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RADIOCARBON

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INSTRUCTIONS TO CONTRIBUTORS

Manuscripts of radiocarbon papers should follow the recommendations in *Suggestions to Authors*, 5th ed.* All copy must be typewritten in *double space* (including the bibliography): manuscripts for vol. 13, no. 1 must be submitted in *duplicate* by February 1, 1971, and for vol. 13, no. 2 by August 1, 1971.

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 $\pm$ 1σ, 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.
5. Reference to relevant publications. Citations within a description should be to author and year, with specific pages wherever appropriate. References to published date lists should cite the sample no., journal (R. for Radiocarbon), year, vol., and specific page (e.g., M-1832, R., 1968, v. 10, p. 97). Full bibliographic references are listed alphabetically at the end of the manuscript, in the form recommended in *Suggestions to Authors.*
6. Date of collection and name of collector.
7. Name of person submitting the sample to the laboratory, and name and address of institution or organization with which submitter is affiliated.
8. Comment, usually comparing the date with other relevant dates, for each of which sample numbers and references must be quoted, as prescribed above. Interpretive material, summarizing the significance and implicity showing that the radiocarbon measurement was worth making, belongs here, as do technical matters, e.g., chemical pretreatment, special laboratory difficulties, etc.

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

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

NOTICE TO READERS

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

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

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

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

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

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

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

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Radiocarbon

1970

CARBON-ISOTOPE FRACTIONATION DURING DRY COMBUSTION OF OXALIC ACID

J. A. LOWDON

Geological Survey of Canada, Ottawa, Canada

Grey *et al.* (1969) have discussed the problems that arise when using the wet oxidation method for the preparation of CO_2 from oxalic acid and suggest that, although offering an effective substitute, the dry combustion method also has problems.

Results obtained in this laboratory over the past 9 years indicate that only minor problems arise when using the dry combustion method.

Between January, 1961 and September, 1969, 47 oxalic acid standard CO_2 gas samples were prepared. Until January, 1968, C^{13}/C^{12} determinations were not available to the laboratory. However, anticipating that carbon isotope ratios would become available in the future, some CO_2 from randomly selected oxalic acid preparations was kept for future analysis. Thirteen such samples have been analyzed (by Isotopes Inc., New Jersey) dating from 1961 to January, 1969. The results are shown in Table 1.

TABLE 1

δC^{13} values for CO_2 from oxalic acid standards prepared by the dry combustion method

Date of preparation	CO_2 yield (%) (approx.)	C^{13}(‰)* (Relative to PDB standard)
January, 1961	97	−19.4
July, 1962	96	−17.8
September, 1963	100	−18.4
January, 1964	100	−19.5
September, 1964	98	−18.3
January, 1965	100	−17.8
December, 1965	93	−18.2
August, 1966	96	−17.8
October, 1967—Analysis 1	97	−20.1
—Analysis 2	97	−20.2
1967-1968**	96	−18.2
November, 1968	93	−20.6
January, 1969	60	−26.9

* Analytical error for each determination is ± 0.2‰.

** The CO_2 gas on which this determination was carried out was made up of a mixture of 4 individual oxalic acids, prepared between August, 1967 and April, 1968.

It has been determined quantitatively, for the volume of the preparation line used in this laboratory, that the expected yield of CO_2 for an oxalic acid combustion is ca. 1.5 cms of CO_2 gas pressure/gm of dry oxalic acid in an expansion volume of 18.5 L. The approximate yields of CO_2 given in Table 1 were calculated on this basis.

The only result obtained that shows any appreciable amount of fractionation is the preparation of January, 1969 (60% yield). This reaction was stopped intentionally about halfway through completion in order to verify that incomplete combustion results in fractionation of carbon isotopes (Craig, 1961). With respect to the total of 47 CO_2 preparations from oxalic acid, only 4 had yields of less than 90%. Because of the "isotope-yield" correspondence, as is evident in Table 1, 2 of these preparations prepared after January 1969 were discarded and not used for counting purposes. It is now our policy to discard all preparations which do not give greater than 90% of the expected yield. Results show safety in assuming that only slight, or negligible, fractionation occurs if more than 90% of the oxalic acid is converted to CO_2. This should not deter workers from obtaining δC^{13} values as a routine policy, but should lend a little more confidence to the dry combustion method of producing CO_2 gas from oxalic acid.

Ignoring the final result (January, 1969) listed in Table 1, the average δC^{13} value is −18.9‰, referred to the PDB standard, which agrees with the value of −19.0‰ determined by Craig (1961).

