagram has been prepared (J.R.P.), from bog between twin summits of Slieve Gallion (54° 45′ N Lat, 6° 45′ W Long; Irish Grid Ref. H 807896; alt 1400 ft O.D.), 6.5 mi N of Cookstown, Co. Tyrone. All samples received acid pretreatment.

2670 ± 80
UB-271. Slieve Gallion monolith, 50 to 52 cm **720 B.C.**

Blanket peat.

3280 ± 75
UB-272. Slieve Gallion monolith, 80 to 82 cm **1330 B.C.**

Blanket peat.

3580 ± 60
UB-273. Slieve Gallion monolith, 110 to 112 cm **1630 B.C.**

Blanket peat.

4165 ± 80
UB-274. Slieve Gallion monolith, 140 to 142 cm **2215 B.C.**

Organic deposit transitional from woody reedswamp peat to blanket peat. Pine and elm pollen permanently reduced to low values.

4895 ± 65
UB-275. Slieve Gallion monolith, 170 to 172 cm **2945 B.C.**

Woody reedswamp peat. Elm decline, 1st plantain pollen. Zone VIIa/VIIb transition *sensu* Jessen (1949).

5870 ± 65
UB-276. Slieve Gallion monolith, 200 to 202 cm **3920 B.C.**

Woody reedswamp peat. Big increase in pollen of sedges and decrease in pollen of hazel.

6735 ± 85
UB-277. Slieve Gallion monolith, 220 to 222 cm **4785 B.C.**

Reedswamp peat. First appearance of alder pollen.

7400 ± 90
UB-278. Slieve Gallion monolith, 235 to 237 cm **5450 B.C.**

Reedswamp peat. First significant rise of pine pollen.

7880 ± 75
UB-279. Slieve Gallion monolith, 250 to 252 cm **5930 B.C.**

Reedswamp peat. First significant rise of oak pollen.

8760 ± 90
UB-280. Slieve Gallion monolith, 265 to 267 cm **6810 B.C.**

Reedswamp peat. Just before 1st appearance of oak and elm pollen. Approx. Zone V-VI boundary.

UB-321. Slieve Gallion monolith, 278 to 280 cm **9210 ± 110**
7260 B.C.

Particulate fraction of reedswamp peat (humic acid removed). *Comment*: sample taken to check on possible humic acid contamination at this level. Date is indistinguishable from sample immediately below, UB-281.

UB-281. Slieve Gallion monolith, 280 to 282 cm **9215 ± 75**
7265 B.C.

Reedswamp peat. Middle of juniper maximum. Zone IV.

UB-298 D. Slieve Gallion monolith, 291 to 293 cm **9660 ± 105**
7710 B.C.

Particulate fraction of reedswamp peat.

UB-298 C. (humic acid) 9505 ± 100

Comment: sample taken to check on possible contamination by younger humic acids. Both fraction dates are older than underlying whole peat sample (UB-282) suggesting removal of some younger peat component during treatment, probably water soluble humic acids. Particulate fraction date could be older than humic acid date and some contamination by alkali-soluble humic acids is possible.

UB-282. Slieve Gallion monolith, 293 to 295 cm **9405 ± 80**
7455 B.C.

Sandy reedswamp peat. Probable end of Pollen Zone III. *Comment*: on basis of results for fractionated Sample UB-298, this sample is probably contaminated by younger humic acids and does not give a reliable measure of the end of Pollen Zone III.

General Comment: Sample UB-298 indicates advisability of removing humic acids from early Post-glacial peats. Sample UB-321 shows that removal of humic acid from samples higher in profile would not have materially altered results. On basis of UB-298 D end of Late-glacial period, defined pollen-analytically, occurred near 9660 ± 105.

Pubble pollen series, Co. Londonderry

Samples are from 2 peat monoliths from barrow described in Pubble archaeol. series (this list), in Loughmore Td., 8 mi SW of Limavady, Co. Londonderry (54° 55′ N Lat, 7° 7′ W Long; Irish Grid Ref. C 585128; alt 600 ft O.D.). Profile I is from N arc of ditch. Base of monolith is adjacent to Sample UB-193 (this list). Profile III is through tail of upcast from ditch close to UB-195 and UB-196 (this list). Coll. 1968. Pollen analyses from profiles made by I. Goddard.

UB-325. Pubble Profile I, 144 to 148 cm **2480 ± 70**
530 B.C.

Fine particulate fraction of blanket peat from 144 to 148 cm depth. Sample from level of beginning of decline of non-tree pollen immediately above level where tree pollen falls sharply from ca. 20% to ca. 10%, with pollen of cereals and weed species.

2765 ± 70
UB-326. Pubble Profile I, 150 to 152 cm **815 B.C.**

Fine particulate fraction of blanket peat from 150 to 152 cm depth. Sample from end of gradual decline of tree pollen from ca. 40% to ca. 20% and just below level of sharp fall to ca. 10% (see UB-325, above).

1665 ± 80
UB-331. Pubble Profile III, 16 to 20 cm **A.D. 285**

Fine particulate fraction of blanket peat from 16 to 20 cm above base. Sample at level of birch peak, decline of grasses and increase of heaths.

2280 ± 70
UB-330. Pubble Profile III, 10 to 14 cm **330 B.C.**

Fine particulate fraction of blanket peat from 10 to 14 cm above base. Sample from base of peat immediately above upcast from ditch. At level of sample oak curve is declining, alder curve is at a maximum, grass curve increases, and heath curve declines.

General Comment (A.G.S., I.G.): UB-326 and UB-325 from Profile I bracket pollen-analytically defined agricultural phase which thus appears to belong to latest part of Bronze age, and shows intensified utilization of area some time after construction of barrow. Date for UB-330 is some 500 yr younger than date for UB-196 F (this list). These 2 samples come from within 2 m of each other; both immediately overlie upcast but porosity of substratum differs.

Carn a Chnuic series, Inverness, Scotland

Samples of mor humus from pine forest and moorland in Abernethy and Kincardine parish, 8 mi S of Grantown-on-Spey, Moray, Inverness, Scotland. Coll. and pretreated 1968 by P. E. O'Sullivan, School of Biol. and Environmental Sciences, New Univ. of Ulster.

105 ± 65
UB-393. Carn a Chnuic, CAC-I, 13 cm **A.D. 1845**

Mor humus from 13 cm depth in soil below pine forest (57° 12′ N Lat, 3° 36′ W Long; Grid Ref. NJ (38) 137147; alt 1400 ft O.D.). Sample from H/F_2 layer interface. *Comment* (P.E.O'S.): pollen analyses indicate transition from open pine-birch woodland to closed pine forest at level of sample.

1035 ± 70
UB-392. Carn a Chnuic, CAC-I, 22 to 23 cm **A.D. 915**

Fine particulate fraction of mor humus from 22 to 23 cm depth in same profile as UB-393 (above). Sample from A_1/H layer interface. Pollen analytically defined change in forest composition at level of sample. *Comment*: (P.E.O'S.): result should indicate minimum date for onset of podsolization at site.

UB-395. Carn a Chnuic, CAC-III, base **1340 ± 70**
A.D. 610

Basal mor humus from *Calluna* moor (57° 12′ N Lat, 3° 37′ W Long;Grid Ref. NJ (38) 034142; alt 1300 ft O.D.). Sample from A_1/H layer interface. *Comment* (P.E.O'S.): result should indicate minimum date for onset of podsolization at site.

UB-394. Ryvoan Pass, Abernethy Forest, Inverness, Scotland, RVS(1), + 7 cm **1425 ± 70**
A.D. 525

Fine particulate fraction of charcoal-containing peat from *Calluna* moor in Abernethy and Kincardine parish, 10.5 mi S of Grantown-on-Spey, Inverness, Scotland (57° 10′ N Lat, 3° 55′ W Long; Grid Ref. NJ (38) 019109). Coll. and pretreated 1969 by P. E. O'Sullivan. *Comment* (P.E.O'S.): pollen analyses show change from pine-birch forest to open moorland at level of sample.

Upland Blanket Peat Samples

The following samples were taken in connection with research by Mrs. A. Goddard into the origins and vegetational changes associated with the initiation of blanket peat growth in NE Ireland. Percentages quoted in relation to pollen-analytical results are calculated on the basis of total pollen. Pretreatments carried out by A.G.