It was stated earlier that problems encountered in the preparation of CO_2 from oxalic acid by the dry combustion method used in this laboratory appear to be minor. Apart from the fact that the oxalic acid is given no pretreatment prior to combustion, only one change in the normal procedure for the preparation of other organic samples must be made. The normal procedure is fully described in Lowdon *et al.* (1969) and Lowdon and Blake (1970). For the successful preparation of CO_2 from oxalic acid, the temperature of the combustion furnace must be lowered from 700°C (for other organic samples) to 450°C, thus allowing the reaction to proceed very slowly. The reason for this change is not so much that a rapid reaction may enhance the chances of fractionation, but rather that a higher temperature causes rapid evaporation of the oxalic acid, giving rise to explosive mixtures in the combustion tube.

The results discussed here, and our experience have shown that the dry combustion method of preparing CO_2 from oxalic acid is reliable and gives reproducible results, provided time and care is taken to convert more than 90% of the carbon to CO_2. The major annoyance in the method is the length of time (ca. 4 hrs for 30 gms of oxalic acid) involved in sample preparation.

ACKNOWLEDGMENTS

The author wishes to thank W. Dyck, who was in charge of the laboratory from 1959 to 1964, for helpful suggestions for this paper.

Thanks are also extended to numerous laboratory personnel who assisted in the preparation and measurement of the samples.

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ATOMIC ENERGY RESEARCH INSTITUTE OF KOREA RADIOCARBON MEASUREMENTS I

KYUNG RIN YANG
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Atomic Energy Research Institute, Seoul, Korea

This radiocarbon dating laboratory was established to complement the research activities in the field of archaeology and geology in Korea. The benzene liquid scintillation counting method (Noakes, Kim, and Stipp, 1965; Noakes, Kim, and Akers, 1967) is employed in this laboratory because of its compatibility with other dating methods and future possibility in application of this procedure to the biomedical research field. The chemical process for converting carbon from a sample to benzene used by this laboratory is briefly outlined below.

The sample is first converted to CO_2 by combustion or acid digestion in a closed system. The CO_2 is converted to lithium carbide (Barker, 1953). Acetylene is then obtained by hydrolysis of lithium carbide. Trimerization of acetylene to benzene is carried out with a vanadium-alumina catalyst. In cases of some organic samples such as peat, silt, or wood, CO_2 is purified by the carbonate formation by absorption of CO_2 in concentrated ammonium hydroxide and addition of calcium chloride solution. All chemicals used are CO_2-free.

To the synthesized benzene, spectrograde benzene is added to make total volume of counting vial. The resulting counting solution contains 0.3% PPO and 0.02% POPOP. The liquid scintillation counter used is from the Beckman Instrument Co., Model LS-100. The background count rate of 4 cc counting vial is about 7.5 cpm, and counting efficiency is about 50%.

Ages are calculated from a C^{14} half-life of 5568 years and the modern reference standard is 95% activity of NBS oxalic acid standard. The error (1σ) quoted is calculated from the uncertainty involved in counting background, NBS oxalic acid standard, and sample.

ACKNOWLEDGMENTS

The author expresses his gratitude to Stephen M. Kim, Illinois State Geological Survey, Urbana, Illinois for his generous technical help and for supplying us with interlaboratory check samples during the construction of our laboratory. Also the author gratefully acknowledges the U.S. Atomic Energy Commission, "Atoms in Action" staff members for their help.

SAMPLE DESCRIPTIONS

I. INTERLABORATORY CHECK SAMPLES

11,510 ± 150
AERIK-1. Two Creeks, U.S.A. — 9650 B.C.

Wood, Two Creeks, Forest bed, Wisconsin, dated and reported previously as ISGS-7, 11,500 ± 300 (Radiocarbon, 1969, v. 11, p. 395); Tx-

541, 11,620 ± 80 (E. M. Davis, pers. commun.); FSU-3, 11,245 ± 450 (Radiocarbon, 1966, v. 8, p. 46-53); ANU-5, 11,700 ± 260 (Radiocarbon, 1967, v. 9, p. 15-27).

24,000 ± 870
AERIK-2. Danvers Section Z-1 22,050 B.C.

Wood, Danvers Sec. Z-1, dated previously as ISGS-12, 23,900 ± 200 (S. M. Kim, pers. commun.); Tx-693, 23,880 ± 490 (E. M. Davis, pers. commun.).

II. ARCHAEOLOGIC SAMPLES

3469 ± 78
AERIK-3. Tongnae site 1519 B.C.

Charcoal fragments from depth 40 to 50 cm below surface in the bottom of hearth built 3 m in diam. at Tongnae site, Tongnae-ku, Pusan, Korea (35° 10′ N Lat, 129° 07′ E Long). Earthenware, animal bone implements, and other animal bones were found in the vicinity of a shell mound of the Early Iron age. Coll. 1968 and subm. by B. S. Han, Natl. Mus. of Korea.

2169 ± 122
AERIK-4. Yangsan site 219 B.C.

Charcoal fragments, probably representing cooking fires from Yangsan site, Yangsan-myon, Yangsan-kun, Kyongsang-nam-do, Korea (35° 20′ N Lat, 129° 02′ E Long). Sample from depth 70 to 80 cm in a dwelling area on the hill at ca. +50 m. Near the dwelling area, a shell mound contained earthenware fragments, animal bone implements, oyster, clam, bones of fish, deer, and bear. Coll. 1967 and subm. by B. S. Han.

30,690 ± 3000
AERIK-5. Sokchang-ni site, Locality 1 28,740 B.C.

Almost indiscernible charcoal contents were collected from a large amount of soil of an undisturbed layer of the Sokchang-ni site, Loc. 1, Changki-myon, Kongju-kun, Chungchong-nam-do, Korea (36° 21′ N Lat, 127° 10′ E Long). Sample from depth 3.5 to 3.7 m in a roughly circular depression ca. 50 cm in diam. where dark soil color was observed. No stone implements were in this layer, but quartz palaeolithic tools were collected above and below. Excavation took place in 1967 and 1969 by P. K. Sohn. Subm. by P. K. Sohn, Yonsei Univ., Seoul, Korea. *Comment* (P.K.S.): date seems younger than expected since layer below is Mousterian tradition, and the uppermost layer bears Aurignacian character. A reasonable explanation is that the samples might have been contaminated before excavation, since the area is flooded almost annually.

3417 ± 60
AERIK-6. Sohak-ni site 1467 B.C.

Charcoal fragments, probably representing cooking fires on flood disturbed slope of Kum R. bank, Sohak-ni site, Kyeryong-myon, Kongju-kun, Chungchong-nam-do, Korea (36° 30′ N Lat, 127° 05′ E Long). Sample from bottom of circularly arranged boulders which might have been hearth. Boulders are below water level all year round. Crude pebble scrapers and chopping tools coll. 1967 and subm. by P. K. Sohn. *Comment* (P.K.S.): date seems extraordinarily young. Most reasonable explanation may be found in contamination by modern carbon in view of the Sokchang-ni site (AERIK-5).

3573 ± 48
AERIK-7. Tokmyong-ni site **1623 B.C.**

Slightly carbonized wood with polished stone tools 1 m below surface of Tokmyong-ni site, Hai-myon, Kosong-kun, Kyongsang-nam-do, Korea (34° 55′ N Lat, 128° 20′ E Long). Coll. 1967 and subm. by P. K. Sohn.

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ALGIERS RADIOCARBON MEASUREMENTS I

O. RAHMOUNI, C. ROUSSILLOT, and F. ARMANET

Service des Applications Nucléaires, Algiers, B.P. 1147, Algeria

The following list shows the age measurements made at Algiers by the Service des Applications Nucléaires using the C^{14} method. The laboratory was created in 1965 to answer the increasing demand of the archaeologic research in N Africa, and made its first measurements in 1967. The electronic apparatus employed was completed and calibrated in 1968 and the first tests were performed during the same year. Regular dating-test samples started in June, 1968. The electronic circuits are of commercial origin or made in the C^{14} Laboratory.

We follow the method used in the Gif s/Yvette Dating Laboratory. Samples are examined and foreign matter is removed. They are treated by leaching in a 5% NH_4OH solution, and then in a N/10 HCl solution. Samples are rinsed in distilled water and dried. Our filling gas, CO_2, is prepared by burning in a stream of oxygen and purified by passage through hot CuO, $AgNO_3$ solution, and H_2SO_4–CrO_3 solution; then it is precipitated as barium carbonate by bubbling in a $Ba(OH)_2$ solution. Sulfuric acid is used to liberate CO_2 from $BaCO_3$. Shells are only washed (twice) in hot distilled water and dried. They are not burnt, but directly attacked by sulfuric acid to liberate CO_2.

After purification by fractional crystallization, the gas is stored in flasks for ca. 30 days to eliminate the radon that may result from impurity of the reagents. Final purification is performed by absorption of CO_2 on alumina followed by desorption at room temperature, and by passage through a P_2O_5 column before and after a second fractional crystallization. This has proved particularly effective and gives a very good filling gas.

The counting unit is a 1.2 liter OFHC copper proportional counter and its filling is made at fixed pressure of 740 mm Hg. The counter is protected by a shield of 20 cm of lead and 5 cm of iron, and by a cylindrical crown of 2 cm of mercury. Anticoincidence shielding is provided by 36 Geiger-Müller tubes, surrounding the sample counter standing in the mercury crown. Working voltage is 4.7 kV with a plateau length of more than 500 V. Measurements are made in an air-conditioned room. Sample counts (of 1000 min) are repeated several times to give a total time of at least 5000 min. Background measurements were made by using industrial CO_2 from coke-ovens delivered in bombs. Our background is 1.40 count/min (error is $\pm \sigma$). The modern C^{14} standard (1950) is obtained from NBS oxalic acid standard multiplied by 0.95. The modern filling gas is prepared by wet oxidation of oxalic acid with potassium permanganate in acid solution. Dates are calculated on the Libby half-life value ($T^{1/2} = 5568 \pm 30$ yr). To test the linearity of our detector we measured artificial samples containing variable known percentages of

C^{14} and we found expected values. Some measurements on several samples already checked by other laboratories (Gif s/Yvette, Monaco, Nancy) are in agreement with ours; some of these are given in this list.