Altnahinch blanket bog series, Co. Antrim

Blanket peat samples from Altnahinch Td., 7.5 mi SW of Cushendall, Co. Antrim (55° 3′ N Lat, 6° 15′ W Long; Grid Ref. D 233125). Coll. 1969 by A.G.

UB-349. Altnahinch blanket bog, 41 to 46 cm **2370 ± 85**
420 B.C.

Fine particulate fraction of very fibrous blanket peat from 41 to 46 cm depth. Heath pollen dominant. Sample is at level of fall of grass pollen and rise of sedge pollen, and just above a charcoal layer.

UB-332 F. Altnahinch blanket bog, 51 to 57 cm **2725 ± 85**
775 B.C.

Fine particulate fraction of basal blanket peat. Sample from immediately above fall of total tree pollen from ca. 90% to ca. 30%.

UB-332 C. (humic acid) 2415 ± 70

UB-333. Altnahinch blanket bog, 58 to 63 cm **2745 ± 70**
795 B.C.

Humic acid from mineral soil below blanket peat. Tree-pollen percentages very high, mostly oak and hazel with some alder.

Lough Lark series, Co. Tyrone

Peat and soil samples from blanket bog near Lough Lark in Meenarodda Td., 20 mi SE of Londonderry, Co. Tyrone (54° 46′ N Lat, 7° 0′ W Long; Irish Grid Ref. H 645926; alt 1080 ft O.D.). Coll. 1966 by J. R. Pilcher.

UB-380. Lough Lark, 98 to 101 cm **3955 ± 75**
2005 B.C.

Fine particulate fraction of basal blanket peat. Sample at level of fall of total tree pollen from ca. 60% to ca. 30% where heath values rise sharply.

UB-381. Lough Lark, 102 to 105 cm **3835 ± 70**
1885 B.C.

Humic acid from mineral soil below blanket peat. Tree pollen percentage high, mostly hazel.

Breen bog (2) series, Co. Antrim

Peat and soil samples from blanket bog in Breen Td., 7.5 mi NW of Cushendall, Co. Antrim (55° 8′ N Lat, 6° 15′ W Long; Irish Grid Ref. D 118326; alt 900 ft O.D.). Coll. 1969 by A. Goddard.

UB-367 F. Breen bog (2), 50 to 55 cm **1485 ± 65**
A.D. 465

Fine particulate fraction of blanket peat from 50 to 55 cm depth. Base of true blanket peat with no mineral content. Sample from immediately above fall of total tree pollen from ca. 70% to ca. 30%.

UB-367 C. (humic acid) 1255 ± 65

UB-368. Breen bog (2), 60 to 65 cm **2715 ± 140**
865 B.C.

Fine particulate fraction of peaty soil from 60 to 65 cm depth. Tree pollen ca. 70%. Sample includes peak of willow curve and is just below rise of birch curve.

UB-369. Breen bog (2), 69 to 74 cm **3425 ± 90**
1475 B.C.

Fine particulate fraction of woody peat with high mineral content, from 69 to 74 cm depth. Just above phase of high alder pollen values and at rise of birch, hazel, and grasses. Tree pollen curve begins slow decline from ca. 90%. First consistent appearance of plantain pollen.

UB-370. Breen bog (2), 79 to 84 cm **3770 ± 95**
1820 B.C.

Humic acid from mineral soil just below base of organic deposits, at 79 to 84 cm depth. High tree pollen percentages, mostly alder and hazel with some birch. Sample is just below sharp rise of alder from ca. 40% to ca. 80% and at end of gradual pine decline.

UB-403. Ballypatrick Forest, 179 to 182 cm **2915 ± 75**
965 B.C.

Fine particulate fraction of blanket peat from 179 to 182 cm depth. Sample from near base of blanket peat which overlies reedswamp peat on slopes of Carneighaneigh Mt., 5.5 mi SE of Ballycastle, Co. Antrim (55° 9′ 30″ N Lat, 6° 7′ 35″ W Long; Irish Grid Ref. D 193364). Sample immediately above fall of total tree pollen. Fine charcoal fragments present. See also UB-265 (R., 1970, v. 12, p. 296, emended this list).

Glens Bridge series, Co. Antrim

Peat and soil samples from blanket peat in Altarichard Td., 8 mi W of Cushendall, Co. Antrim (55° 7′ N Lat, 6° 16′ W Long; Irish Grid Ref. D 106299; alt 760 ft O.D.). Coll. 1967 by A. Goddard.

1035 ± 75
UB-373. Glens Bridge, 64 to 68 cm **A.D. 915**

Fine particulate fraction of blanket peat from 64 to 68 cm depth. Sample is at level of fall of tree pollen, particularly hazel, and rise of sedges and grasses; plantain curve rises sharply.

1895 ± 70
UB-374. Glens Bridge, 117 to 123 cm **A.D. 55**

Fine particulate fraction of blanket peat from 117 to 123 cm depth. Sample at maximum of plantain curve and rise of grass and *Sphagnum* curves just above decline of hazel, the major tree species present.

2440 ± 100
UB-375. Glens Bridge, 171 to 175 cm **490 B.C.**

Fine particulate fraction of blanket peat from 171 to 175 cm depth. Sample at rise of heath pollen from ca. 15% to ca. 60% of total pollen, and fall of tree pollen.

3610 ± 75
UB-376 F. Glens Bridge, 199 to 203 cm **1660 B.C.**

Fine particulate fraction of basal blanket peat from 199 to 203 cm depth. Drop in tree pollen from ca. 90% to ca. 40% and end of alder peak; immediately above end of pine and elm curves.

UB-376 C. (humic acid) 3345 ± 70

General Comment (A.G. and A.G.S.): UB-376 F dates transition from locally dense scrub to open conditions, and initiation of blanket peat (see general comment on upland peat samples). At level of UB-374 pollen evidence suggests clearance of hazel scrub for pasture, and, subsequently, regeneration of scrub. Date shows clearance to have taken place in Iron age. Promontory forts in N Antrim thought to belong to this period. Renewed scrub clearance for pasture is indicated by pollen evidence at level of UB-373. Date implies that clearance may have been in response to Viking settlement as envisaged by Mitchell (1956, p. 247).

Loughaveema series, Co. Antrim

Peat and soil samples from blanket bog in Ballyvennaght Td., 5.5 mi NNW of Cushendall, Co. Antrim (55° 9′ N Lat, 6° 7′ W Long; Irish Grid Ref. D 205363; alt 740 ft O.D.). Coll. 1969 by A. Goddard. One sample of this series previously dated, UB-264 (172-175 cm, 2780 ± 95, R., 1970, v. 12, p. 296, emended this list).

2430 ± 70
UB-335. Loughaveema, 146 to 148 cm **480 B.C.**

Blanket peat from 146 to 148 cm depth. Sample at end of willow peak, fall of grasses, rise of heaths, sedges and *Sphagnum*. Acid pretreatment.

2360 ± 45
UB-365. Loughaveema, 160 to 166 cm **410 B.C.**

Humic acid fraction of woody peat from 160 to 166 cm depth. Sample at beginning of willow peak.

3075 ± 70
UB-334. Loughaveema, 189 to 193 cm **1125 B.C.**

Humic acid from mineral soil above iron pan at 189 to 193 cm depth. Sample falls during slow decline of tree pollen (mainly hazel) from ca. 35% to ca. 20% and rise of heath pollen. Grass and plantain pollen abundant.

General Comment (A.G. and A.G.S.): pollen evidence at level of UB-334 indicates site was pasture land. Date suggests this existed in Bronze age and is compatible with proximity to Bronze age cairn (UB-264, R., 1970, v. 12, p. 296, emended this list) though actual age may be slightly older since material dated was humic acid (see general comment on upland peat series). UB-365 and UB-335 bracket peak of willow pollen and, even though different peat fractions were dated, fact that dates are indistinguishable suggests that willow phase was short.

2520 ± 70
UB-347. Beaghs Forest, 42 to 44 cm **570 B.C.**

Humic acid from base of blanket peat at 42 to 44 cm depth in blanket bog in Beaghs Td., 5 mi SW of Cushendall, Co Antrim (55° 4′ N Lat, 6° 11′ W Long; Irish Grid Ref. D 158248; alt 1050 ft O.D.). *Comment*: abundance of grasses and plantains suggests site was pasture land. Date shows this was in existence in Bronze age.