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We are grateful to J. Labeyrie and G. Delibrias and her collaborators for their continuous support, and to many in the Institut d'Etudes Nucléaires who gave us technical advice. We also thank Y. Pinatel, S. A. Boutemine, and R. Aït Ameur for their valuable help in routine work, as well as B. Abdelkader and O. L. Belaguida who preceded us in the laboratory. Sample descriptions were prepared in collaboration with collectors and submitters of samples. Most of them were submitted by the Centre Algérien de Recherches Archéologiques, Préhistoriques et Ethnographiques (C.A.R.A.P.E.), the others were submitted by the Service des Antiquités d'Algérie (Sous-Direction des Beaux-Arts).

SAMPLE DESCRIPTIONS

ALG-3. Rassel **14,270 ± 590**
12,320 B.C.

Terrestrial shells from lower level in a demolished cave on the seaside near Tipasa, Dept. Algiers (36° 38′ N Lat, 2° 24′ E Long) Algeria. Coll. 1967 and subm. by C. Brahimi, C.A.R.A.P.E. *Comment*: sample is assoc. to an Ibero-Maurusian industry. It is the oldest date known for the Epipaleolithic culture.

Tamar Hat series, Algeria

Charcoal from a layer of a shelter in rocks at Tamar Hat, Souk el Tnine, Dept. Bejaia, Algeria (36° 39′ N Lat, 5° 22′ E Long). Coll. 1967 and subm. by C. Brahimi.

ALG-5. Tamar Hat 2-99 **10,350 ± 375**
8400 B.C.

Charcoal found in the superficial part (0 to 30 cm) of the upper level.

ALG-4. Tamar Hat 1-98 **12,450 ± 480**
10,500 B.C.

Charcoal found in a deeper area (30 to 50 cm) of the upper level. *General Comment*: presence of an Ibero-Maurusian lithic industry.

ALG-7. Ain Boucherit 2 **5540 ± 190**
3590 B.C.

Charcoal from a deep level (120 to 140 cm) in a snailery of Upper Capsian from Aïn Boucherit, El Eulma, near Setif (36° 13′ N Lat, 5° 39′ E Long). Coll. 1966 and subm. by G. Camps, C.A.R.A.P.E. *Comment*: expected age, also dated by Nancy Natural Radiocarbon Lab. (Ny-76, 3170 ± 130 B.C., Radiocarbon, 1968, v. 10, p. 123).

Dahmous El Ahmar series, Algeria

Snail and ostrich egg shells from archaeologic layer of ashes from a snailery in cave near Tebessa, Dept. Annaba (33° 21′ 12″ N Lat, 8° 5′ 25″ E Long) Algeria. Coll. 1964 and subm. by C. Roubet, C.A.R.A.P.E.

5720 ± 195
ALG-10. Dahmous El Ahmar 1 **3770 B.C.**

Snail shells.

5400 ± 190
ALG-11. Dahmous El Ahmar 2 **3450 B.C.**

Ostrich eggs.

General Comment: Neolithic of Capsian tradition.

Ain Naga series, Algeria

Samples from Aïn Naga, Messad, Dept. Titteri, Algeria (34° 21′ N Lat, 3° 29′ E Long). Coll. 1968 and subm. by D. Grebenart, C.A.R.A.P.E.

9300 ± 300
ALG-12. Ain Naga 4 **7350 B.C.**

Terrestrial shells (*Helix*) 20 to 30 cm deep in the Epipaleolithic deposit of Upper Capsian and Neolithic layer.

8900 ± 280
ALG-13. Ain Naga 5 **6950 B.C.**

Terrestrial shells (*Helix*) found in a deeper area (30 to 40 cm).

General Comment: though deeper than the last one, this sample was dated younger. Both dates agree with the age of charcoal from the same level (7220 ± 200 B.C., Gif-1220, unpub.). Charcoal from Neolithic layer was dated 5550 ± 220 B.C. (Gif-1221, unpub.).

El Marmouta series, Algeria

Samples from El Marmouta, Lioua, Dept. Batna (34° 35′ N Lat, 5° 21′ E Long) Algeria. Coll. 1967 and subm. by D. Grebenart.

6450 ± 260
ALG-18. El Marmouta 4 **4500 B.C.**

Fragments of ostrich eggs.

6240 ± 270
ALG-20. El Marmouta 5 **4290 B.C.**

Fragments of ostrich eggs.

General Comment: superficial deposit in Upper Capsian layer.