Loughermore blanket bog series, Co. Londonderry

Samples of peat and soil from blanket bog in Loughermore Td., 9 mi ESE of Londonderry (54° 55′ N Lat, 7° 7′ W Long; Irish Grid Ref. C 585128). Site is close to Barrow from which Pubble series samples derive (this list). Coll. 1968 by C. Warhurst and sub-sampled 1969 by A. Goddard.

1940 ± 70
UB-350. Loughermore, 18 to 22 cm **A.D. 10**

Fine particulate fraction of blanket peat from 18 to 22 cm above base of peat. Sample at rise of heath pollen and fall of tree pollen.

2900 ± 70
UB-337 F. Loughermore, 0 to 5 cm **950 B.C.**

Fine particulate fraction of blanket peat from 0 to 5 cm above base of peat. Sample immediately above fall of oak curve from ca. 30% to ca. 5%, fall of hazel and rise of heath curves. *Comment*: pollen evidence implies oak-hazel scrub present on site until level immediately below sample. Result suggests this scrub disappeared in later part of Bronze age.

UB-337 C. (humic acid) 2640 ± 70

3705 ± 65
UB-346. Beaghs sand quarry, 155 to 158 cm **1755 B.C.**

Fine particulate fraction of basal, charcoal-containing, layer of blanket peat at sand quarry in Beaghs Td., 5 mi W of Cushendall, Co. Antrim (55° 5′ N Lat, 6° 11′ W Long; Irish Grid Ref. D 157274; alt 910 ft O.D.). Coll. 1969 by A. Goddard. Sample at fall of tree pollen (mostly hazel and birch) from ca. 90% to ca. 30% and rise of heaths, sedges and plantains. *Comment*: pollen evidence indicates hazel scrub disappeared from site at level of sample: date suggests this was in early part of Bronze age. See also Beaghs sand pit series in Pt. IV of this list.

Gruig Top series, Co. Antrim

Peat and soil samples from blanket peat in Timpan Td., 4 mi. NW of Cushendall, Co. Antrim (55° 6′ N Lat, 6° 8′ W Long; Irish Grid Ref. D 306198; alt 900 ft O.D.). Coll. 1968 by A. Goddard.

3055 ± 95
UB-406. Gruig Top, 69 to 75 cm **1105 B.C.**

Fine particulate fraction of blanket peat from 69 to 75 cm depth. Sample from beginning of rise of sedge pollen.

3335 ± 70
UB-364 F. Gruig Top, 79 to 84 cm **1385 B.C.**

Fine particulate fraction of basal, charcoal-containing, layer of blanket peat from 79 to 84 cm depth. Sample at end of decline of tree pollen (see UB-339, below) and rise of heath pollen.

UB-364 C. (humic acid) 3260 ± 70

3375 ± 75
UB-339. Gruig Top, 85 to 88 cm **1425 B.C.**

Humic acid fraction of mineral material from 85 to 88 cm depth, just below blanket peat. Sample at beginning of fall of tree pollen, mainly hazel, from ca. 85% to ca. 45% at level of UB-364 (above), peak of birch pollen.

General Comment: results for UB-364 and UB-339 show little or no discontinuity between mineral and organic deposits. Pollen evidence indicates transition from scrub to heath between levels of UB-364 and UB-339. Dates show transition took place in middle of Bronze age.

Crocknamoyle series, Co. Antrim

Peat samples from Drumfresky Td., 4 mi NW of Cushendall, Co. Antrim (55° 7′ N Lat, 6° 9′ W Long; Irish Grid Ref. D 313188; alt 750 ft O.D.). Coll. 1968 by A. Goddard.

2715 ± 85
UB-404. Crocknamoyle, 84 to 89 cm **765 B.C.**

Fine particulate fraction of blanket peat from 84 to 89 cm depth. Sample at level of peaks of grass, sedge, and plantain pollen curves, at end of temporary decline of tree pollen by ca. 25%.

UB-405. Crocknamoyle, 105 to 112 cm **2815 ± 90**
865 B.C.

Fine particulate fraction of blanket peat from 105 to 112 cm depth. Sample from level of minimum of tree pollen (mainly hazel).

General Comment (A.G. and A.G.S.): site is close to present-day hazel scrub. Samples are from levels where recession of scrub is suggested by pollen evidence. Dates indicate rapid peat accumlation rate close to base of bog and that hazel scrub is of long standing, originating at least as early as Bronze age.

General Comment on Upland Peat Samples: samples selected for dating basal peat are from purely organic layers, generally containing fine charcoal fragments, immediately above mineral soil. In most cases total tree pollen percentage falls markedly at level of sample. Dates of basal peats appear to fall into 2 groups. First group (UB-346, UB-376, UB-364, and UB-380) fall in a few centuries either side of 1700 B.C. UB-265, 1730 ± 95 B.C. (R., 1970, v. 12, p. 296, emended this list), for basal *Phragmites* peat in same area, seems also to belong to this group. Second group UB-332, UB-347, and UB-337), together with UB-264 (R., 1970, v. 12, p. 296, emended this list) fall in a few centuries either side of 750 B.C.

In 4 cases both humic acid (C) and fine particulate (F) fractions of blanket peat samples were dated. Taking the means, the humic acid dates are some 100 to 300 yr younger than the fine particulate fraction dates. The determinations are:

UB-332 F.	2725 ± 85
UB-332 C.	2415 ± 70
UB-337 F.	2900 ± 70
UB-337 C.	2640 ± 70
UB-364 F.	3335 ± 70
UB-364 C.	3260 ± 70
UB-367 F.	1485 ± 65
UB-367 C.	1255 ± 65

General Comment on Palaeoecologic Samples relevant to dating of Irish Pollen Zone Boundaries: certain determinations are relevant to dating of pollen zone boundaries. Pollen Zone Boundary V-VI, previously dated in Ireland only by Q-367 (Roddans Port, Co. Down), 7140 ± 150 B.C. (R., 1964, v. 6, p. 119), is dated by UB-280 (Slieve Gallion, Co. Tyrone), 6810 ± 90 B.C. and UB-258 (Ballynagilly, Co. Tyrone), 6145 ± 80 B.C.

The Boreal-Atlantic transition (Pollen Zone VI-VII boundary) is dated by UB-120 (Ballyscullion, Co. Antrim), 5000 ± 85 B.C., UB-221 A (Sluggan, Co. Antrim), 4810 ± 90 B.C., and UB-277 (Slieve Gallion, Co. Tyrone), 4785 ± 85 B.C. These may be compared with UB-96 (Beaghmore, Co. Tyrone), 5050 ± 90 (R., 1970, v. 12, p. 294). Other determinations for this zone boundary in Ireland are:

Woodgrange, Co. Down (LJ-904) 5700 ± 400 B.C. (R., 1965, v. 7, p. 83)

Ringneill Quay, Co. Down (Q-632)	5395 ± 150 B.C.
	5550 ± 150 B.C. (R., 1962, v. 4, p. 58)
Redbog, Co. Louth (D-2)	4450 ± 200 B.C. (R., 1961, v. 3, p. 27)

Pollen Zone Boundary VIIa-VIIb at Ballyscullion, Co. Antrim, is dated by UB-114, 3040 ± 55 B.C. which comes from point where elm decline is under way. Elm decline begins at this site approx. at level of UB-115, 3180 ± 60 B.C. These results may be compared with dates for the elm decline at Co. Tyrone sites, Beaghmore (UB-99), 3335 ± 75 B.C. (R., 1970, v. 12, p. 293, emended this list) and Ballynagilly (UB-253) 3195 ± 70 B.C. (R., 1970, v. 12, p. 295). Other radiocarbon dates for this zone boundary in Ireland are:

Fallahogy, Co. Londonderry (Q-555)	3385 ± 120 B.C.	(R., 1962, v. 4,
	3170 ± 120 B.C.	p. 67-8)
(Q-653)	3325 ± 120 B.C.	
	3250 ± 120 B.C.	
Redbog, Co. Louth (D-3)	3220 ± 190 B.C.	(R., 1961, v. 3, p. 28)
Lomcloon, Co. Sligo (D-12)	3210 ± 190 B.C.	(R., 1961, v. 3, p. 28)
Treanscrabbagh, Co. Sligo (D-13)	3020 ± 190 B.C.	(R., 1961, v. 3, p. 29)

The pine decline used by Jessen (1949) as one criterion for the definition of his Zone Boundary VII-VIII (Sub-Boreal—Sub-Atlantic) has previously been dated to 2390 ± 65 (UB-250, Ballynagilly, Co. Tyrone) and between 1930 ± 65 and 2575 ± 55 B.C. (UB-91, UB-92, Beaghmore, Co. Tyrone). New determinations in this list are:

(a) From long pollen diagrams through deep peats:—

Ballyscullion, Co. Antrim (UB-111)	2250 ± 85 B.C.
Slieve Gallion, Co. Tyrone (UB-274)	2215 ± 80 B.C.

(b) From base of blanket peats:—

Lough Lark, Co. Tyrone (UB-380) (sample immediately below pine decline)	2005 ± 75 B.C.
Breen bog (2), Co. Antrim (UB-370)	1820 ± 95 B.C.
Ballypatrick, Co. Antrim (UB-265) (sample immediately below pine decline)	1730 ± 95 B.C.
Glens Bridge, Co. Antrim (UB-376F) (sample immediately above pine decline)	1660 ± 75 B.C.
Altnahinch, Co. Antrim (UB-333)	795 ± 70 B.C.

With the exception of UB-333 (for which the sample was humic acid from a mineral soil) these dates fall in few centuries either side of 2000 B.C. Range of dates might be taken as confirming Mitchell's opinion (Mitchell, 1956) that zone boundary is not synchronous. Dates from deep peats, however, appear to show some consistency. Jessen suggested zone boundary fell at ca. 500 B.C. These determinations show it to be much older.

III. TIMBER SAMPLES

Samples from timbers collected from Irish sites for dendrochronologic studies.

685 ± 80
UB-267. Mill Lough No. 203, Co. Fermanagh **A.D. 1265**

Morticed oak beam from crannog (lake dwelling) in Mill Lough, Loughgare Td., Co. Fermanagh (54° 13′ 30″ N Lat, 7° 17′ W Long; Irish Grid Ref. H 467313). Coll. 1968 by M. G. L. Baillie. Sample was 10 annual rings taken 25 yr from outside of 97-yr-old tree. Pretreatment by bleaching and charring. Remains of structure summarily excavated by R. Warner (Ulster Mus., Belfast) in 1968. *Comment* (R.W.): structure, which is typical 'Fermanagh Crannog', produced 'crannog-ware' pottery, ascribed by most authors to Medieval period, and leather shoes of this period. Result tends to confirm Medieval date of 'crannog-ware'.

4395 ± 80
UB-293. Ballynagilly bog oak, Co. Tyrone **2445 B.C.**

Bog oak from 175 m W of Neolithic habitation site in Ballynagilly Td., 5 mi NW of Cookstown, Co. Tyrone (54° 42′ N Lat, 6° 51′ W Long; Irish Grid Ref. H 743837). See Ballynagilly Series I and II, this list, for other samples from this site. Sample was 10 annual rings taken 60 yr from outside of 270-yr-old tree found in shallow blanket peat. Coll. 1969 by M. G. L. Baillie.

1025 ± 60
UB-287. Blackwater bog oak No. 303 **A.D. 925**

Sample from bog oak found during river deepening at Verners Bridge, River Blackwater, Co. Tyrone (54° 29′ 30″ N Lat, 6° 38′ W Long; Irish Grid Ref. H 883615). Sample of 10 annual rings 170 yr from outside of 260-yr-old tree. Coll. 1968 by M. G. L. Baillie.

4490 ± 60
UB-286. Derrykerran bog oak No. 128 **2540 B.C.**

Sample from bog oak found during motorway construction at Derrykerran Td., Co. Armagh, 1 mi W of point where motorway crosses R. Bann (54° 28′ N Lat, 6° 27′ W Long; Irish Grid Ref. J 006588). Sample of 10 annual rings taken 80 yr from outside of 220-yr-old tree. Coll. 1968 by M. G. L. Baillie.

IV. GEOCHEMICAL SAMPLES

Samples in this section form part of a continued program for investigation of reliability of various peat types and fractions for dating. Fraction pretreatment and nomenclature follows that in R., 1970, v. 12, p. 296, Sec. III. In addition, a fine particulate fraction was prepared from material in Fraction D $< 250\ \mu$; this is called Fraction F.

Beaghs sandpit series, Co. Antrim

Samples from W side of sand quarry at Beaghs Td., 2 mi W of Cushendall, Co. Antrim (55° 5′ N Lat, 6° 11′ W Long; Irish Grid Ref.

D 156276). Samples taken to date blanket peat and iron pan formation. Coll. 1969 by P. Q. Dresser.

4140 ± 55
UB-270 A. Beaghs sandpit, No. 1 **2190 B.C.**

Unfractionated basal 2 cm layer of blanket peat from N of Sample 5. Fractions dated:

UB-270 B.	(water soluble matter)	3600 ± 55
UB-270 C.	(humic acid)	4110 ± 55
UB-270 D.	(residue)	4255 ± 60
UB-270 F.	(fine particulate)	4355 ± 60

4905 ± 85
UB-291. Beaghs sandpit, No. 5 **2955 B.C.**

Peripheral portion of prostrate pine trunk in basal layer of peat. *Comment* (P.Q.D.): sample thought to provide lower limit for date of iron pan formation, due to manner in which pan formed around pine roots.

General Comment (P.Q.D.): UB-270 B is significantly younger, and UB-270 F significantly older, than whole peat, Fraction A, using 2 σ limits.

Sluggan series, Co. Antrim

Series continued from R., 1970, v. 12, p. 296. Peat samples from Sluggan bog, Magheralane Td., 1.5 mi NE of Randalstown, Co. Antrim (54° 46′ N Lat, 6° 18′ W Long; Irish Grid Ref. J 009921). Samples obtained by excavation at a part of bog 5.2 m deep. Coll. 1968 by P. Q. Dresser.

985 ± 45
UB-210 A. Sluggan, No. 1, 42 to 47 cm **A.D. 965**

Fresh, light-brown *Sphagnum imbricatum* peat, with some *Eriophorum.*

1225 ± 65
UB-211 A. Sluggan, No. 2, 47 to 52 cm **A.D. 725**

Dark-brown well-humified *Sphagnum imbricatum* peat with *Eriophorum* and *Calluna.*

6760 ± 90
UB-221 A. Sluggan, No. 12, 295 to 300 cm **4810 B.C.**

Highly humified moss peat with pine and birch twigs and rootlets. *Comment*: sample from Pollen Zone Boundary VI-VII (Boreal-Atlantic).

8195 ± 65
UB-223 A. Sluggan, No. 14, 365 to 370 cm **6245 B.C.**

Fine reedswamp peat with seeds of *Menyanthes* and wood. Other dated fractions:

UB-223 B.	(water soluble matter)	7975 ± 70
UB-223 D.	(residue)	8360 ± 60

Comment: Fraction D is significantly older than whole peat (Fraction A) using 2 σ limits.

CORRECTION TO DATES IN BELFAST II

Owing to a previously undetected change in standard count-rate caused by accidental dilution, a small correction has to be applied to the following dates pub. in R., 1970, v. 12, p. 291-297.

Sample no.	Name	Corrected date
UB-240	Annaghmare Cairn, Chamber 2	1600 ± 50
UB-241	Annaghmare Cairn, forecourt	4395 ± 55
UB-266	Teeshan, No. 9	1970 ± 80
UB-94	Beaghmore Series I, 308 to 312 cm	6050 ± 60
UB-97	Beaghmore Series I, 278 to 280 cm	4640 ± 55
UB-99	Beaghmore Series I, 286 to 288 cm	5285 ± 70
UB-11	Beaghmore Stone Circles, Cairn 10	3485 ± 55
UB-261 A	Beaghmore, basal blanket peat	2230 ± 60
UB-261 B, 1765 ± 50.	UB-261 C, 1920 ± 60. UB-261 D,	2275 ± 65
UB-248	Ballynagilly core, 204 to 207 cm	3955 ± 55
UB-255	Ballynagilly core, 270 to 273 cm	5920 ± 60
UB-264	Loughaveema, 170 to 173 cm	2780 ± 95
UB-265	Ballypatrick Forest, 203 to 206 cm	3680 ± 95

These changes do not affect the conclusions derived from the dates.