Rabah series, Algeria

Samples from Rabah, Ouled Djellal, Dept. Batna, Algeria (34° 26′ N Lat, 5°8′ E Long). Coll. 1968 and subm. by D. Grebenart.

7300 ± 300
ALG-17. Rabah 15 **5350 B.C.**

Fragments of ostrich eggs.

ALG-22. Rabah 12 — **7000 ± 280** / **5050 B.C.**

Fragments of ostrich eggs.

ALG-23. Rabah 16 — **6980 ± 275** / **5030 B.C.**

Fragments of ostrich eggs.

ALG-8. Rusguniae — **1380 ± 115** / **A.D. 570**

Charcoal from Rusguniae, Cap Matifou, Dept. Algiers (36° 40′ N Lat, 3° 14′ E Long) Algeria. Coll. by M. Guéry, Service des Antiquités d'Algérie, subm. by G. Camps. *Comment*: stratigraphic study of post-Roman dwelling places previously occupied by the Romans. Sample coll. at 80 cm depth.

Tebessa series, Algeria

Charcoal from Tebessa, Dept. Annaba, Algeria (35° 20′ N Lat, 8° 0′ 41″ E Long). Coll. 1967 by M. Lequément, Service des Antiquités d'Algérie; subm. by G. Camps.

ALG-14. Tebessa 1 — **1290 ± 115** / **A.D. 660**

Charcoal.

ALG-15. Tebessa 2 — **750 ± 110** / **A.D. 1200**

Charcoal.

ALG-9. Tebessa 3 — **1040 ± 110** / **A.D. 910**

Charcoal.

General Comment: stratigraphic study of the different medieval dwelling places which succeeded in the Roman theater from the Byzantine, through the Moslem period, up to now. Dates were expected.

ALG-21. Medracen — **2170 ± 155** / **220 B.C.**

Wood from a beam propping the inside gallery of a Berber funeral monument from Aïn Yagout, Dept. Batna (35° 42′ N Lat, 6° 25′ E Long) Algeria. Coll. 1969 and subm. by G. Camps.

ALG-24. Tipasa — **2060 ± 140** / **110 B.C.**

Charcoal from Tipasa, Dept. Algiers (36° 30′ N Lat, 2° 26′ E Long) Algeria. Coll. 1967 and subm. by S. Lancel, Fac. Lettres et Sci. Humaines d'Alger. *Comment*: sample was found in a wood shed used for incineration in a pre-Roman necropolis.

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BERN RADIOCARBON DATES VII

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INTRODUCTION

This list contains a selection of dates from analyses carried out during the past few years. Samples are grouped in geologic-palynologic, and archaeologic sections according to main problem. When influence of human activity on pollen diagrams has been observed it has been explicitly indicated. The descriptions and comments have been written in collaboration with collectors and submitters. For the samples from Switzerland, general reference has also been made to Welten (1958a) and to sections on palynology, geology, and archaeology in work edited by the Schweizerische Gesellschaft für Ur- und Frühgeschichte (1968-1970).

Combustion of samples and gas counting have been done according to description in previous list (Radiocarbon, 1965, v. 7, p. 1-2). The samples were treated before combustion only with cold hydrochloric acid. No more elaborate procedure was performed. Results are expressed in conventional C^{14} years as defined in the Editorial Statement of Radiocarbon (w.r.t. NBS standard; $t_{1/2} = 5568$ yr; reference year A.D. 1950 = 0 B.P.). The given standard deviations σ (or "errors") are derived with the following formula

$$\sigma = \sqrt{\sigma_c^2 + \sigma_f^2}$$

where: σ_c = counting statistics including estimated uncertainties in filling temperature, barometric pressure, working voltage, etc.; σ_f = estimated uncertainty due to isotope fractionation effects. The term σ_f has been included because no $^{13}C/^{12}C$ ratios have been measured on samples of present list; it was estimated to be 80 years from the observed distribution of deviations of $\delta^{13}C_{PDB}$ (ca. $\pm$ 5‰) from the "normal" value ($\delta^{13}C_{PDB} = -25.0$‰) in wood, peat, gyttja and charcoal from European localities (Radiocarbon, v. 9, 1967, p. 113-144; v. 11, 1969, p. 519-539) considered valid only for materials derived from plants with Calvin photosynthetic cycle. The formula is not valid for materials related to plants with Slack-Hatch cycle (and lack of photorespiration) and CAM (Crassulacean Acid Metabolism) as pointed out by Lerman (ms. in prep.); in such a case the age must be increased in about (240 $\pm$ 20) yr (Lerman, 1970, p. 104-105; Radiocarbon, 1969, v. 11, p. 351, 369, 378-383). The original counting standard deviation (σ_c) can be retrieved from the given σ by:

$$\sigma_c = \sqrt{\sigma^2 - 640} \qquad \text{(in years)}$$

When considered interesting, the dates have been corrected for secular variations by means of the calibration curve suggested by Suess (1970). The derived calendar dates for the interval $\pm$ 1σ are given in the comments to the dates. Analysis numbers between B-1001 and B-2000 have been reserved for ice dating (Radiocarbon, 1967, v. 9, p. 28).

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I. GEOLOGIC-PALYNOLOGIC SAMPLES

A. Switzerland

Ballmoos series, Appenzell, Switzerland

Sec. in bog of Ballmoos (47° 22′ N Lat, 9° 30′ E Long) alt 950 m, near Stoss pass, between Altstätten and Gais, Appenzell Ausserrhoden, Switzerland. Investigated within general program of phytopaleontologic and paleoclimatic studies in NE Switzerland. Core 8.5 m long taken with Hiller borer. Coll. 1959 and subm. by P. Wegmüller and M. Welten, Syst.-Geobot. Inst., Univ. Bern, Switzerland.

3680 ± 190
B-958. Ballmoos, 120 cm **1730 B.C.**

Sphagnum peat from 110 to 130 cm depth.

6000 ± 100
B-957. Ballmoos, 190 cm **4050 B.C.**

Sphagnum peat from 180 to 200 cm depth.

7810 ± 130
B-956. Ballmoos, 370 cm **5860 B.C.**

Telmatic peat (*Phragmites* and Magnocarices) from 360 to 380 cm depth.

9330 ± 130
B-955. Ballmoos, 515 cm **7380 B.C.**

Gyttja from 505 to 525 cm depth.

10,060 ± 130
B-954. Ballmoos, 535 cm **8110 B.C.**

Gyttja from 525 to 545 cm depth.

7460 ± 120
B-953. Ballmoos, 625 cm **5510 B.C.**

Gyttja from 610 to 640 cm depth, contained some mineral sediments. *Comment*: material clearly dates palynologically from Allerød and shows no evidence of younger intrusions. Discrepancy of C^{14}-date is not understood.

General Comment (M. Welten, written commun., 1970): dates form very consistent series from end of Younger Dryas to Sub-Boreal. *Abies* invaded mixed oak forest at ca. 6500 B.P. Relatively late date of upper layers fully agrees with fact that several m of upper stratum of *Sphagnum* peat have been cut away in modern times.

Oberaar series, Bern, Switzerland

Two secs. at end moraine of Oberaar Glacier (46° 32′ 52″ N Lat, 8° 15′ 23″ E Long), alt 2320 m, on S slope of Zinggenstock Mt., W of Grimsel pass, near Guttannen, canton Bern, Switzerland, ca. 500 m above present timber line; recent vegetation ranges from very young pioneer plant communities to consolidated alpine meadows. Purposes of investigation were, (1) to study vegetational history above timber line in Bernese Oberland region by means of pollen analyses in soil profiles, (2) to date moraines of Oberaar Glacier.

Pollen profiles analyzed and interpreted by K. Ammann (ms. in preparation). Coll. 1967 and subm. by K. Ammann, Syst.- Geobot. Inst., Univ. Bern, Switzerland.

270 ± 90
B-906. Oberaar A **A.D. 1680**

Sandy terrestrial peat from 195 cm depth in transect (G II) at middle of S side of end moraine. *Comment*: compare with B-254 (Radiocarbon, 1961, v. 3, p. 19): 4600 ± 80 B.P. from wood found after dredging at 4 to 5 m depth inside same moraine (now below water level of storage lake) 100 to 200 m S of present transect (according to A. Minning, oral commun.). Thus both depth and age difference of samples indicate earlier death for B-254 than glacier advance dated by present sample. Calendar date estimated from calibration curve (see Introduction) is between A.D. 1450 and A.D. 1740. To attempt more precise dating of moraine, succession of several samples would be necessary due to wriggles in curve.

5100 ± 130
B-908. Oberaar I **3150 B.C.**

Slightly foliated terrestrial peat in upper part of stratum, from 22 to 23 cm depth, in Cut GI, at 13 m outside end moraine. High content of Cyperaceae (60%), low content of Gramineae (20%), and high amounts of herbaceous pollen, indicate warm climate. Considered end of Atlantic.

6300 ± 100
B-907. Oberaar B **4350 B.C.**

Slightly foliated terrestrial peat from 26 to 28 cm depth in central part of stratum in Cut GI, at 7 m outside end moraine, at ca. 6 m S of sample Oberaar I, with same pollen content (see above). *Comment*: calculated sedimentation rate averages ca. 0.5 cm/100 yr.

General Comment: last 2 dates show that well-developed alpine meadows vegetation existed at 2300 m alt in Bernese Oberland region at end of Atlantic period. Other soil profiles in Swiss Alps have been studied earlier by Welten (1958b).