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VIENNA RADIUM INSTITUTE RADIOCARBON DATES II

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Measurements have continued with the same proportional counter system, the same procedure in sample pretreatment, methane preparation and measurement, and the same age calculation using a half-life of 5568 ± 30 yr as described previously (R., 1970, v. 12, p. 298-318).

Uncertainties quoted are single standard deviations originating from the statistical nature of radioactive decay including standard, sample, background, and half-life. No C^{13}/C^{12} ratios were measured.

The following list presents most samples of our work in the last year. Sample descriptions have been prepared in cooperation with submitters.

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I have again to express many thanks to I. L. Stein for the excellent work in sample preparation and to E. Pak for the careful work in operation of the dating equipment.

SAMPLE DESCRIPTIONS

I. GEOLOGY, GEOGRAPHY, SOIL SCIENCE, AND FORESTRY

Austria

8500 ± 130
VRI-170. Grossenzersdorf, N.Ö. 6550 B.C.

Oak wood, taken from depth 10 to 12 m below surface (154 m sea level) near Grossenzersdorf (48° 12′ N Lat, 16° 36′ E Long), Lower Austria. Coll. 1969 and subm. by H. Bednar, Inst. f. Holzforschung, Hochschule f. Bodenkultur, Vienna. *Comment* (H.B.): dating necessary for biologic and technical analysis of wood.

7000 ± 160
VRI-175. Rutzendorf, N.Ö. 5050 B.C.

Wood from layer of main stems of trees ca. 8 m below surface in gravel of river platform "Prater Terrasse" (Danube), Rutzendorf (48° 12′ 16″ N Lat, 16° 36′ 38″ E Long), Lower Austria, E of Vienna. Coll. 1969 and subm. by J. Fink, Geog. Inst., Univ. of Vienna. *Comment* (J.F.): for a long time the Prater Terrasse has been considered of late Pleistocene age (Fink and Majdan, 1954). Similar wood findings near Linz by H. Kohl and in the Tullner Feld by L. Piffl, suggest a Holocene age. This sample proves suggestion. However, some parts of Prater Terrasse are surely of Pleistocene age (Fink, 1955).

Lugendorfer Au series, N.Ö.

Peat and wood taken from different depths of bog, Lugendorfer Au (48° 30′ N Lat, 15° 12′ E Long), ca. 15 km S of Zwettl, Lower Austria. Coll. 1967 and subm. by F. Kral, Inst. f. Waldbau, Hochschule f. Bodenkultur, Vienna. Absolute dating of pollen-analyzed horizons in peat profile was undertaken to clarify questions on forest history.

VRI-180. Depth 31 to 39 cm **1860 ± 80**
A.D. 90

Brown wood-peat (usual sort of peat in bogs of Low Austrian landscape "Waldviertel") from depth 31 to 39 cm. *Comment* (F.K.): pollen diagram gives evidence that sample covers the change from naturally grown *Pinus-Abies-Fagus*-forest to man-influenced forest rich in *Pinus*. Small pieces of charcoal point to rooting out by burning. Evidently human influence did not begin before 12th century (Foundation of Stift Zwettl 1137). Date not in contradiction because sample is composed of peat of different age: blackish-brown wood-peat lying below 35 cm is essentially older than date, brown *Sphagnum*-wood-peat overlying 35 cm grew after rooting out and is relatively young. In sample both components are mixed in equal parts by volume, but material of higher age overbalances because of its much slower growth rate.

VRI-181. Depth 70 to 80 cm **5130 ± 100**
3180 B.C.

Decayed wood (*Alnus* and *Quercus*) from depth 70 to 80 cm. *Comment* (F.K.): pollen-analytic placement of sample (in Sub-boreal) is uncertain for several reasons. Hence, date is not necessarily in contradiction. In this horizon scattered pollen grains of Larix are observed, suggesting that Larix grew locally even in the Neolithic. Up to now *Larix* in this area was thought not to be of natural origin, but artificially brought in.

VRI-182. Dachstein, O.Ö. **Recent**

Partially decayed wood (*Pinus cembra*?) in 23 to 25 cm depth of a 55-cm-thick raw humus layer. "Zirmgrube" on plateau of Mt. Dachstein, ca. 6 km S of Hallstatt (47° 31′ N Lat, 13° 39′ E Long), Upper Austria. Coll. 1969 and subm. by F. Kral. *Comment* (F.K.): raw humus formation began in 1500 B.C., Sub-boreal, and stopped in 17th century A.D. as was indicated by pollenanalytic dating. This method puts horizon of depth 23 to 25 cm into the last centuries B.C. Date suggests that much later a branch may have fallen into relatively loose deposit.

Wallsee-Mitterkirchen series, O.Ö.

Wood from depths 6-to-7-m-thick pebble horizon lying on slate-clay and covered by alluvial sand. Samples dredged during work on Danube water-power sta. in Wallsee-Mitterkirchen area (48° 10′ N Lat, 14° 43′ E Long), Upper Austria. Coll. 1966 and subm. by F. Makovec, Österr. Donaukraftwerke AG., Ybbs a.d.Donau.

VRI-85. Wallsee I **310 ± 80**
A.D. 1640

Wood from wood bearing layer in ballast horizon, 3 m above slate-clay. *Comment* (F.M.): date agrees with supposed connection between wood-bearing layer and high level of Danube R. at end of 16th century.

VRI-86. Wallsee II **1990 ± 80** **40 B.C.**

Stem-wood from pebble horizon, taken near slate-clay zone. *Comment* (F.M.): date supports supposition that pebble horizon was formed in last 2000 yr.

VRI-87. Wallsee III **6560 ± 140** **4610 B.C.**

Stem-wood from pebble horizon, lying on slate-clay boundary. *Comment* (F.M.): sample transposed; does not date alluvial detritus deposition.

Ödenwinkelkees series, Salzburg

Peat and wood taken at moraine ridge of Ödenwinkelkees (Slupetzky, 1968) near lake Eisbodenlacke (47° 07′ N Lat, 12° 38′ E Long), 2060 m alt., Stubachtal, Hohe Tauern, Salzburg. Coll. by H. Slupetzky and G. Patzelt; subm. by H. Slupetzky, Geog. Inst., Univ. of Salzburg. Approx. date of glacier advance is expected.

VRI-154. Ödenwinkelkees 1 **6690 ± 110** **4740 B.C.**

Wood sample from peat bed taken at terminus of moraine ridge. Coll. 1967.

VRI-155. Ödenwinkelkees 2 **5580 ± 100** **3630 B.C.**

Peat sample from pressed peat bed. Coll. 1968.

VRI-150. Imst, Tirol **1450 ± 70** **A.D. 500**

Charcoal from burning horizon below weathering zone of B-horizon in colluvial calcareous brown earth over loamy-sandy slope material. Over burning horizon there lay 30 cm of B-horizon and 5 cm of humus horizon, at Untermarkter Alm ob Imst (47° 15′ N Lat, 10° 41′ E Long), Tyrol, 1500 m alt. Coll. 1968 and subm. by I. Neuwinger, Forstliche Bundesversuchsanstalt, Bodenkundliches Lab., Imst. *Comment* (I.N.): displacement of horizons by slope sliding is possible. Date fixes burning horizon chronologically.

VRI-151. Untergurgl-Poschach, Tirol **3640 ± 150** **1690 B.C.**

Charcoal from burning horizon over eroded iron-podsol, ca. 30 cm below surface, partially carried away or buried by torrents carrying stones and earth. *Pinus cembra* forest above Untergurgl-Poschach (48° 53′ N Lat, 11° 02′ E Long), Ötztal, Tyrol, in area of the bioclimatic sta. of Forstliche Bundesversuchsanstalt Obergurgl (Neuwinger, Czell, 1959) at 2050 m alt. Coll. 1968 and subm. by I. Neuwinger. *Comment* (I.N.): displacement of horizons by sliding is possible. Date gives *terminus ante quem* for soil genesis.

VRI-160. Obergurgl, Tirol **1700 ± 90**
A.D. 250

Charcoal pieces mixed with sand, humus, and rootlet remnants, from burning horizon 15 to 25 cm below recent humus horizon of an iron-podsol over an eroded older podsol. Austrian Alps of Ötztal, surroundings of Obergurgl (46° 52′ N Lat, 11° 02′ E Long), on road to the Timmelsjoch, alt. 2040 m. Coll. 1965 by M. Doenecke; subm. by I. Neuwinger. A special pretreatment was used (similar to that of Haynes, 1966), to remove plant contaminants. *Comment* (I.N.): date gives *terminus ante quem* for soil genesis.

Rotmoos series, Tirol

Cyperaceae-peat samples from bog Rotmoos, from different depths. Rotmoostal (46° 50′ 30″ N Lat, 11° 01′ 30″ E Long), 2260 m alt, Obergurgl, Tyrol. Coll. 1969 and subm. by S. Bortenschlager, Inst. f. Bot. Systematik und Geobot., Univ. of Innsbruck.

VRI-156. Rotmoos I **5170 ± 100**
3220 B.C.

Depth 243 to 244 cm. *Comment* (S.B.): indicates beginning of organic sedimentation.

VRI-157. Rotmoos II **4680 ± 100**
2730 B.C.

Depth 223 to 226 cm. *Comment* (S.B.): 1st peat layer being thicker, it could coincide with major glacier retreat.

VRI-158. Rotmoos III **4340 ± 90**
2390 B.C.

Depth 182 to 185 cm. *Comment* (S.B.): thick peat layer with remains of wood between clay layers, perhaps proving main glacier fluctuation.

Roppen north series, Tirol

Pieces of charcoal from burning horizon in forest S of Roppen (47° 13′ N Lat, 10° 49′ E Long), near Imst, Tyrol, coll. near new forest road, 900 m alt. Subm. by H. Heuberger, Geog. Inst., Univ. of Innsbruck. *General Comment*: burning horizon of brown earth buried under landslide moraine of Mt. Tschirgant (Heuberger, 1968). Brown earth was formed on silicic moraine. Landslide moraine, predominantly dolomitic limestones, is ca. 4 m thick at this location. At site landslide moraine was cut by dredger.

VRI-144. Roppen north 1 **3230 ± 90**
1280 B.C.

Coll. 1968 by H. Heuberger. Sample not free from recent rootlets, which could not be removed chemically because material was not perfectly charred and much of it would have been lost. With assumed admixture of 5% recent material, charcoal age is 3440 B.P.

VRI-190. Roppen north 2 **2820 ± 110**
870 B.C.

Coll. 1969 by I. Neuwinger. Sample free of recent contaminants.

700 ± 70
VRI-176. Roppen, Tirol **A.D. 1250**

Charcoal mixed with sand, humus and rootlet remnants from burning horizon below 20-cm-thick colluvial A-horizon, taken near new forest road, 900 m alt., ca. 200 m from moraine of Mt. Tschirgant landslide. Forest S of Roppen (47° 13′ N Lat, 10° 49′ E Long), near Imst, gorge of Oetz Valley, Tyrol. Coll. 1969 and subm. by I. Neuwinger. *Comment* (I.N.): dating is to aid interpretation of the complex soil profile.

Baumkirchen-Fritzens series, Tirol

Samples from clay-pit Baumkirchen-Fritzens (47° 18′ 25″ N Lat, 11° 34′ 19″ E Long), Tyrol.

General Comment (F.F.): banded silt and clay is doubtless primary sedimentation. VRI-161 dates 1st fossils found in a 30 yr search; up to now, banded silt was thought to be sterile. Dates were surprising because until now this lacustrine sediment was thought to be either Riss Würm Interglacial or Early Würm (Fliri *et al.*, 1970).

26,800 ± 1300
VRI-161. Baumkirchen 1 **24,850 B.C.**

Small sample of conifer needles and fragments of branch from *Pinus mugo* found at 681 m alt. in perpendicular wall, at NNW part of excavation, 10 m below surface. Location of sampling was below horizontal layer of banded silt, 6.5 m thick, in completely undisturbed position. Sample discovered 1969 by O. Melander; coll. by F. Fliri and W. Resch; subm. by F. Fliri, Geog. Inst., Univ. of Innsbruck. *Comment* (F.F.): sample was prepared from 100 = dm^3 block of clay with many tracks of aquatic animals and calcareous pebbles. Very little pollen was detected (S. Bortenschlager: *Pinus, Gramineae, Cyperaceae*).

28,900 ± 700
VRI-173. Baumkirchen 2 **26,950 B.C.**

Wood (*Hippophae rhamnoides*), at 660 m alt. in perpendicular wall at S part of excavation. Location of sample was below layer of nearly horizontal banded silt, 30 m thick, in completely undisturbed position. Coll. 1969 and subm. by F. Fliri. *Comment* (F.F.): intensive search for organic material brought this sample only 5 mos. after VRI-161. In same horizon again were found many tracks of fishes and a fist-sized calcareous pebble. Date consistent with VRI-161.

Schlatenkees series, Venediger Group, Osttirol

Peat and wood from different depths of peat profile of bog, 135 cm thick, present-day above timber line. Schlatenkees (47° 06′ 53″ N Lat, 12° 26′ 46″ E Long), outside of right lateral moraine, SW of Salzbodensee, 2165 m alt., Venediger Group, Hohe Tauern, East-Tyrol. Coll. 1969 and subm. by G. Patzelt, Meteorolog. Inst., Univ. of Innsbruck.

General Comment (G.P.): pollen analysis proves repeated changes in vegetation. The horizons pointing to climate deterioration and advances of glacier Schlatenkees are chronologically fixed by dating. Wood samples throughout were clearly older than peat samples, as inferred from stratigraphic interpolation; similar observations have been made on other peat profiles: Wood horizons are always found immediately *above* peat layers pollen analysis of which points to clearly deteriorated climatic conditions for tree growth. Interpretation is that trees do not fall into bog immediately after dying, but are transported from up-valley after being killed by the advancing glacier.

6000 ± 110
VRI-138. Depth 25 cm **4050 B.C.**

Peat.

7280 ± 120
VRI-134. Depth 33 to 35 cm **5330 B.C.**

Wood from uppermost, youngest, wood horizon of peat profile, pointing to climatic deterioration; belongs to glacier maximum.

6600 ± 110
VRI-139. Depth 45 cm **4650 B.C.**

Peat.

7340 ± 120
VRI-135. Depth 65 to 67 cm **5390 B.C.**

Wood from 2nd wood horizon overgrown by wood-free peat; belongs to glacier maximum.

7100 ± 110
VRI-172. Depth 80 cm **5150 B.C.**

Peat.

7600 ± 120
VRI-177. Depth 105 cm **5650 B.C.**

Peat.

8970 ± 130
VRI-137. Depth 135 cm **7020 B.C.**

Wood. *Comment* (G.P.): sample taken from base of bog gives minimum age of underlying moraine.

Rostocker Hütte series, Venediger Group, Osttirol

Peat from different depths of a bog near refuge Rostocker Hütte (47° 03′ 19″ N Lat, 12° 18′ 07″ E Long), 2200 m alt., Venediger Group, East-Tyrol. Coll. 1969 and subm. by G. Patzelt.

425 ± 60
VRI-178. Depth 35 cm **A.D. 1525**

Sample from peat layer between loamy deposits. *Comment* (G.P.): sample dates loamy deposits above and below peat layer, washed in by brook draining Simonykees Glacier at the time of its maximum extension.

4110 ± 90
VRI-179. Depth 170 cm **2160 B.C.**

Comment (G.P.): pollen analysis reveals change of vegetation pointing to deterioration of climatic conditions which is chronologically fixed by dating.

II. ARCHAEOLOGIC SAMPLES

A. Austria

VRI-164. Klosterneuburg, N.Ö. **<220**

One of several wooden posts arranged in a double row, 70 cm below ground in loess, obviously, to save a water-ditch. Klosterneuburg (47° 21′ N Lat, 16° 18′ E Long), boundary towards Kierling, field "Eisenhütte." Coll. 1969 by J. W. Neugebauer; subm. by R. Pittioni, Inst. f. Ur- und Frühgeschichte, Univ. of Vienna. *Comment* (R.P.): exact interpretation impossible because no systematic excavation exists.