Hängstli series, Bern, Switzerland

Sec. in raised bog near Hängstli (46° 47′ 5″ N Lat, 7° 50′ 0″ E Long), alt 1260 m, near Eriz, 17 km E of Thun, canton Bern, Switzerland. Core

4.6 m long taken with Hiller borer for pollenanalytical study of vegetational development in transition zone from montane to sub-alpine belts (K. Heeb, ms. in preparation). Coll. 1967 and subm. by K. Heeb, Syst.-Geobot. Inst., Univ. Bern, Switzerland.

1960 ± 110
B-927. Hängstli, 75-100 cm **10 B.C.**

Sphagnum peat from 75 to 100 cm depth. *Picea* dominant. *Fagus* increase (Sub-Atlantic). Appearance of cereals pollen. *Comment*: forest composition similar to present. From correction of C^{14} secular variations by means of calibration curve (see Introduction), calendar age is 130 B.C. to A.D. 100.

4860 ± 110
B-928. Hängstli, 315 cm **2910 B.C.**

Sphagnum peat from 315 cm depth. From 290 to 330 cm immigration of *Picea* which competes with *Abies*. Mixed oak forest with *Quercus* dominance. *Comment*: pollen spectrum shows transition to more continental climate at beginning of Sub-Boreal.

5920 ± 130
B-929. Hängstli, 390 cm **3970 B.C.**

Cyperaceous peat from 390 cm depth. From 370 to 440 cm, immigration of *Abies alba*, dominating later; mixed oak forest and *Corylus* decrease. *Comment*: transition from Boreal to Atlantic.

General Comment: profile shows typical development for alt, consisting in change of *Abies* to *Picea* forest. Correlates in general with sec. at Wachseldorn (this list) where immigration of *Picea* is synchronous. Peat sedimentation did not begin before Atlantic; mean calculated peat growth rate is ca. 8 cm/100 yr. Cereal pollen indicate human activity in historical times.

Wachseldorn series, Bern, Switzerland

Two secs. in Untermoos raised bog in Wachseldorn (46° 49′ 15″ N Lat, 7° 44′ 5″ E Long), 980 m alt, 11 km E of Thun, Aare valley, canton Bern, Switzerland. Taken to study Late Glacial vegetational history. Present dates continue previously pub. series (Radiocarbon, 1967, v. 9, p. 30-31); samples named Wachseldorn are from same cut (545 cm length) in peat wall of mentioned series. Sample B-962, Untermoos, is from cut in peat wall at 170 m ESE from previous cut, and belongs to same bog. Thickness of samples, in general, ca. 2 cm.

Aare glacier covered E region up to ca. 1000 m alt. This combined with high precipitation made growth of raised bogs possible. Special vegetational conditions observed in locality are, (1) very early beginning of peat growth, (2) exceptionally fast peat growth during Pre-Boreal, (3) exceptional composition of pollen during Late Glacial with dominance of Cyperaceae and lack of *Betula*, possibly due to poor soils of Molasse substratum.

Pollenanalytically investigated by K. Heeb (ms. in preparation). Coll. 1965 by M. Welten and K. Heeb; subm. by M. Welten.

4770 ± 100
B-692. Untermoos, 150 cm **2820 B.C.**

Sphagnum peat from 150 cm depth. *Comment*: despite immigration of *Picea*, dominance of *Abies* (Sub-Boreal). Mixed oak forest pollen from lower alts is present (mainly *Quercus*, due to decrease of *Ulmus*, *Fraxinus*, and *Tilia*).

6690 ± 100
B-924. Wachseldorn, 225 cm **4740 B.C.**

Sphagnum peat from 225 cm depth. *Comment*: pollen spectrum from 200 to 230 cm depth shows: decrease of *Corylus* and mixed oak forest pollen, latter due to *Ulmus* decrease; *Abies* increase (Atlantic). Change of mixed oak forest to *Abies* forest due to wetter climate of period.

8950 ± 110
B-2011. Wachseldorn, 330 cm **7000 B.C.**

Cyperaceous peat from 330 cm depth. *Comment*: pine pollen dominant but decreasing, simultaneous increase of Cyperaceae, sharp increase of *Corylus* and mixed oak forest pollen.

9680 ± 130
B-2012. Wachseldorn, 358 cm **7730 B.C.**

Cyperaceous peat from 358 cm depth. See comment to B-926 (below).

9400 ± 130
B-2013. Wachseldorn, 365 cm **7450 B.C.**

Cyperaceous peat from 365 cm depth. See comment to B-926 (below).

9250 ± 120
B-925. Wachseldorn, 387.5 cm **7300 B.C.**

Cyperaceous peat from 385 to 390 cm depth. See comment to B-926 (below).