Pottenbrunn series, N.Ö.

Wood, remnants of coffin from grave field in tertiary ballast. Ballastpit Haas, Pottenbrunn (48° 14′ N Lat, 15° 42′ E Long), Lower Austria. Coll. 1964 by H. Friesinger; subm. by R. Pittioni.

General Comment (R.P.): archaeologic chronology fixes grave field at change of 9th to 10th century A.D.

1150 ± 70
VRI-117. Grave 29 **A.D. 800**

120 cm below surface. *Comment* (R.P.): after correction for de Vries-effect (Suess, 1965), date gives useful completion of archaeologic chronology.

1400 ± 70
VRI-118. Grave 40 **A.D. 550**

140 cm below surface. *Comment* (R.P.): even after correction for de Vries-effect (Suess, 1965) date too old by 300 to 400 yr.

2160 ± 80
VRI-116. Trasdorf, N.Ö. **210 B.C.**

Charcoal from ground plan of late Hallstattian settlement object found in loam pit of brickyard in Trasdorf (48° 19′ N Lat, 15° 53′ E Long), Lower Austria. Coll. 1965 by A. Persy; subm. by R. Pittioni. *Comment* (R.P.): present date agrees with earlier date, VRI-60 (Felber, 1968; 1970) with result 2240 ± 90. Date younger than expected by archaeologic evidence.

VRI-149. Hallein, Slzbg. **<200**

Wood (*Picea*) remnants of fire sticks in so-called "Heidengebirge," former salt mine pits filled with loam, clay, and different salts. Salt mine Dürrnberg, Hallein (47° 41′ N Lat, 13° 05′ E Long), Salzburg. Coll. 1967 by O. Schauberger; subm. by F. Morton, Prähist. Sta., Hallstatt, O.Ö. *Comment* (F.M.): fire sticks could belong to Hallstatt period or to Middle age. According to estimated age limit, after correction for de Vries-effect (Suess, 1965), sample belongs to time after A.D. 1650.

Dormitz series, Tirol

Charcoal from an "Aufschüttungslinse" (fill up lens) in "Ackerterrassen" (soil rising in terraces) at Dormitz (47° 20′ N Lat, 10° 50′ E Long), Tyrol. Coll. 1968 and subm. by S. Bortenschlager, Inst. Bot. Systematik und Geobot., Univ. of Innsbruck.

2130 ± 90
VRI-142. Dormitz I **180 B.C.**

Charcoal uniformly dispersed in lens from 25 to 65 cm depth. *Comment* (S.B.): sample dates Ackerterrassen, frequently found in Tyrol and in Alpine foreland. Pollen analysis and conclusions of historians suggest post-Roman origin but before A.D. 800. All previous speculations from natural origin to origination by Illyrians are discarded.

2230 ± 70
VRI-143. Dormitz II **280 B.C.**

Charcoal from base of lens, 70 cm below surface. *Comment* (S.B.): sample was taken from a stone ring, presumably from a fireplace. It is questionable whether sample is related to lens or not. If it is, sample should have the same age as VRI-142, and human origin of Ackerterrassen would be proved. Result verifies human origin.

Brigantium-Bregenz series, Vorarlberg

Samples from stables of Roman camp Brigantium, excavated below Josef-Huter-Street 12, Cut II, SW profile, Bregenz (47° 30′ N Lat, 9° 43′ E Long), Vorarlberg. Coll. 1967 by E. Vonbank; subm. by R. Pittioni. *General Comment* (E.V.): dates in excellent agreement with ceramic dating and stratigraphy.

2000 ± 80
VRI-113. Bregenz 1 **50 B.C.**

Horse dung, taken from undermost dark layer, depth 2.40 m.

2020 ± 80
VRI-114. Bregenz 2 **70 B.C.**

Unknown organic material, depth 2.40 m.

1870 ± 80
VRI-115. Bregenz 3 **A.D. 80**

Wood from intact bottom boards of stables. Depth 1.70 m below Roman road.

B. Italy

1080 ± 70
VRI-136. Lago di Ledro, Italy **A.D. 870**

Wood from pile from Lake Ledro (45° 51′ 37″ N Lat, 10° 45′ 56″ E Long) 7 km SE of Riva del Garda, prov. Trento, Italy, 655 m alt. Pile was lifted when power sta. was built. Coll. 1950 by Mus. Civico, Riva; subm. by F. Morton. *Comment* (F.M.): part of pile dwelling (Battaglia, 1953; Morton, 1967). Main part of findings from Lake Ledro belongs to Neolithic. Some Bronze age artifacts are also found. Therefore, pile dwellings reach into Bronze age. Date incomprehensible in this connection. A similar date was established from another sample by Univ. of Rome: Lago di Ledro B, R-339, 950 ± 50 (R., 1968, v. 10, p. 357). Older samples were also dated, Pi-88: 3137 ± 105 (R., 1961, v. 3, p. 102), R-7: 3310 ± 210 (R., 1964, v. 6, p. 82).

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RUDJER BOŠKOVIĆ INSTITUTE RADIOCARBON MEASUREMENTS I

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The routine processing and measurement of samples in our Radiocarbon Laboratory began early in 1970 following a one-year testing period during which standard samples (anthracite and NBS oxalic acid) as well as samples of known age were prepared and measured. Our system is based on the studies of de Vries and Barendsen (1953), Fairhall *et al.* (1961) and Olson and Nickoloff (1965). However, several modifications of the cited methods were introduced and are briefly discussed below. A detailed description of the whole system will be published elsewhere (Srdoč *et al.*, 1970).

Samples are prepared before combustion by the standard method used in most radiocarbon dating laboratories. The samples are boiled in a 4% solution of HCl washed with distilled water, then left overnight in a 4% solution of NaOH heated at 80°C, washed and boiled in distilled water to neutrality and dried at 95°C. The sample thus prepared is burnt following the method described by de Vries (1953). The carbon dioxide is purified by passing over silver wool heated at 450°C. Nitrogen oxide is removed in an absorption tube filled with manganese dioxide. Carbon dioxide is collected in traps and transferred into the apparatus for conversion to methane. We applied the methane synthesis method of Fairhall *et al.* (1961), modifying the reactor vessel design to avoid any dead space.

The samples are stored after combustion and conversion to methane for 14 days and then counted twice for approximately 1000 min at roughly 10-day intervals.

The proportional counter consists of a steel tube 6 cm in diameter and 40 cm long. End insulators are machined from Araldite/CT 200, CIBA, Basel, Switzerland. The anode is a stainless steel wire 25.4 $m\mu$ in diameter. A beryllium window having a high transmission for 6 keV X-rays allows counter calibration. Checking the counter gas for purity and setting the gas multiplication is performed by a routine procedure in our laboratory. This routine check consists in measuring the counter resolution and the position of the Fe^{55} peak (5.88 keV) with a multichannel analyzer. The guard counter consists of two concentric tubes divided into 18 separate counters by means of radially inserted metal sheets. The guard counter is filled with a mixture of butane and argon and operates in the Geiger region. The shielding is made of 6 cm of boron-loaded paraffin and of 20 cm of lead.

The charge from the anode of the proportional counter is amplified by an FET charge–sensitive preamplifier. The gate of the field effect transistor is directly coupled to the anode. The negative high voltage is connected to the cathode. The preamplifier input noise is about 250 e RMS. Signals from the preamplifier are amplified by a non-overloading amplifier with integrated circuits. The pulses are formed by a pulse shaping network consisting of a single RC differentiation and a double RC integration; the time constants in both cases are 1.8 μsec. The amplifier output is connected to a single channel analyzer which defines the upper and lower limits of the amplitude of signals. The output pulses from the single channel analyzer as well as the pulses from the Geiger guard counters are led to an anticoincidence circuit. Non-coincident pulses from the proportional counter are counted on a slow scaler. The number of pulses registered by the scaler is printed out on a strip printer every 20 minutes to make the statistical processing possible. The total number of pulses is registered in every tenth printout giving the information on the background counting rate. The data thus obtained are processed on the CAE 90-40 computer. The age of samples, the standard deviations of measurements based on the Poisson distribution as well as the best estimate of the true variance are calculated.

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SAMPLE DESCRIPTIONS

A series of measurements of samples of carbon, recent wood, and NBS oxalic acid was performed to check the reliability of the system. Tables 1 and 2 show the results.

While the results for modern wood and NBS oxalic acid were in good agreement when properly corrected, the background count was different for natural old methane (8.53 $\pm$ 0.08) and anthracite (8.89 $\pm$ 0.08). The increase of counting rate was presumably due to tritium contamination during methane synthesis. This was proven in the following way: old natural methane was burnt into CO_2 and CO_2 converted back to CH_4 by applying the standard procedure. The resulting counting rate was higher and close to that of anthracite indicating that

TABLE 1

Measurement of NBS oxalic acid standard. Two samples were prepared from the same batch of oxalic acid.

Sample	Date	Counting rate, cpm
Z-139/I	Feb. 27, 1970	20.89 ± 0.16
Z-139/II	March 3, 1970	21.31 ± 0.14
Z-139/I	March 8, 1970	20.83 ± 0.17
Z-139/II	March 9, 1970	21.16 ± 0.17
Z-139/II	March 10, 1970	21.30 ± 0.16
Z-139/I	March 12, 1970	21.10 ± 0.15
Z-139/II	March 15, 1970	21.33 ± 0.17
Z-139/I	March 18, 1970	21.14 ± 0.15
Z-139/I	March 24, 1970	21.06 ± 0.19
Z-139/II	April 22, 1970	21.08 ± 0.12

TABLE 2

Background counting rate

Sample	Date	Counting rate, cpm
Methane*	Feb. 26, 1970	8.54 ± 0.09
	March 2, 1970	8.58 ± 0.08
Coke	March 1, 1970	9.20 ± 0.1
	April 15, 1970	8.82 ± 0.06
Anthracite	March 7, 1970	9.01 ± 0.09
	March 14, 1970	9.27 ± 0.08
	April 2, 1970	9.11 ± 0.1
	April 13, 1970	9.08 ± 0.06
	April 27, 1970	8.83 ± 0.06
	May 12, 1970	8.89 ± 0.08
Marble	March 6, 1970	9.61 ± 0.09
	March 18, 1970	9.79 ± 0.1

* Natural gas obtained from oil deposits near Stružec, Yugoslavia.

hydrogen used for the methane synthesis was the source of contamination. This assumption was confirmed when a new cylinder of hydrogen was used for methane synthesis (tritium-free hydrogen, Griesheim, Germany). No discrepancy was observed between anthracite and old natural methane counting rates when tritium-free hydrogen was used.

CHECK SAMPLES

TABLE 3

Check samples

Sample	Age, years B.P.*	Our measurement, years B.P.
UW-147. Subm. by A. W. Fairhall	12,600 ± 150	12,700 ± 200
Hv-2637. Subm. by M. A. Geyh	7735 ± 70	7860 ± 150
Z-114. Measured by Ingrid Olsson, Uppsala, Sweden	150 ± 50	95 ± 50
Z-111. Measured by L. Engstrand, Stockholm	910 ± 100	910 ± 100
Sequoia tree rings**	1080 –1100 B.C.	2920 ± 120 970 B.C.

* Measured by authors listed in Col. 1.

** Age based on tree-ring chronology. Radiocarbon age is ca. 110 yr younger according to observations of other authors (Suess, 1967).

III. ARCHAEOLOGIC SAMPLES

Samples were collected in various places of archaeologic interest in NW Croatia (Zagreb, Varaždin) and along the Adriatic Littoral (Zadar, Nin), Serbia (Lepenski vir) and Macedonia (Stobi). Most of the settlements were inhabitated by Illyrian tribes, followed by Romans and Slavs.

910 ± 100
Z-111. Nin **A.D. 1040**

Wood from ship found from 180 to 200 cm depth in the sea, under 40 cm thick sandy layer, ca. 200 m off coast, at site Ždrijac (44° 14′ N Lat, 12° 52′ E Long). Sample coll. 1966 by Z. Brusić, Archaeologic Collection, Nin.

802 ± 94
Z-124. Nin **A.D. 1148**

Fragment of beam, probably from ship, found in port of Nin (44° 14′ N Lat, 12° 52′ E Long). Sample buried in mud, at 1 m depth, from hole dug out by the dredge during excavation of silt from sea bottom in the port. Sample coll. 1969 by K. Radulić, Inst. for Preservation of Cultural Monuments, Zadar.

Z-129. Zaton near Nin **2063 ± 67**
113 B.C.

Fragment of wooden beam, at 1.80 m depth, in 40 cm thick sandy layer. Coll. 1967, by Z. Brusić.

Z-110. Nin **767 ± 74**
A.D. 1173

Wood from stake of palisade in port of Nin. Coll. 1967 by Z. Brusić.

Z-114. Budva **95 ± 50**
A.D. 1855

Wood from ship, found in sand, Budva (42° 17′ N Lat, 16° 30′ E Long) in 1966. Hulk of ship completely buried in sand except for a few ribs. Measurements indicate remains of a ship of recent historic dating. Coll. 1966 by V. Stanišić, Budva.

Z-115. Lepenski vir **6984 ± 94**
5034 B.C.

Remains of rafter from House 54, Neolithic settlement, Lepenski vir I (44° 38′ N Lat, 20° 16′ E Long). Settlement excavated during construction of a hydro-electric power plant, Djerdap. Sample coll. 1968 by Z. Letica, Fac. of Arts, Belgrade.

Z-143. Lepenski vir **7300 ± 124**
5350 B.C.

Charcoal from Corner A of House 54, Neolithic settlement, Lepenski vir I. Coll. 1969 by Z. Letica.

Z-95. Sisak **1850 ± 150**
A.D. 100

Wood from Roman fortification, near Sisak (45° 28′ N Lat, 14° 02′ E Long). Coll. 1967 by S. Vrbanović, Mus., Sisak.

Z-132. Varaždinske toplice **1900 ± 150**
50 B.C.

Fragments of wood (probably remains of rafter from house) dug out at site of wooden dwellings of early imperial settlement Aquae Iasae, Roman Empire (46° 14′ N Lat, 14° 05′ E Long). Locality is high in moisture and swampy ground. Archaeologic evidence confirms same environmental features in early times. Upper layers are heavy humus followed by clay and loam underlain by larger or smaller amount of rotten matter, or various streaks of sand and marl. Coll. 1967 by M. Gorenc and B. Vikić, Archaeologic Mus., Zagreb.

Z-146. Ščitarjevo **2011 ± 80**
61 B.C.

Early imperial layer submerged in ancient times. Grain found at 1 m depth during sounding in Roman municipality Andautonia in vicinity of Zagreb. Sample coll. 1969 by M. Gorenc.

Z-144. Stobi **1750 ± 180**
A.D. 200

Charcoal from remains of fire destroyed settlement Stobi (41° 32′

N Lat, 21° 51′ E Long). Sample from a layer of ash and charcoal found during excavation of ancient theatre, Stobi. Layer of ash and charcoal spreads along entire cross section of fire area. Coll. 1969 by N. and D. Srdoč.

830 ± 103
Z-142. Zagreb **A.D. 1120**

Wood of rafter, depth 2 m, in medieval layer (45° 48′ N Lat, 13° 38′ E Long). Probably from foundation of former Capuchin convent in the Upper Town. Coll. 1969 by I. Šarić, Regional Inst. for Preservation of Cultural Monuments.

37,400 ± 640
Z-134. Velika Pecina **35,450 B.C.**

Charcoal from fireplace, found in a cave, Ravna Gora, NW dist. of Croatia (46° 17′ N Lat, 16° 2′ E Long, height 428 m).

IV. GEOLOGIC SAMPLES

1200 ± 100
Z-135. Dabar near Otočac **A.D. 750**

Sub-fossil wood that started to emerge at the bank of a peat bog in 1965. Coll. 1966 by I. Horvat, Fac. of Forestry, Zagreb.

896 ± 94
Z-147. Oroslavje **A.D. 750**

Wood emerging from steep bank of stream Topličina. Coll. 1969 by A. Sliepčevič.

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