9880 ± 120
B-926. Wachseldorn, 403.5 cm **7930 B.C.**

Cyperaceous peat from 402 to 405 cm depth. *Comment*: at 345 cm appear 1st signs of mixed oak forest. In all 4 previous samples pine pollen is dominant, with decrease (from 85% to 48%) between 360 and 400 cm and simultaneous increase of Cyperaceae. Due to extraordinarily rapid peat growth during this period (Pre-Boreal) change in pine pollen indicates climatic deterioration not usually found in other profiles; direct comparison of this deterioration with that of Piottino (Zoller, 1968) cannot be done because of lack of evidence (Lang, 1952). Similar but stronger (75% to 30%) decrease in pine with simultaneous increase of Cyperaceae (and heliophile plants as *Selaginella*, *Artemisia*, and *Salix*) between 410 and 430 cm indicate Younger Dryas. Compare Samples B-700:

10,320 ± 150 B.P. for 416 cm, and B-701: 10,550 ± 150 B.P. for 421 cm depth in same profile (Radiocarbon, 1967, v. 9, p. 31).

B-921. Wachseldorn, 430 cm **10,130 ± 110**
8180 B.C.

Cyperaceous peat from 430 cm depth. *Comment*: compare with B-702: 10,980 ± 200 B.P. from 451 cm depth in same profile (Radiocarbon, 1967, v. 9, p. 31). From 430 to 465 cm, dominance of pine (65%) and few *Juniperus*, *Salix*, and *Artemisia* indicate Allerød pine forest. Deeper layers indicate weak pine increase with much Cyperaceae (60%) and less *Juniperus* and *Betula*, suggesting bad climate of Older Dryas. Compare with B-703: 11,660 ± 150 B.P. from 466 cm; B-704: 11,810 ± 150 B.P. from 470 cm depth in same profile (Radiocarbon, 1967, v. 9, p. 31). At 479 cm depth *Betula nana* maximum (9%) and decrease of Cyperaceae. At 487.5 cm depth, pine pollen is rare and maximum of *Juniperus* (64%) indicates beginning of reforestation after retreat of glaciers (assumed to be Bølling). Compare with B-705: 12,345 ± 150, from 479 cm; B-706: 12,210 ± 150, from 481 cm; B-707: 12,395 ± 130, from 489 cm; B-708: 12,500 ± 150 B.P., from 491 cm depth in same profile (Radiocarbon, 1967, v. 9, p. 31). At 505 cm depth, Cyperaceae dominates (85%) and traces of *Juniperus* and pine pollen are found, showing lack of forest; considered transition Oldest Dryas/Bølling, dated as B-709: 12,915 ± 130 B.P. (Radiocarbon, 1967, v. 9, p. 31).

General Comment: profile shows very marked minerogenous sedimentation, due to local conditions present only during deterioration of climate in Pre-Boreal (365 to 380 cm depth), Younger Dryas (415 to 430 cm), and Older Dryas (465 to 475 cm). Calculated mean sedimentation rates are 6.5 cm/100 yr, from 12,900 to ca. 9500 B.P. and 4.7 cm/100 yr, from ca. 9300 to 6700 B.P. Dates B-2012, B-2013, and B-925 are explained, within statistics, by a possible faster organic sedimentation between ca. 9500 and ca. 9300 B.P.

Seeliswald series, Bern, Switzerland

Sec. in raised bog at Seeliswald (46° 42′ 19″ N Lat, 7° 36′ 0″ E Long), 618 m alt, near Reutigen, canton Bern, Switzerland. Purpose of investigation was to date beginning of organic sedimentation. General stratigraphy shows change from Cyperaceous (*Phragmites* and *Carex*) peat in lower strata to *Sphagnum* peat in upper strata. Bog is underlain by clay and sand. Four cores taken with Hiller borer for vegetational studies by W. Strasser (ms. in preparation). Coll. 1968 by W. Strasser, Schönauweg 17a, Steffisburg, Switzerland; subm. by M. Welten.

B-910. Seeliswald 2-535 **2900 ± 90**
950 B.C.

Sphagnum peat from 530 to 540 cm depth in Core 2.

B-911. Seeliswald 2-555 — **2900 ± 90** / **950 B.C.**

Sphagnum peat from 550 to 560 cm depth in Core 2.

B-912. Seeliswald 3-430 — **2940 ± 90** / **990 B.C.**

Sphagnum peat from 430 to 440 cm depth in Core 3.

B-913. Seeliswald 3-470 — **3000 ± 100** / **1050 B.C.**

Sphagnum peat from 470 to 480 cm depth in Core 3.

B-914. Seeliswald 4-575 — **3030 ± 130** / **1080 B.C.**

Sphagnum peat from 570 to 580 cm depth in Core 4.

B-915. Seeliswald 5-130 — **2160 ± 100** / **210 B.C.**

Sphagnum peat from 125 to 135 cm depth in Core 5, taken ca. 150 m N from Borings 1 to 4.

General Comment: beginning of young bog is dated ca. 3000 B.P. when rock slide from Moosfluh Mt. blocked Reutigen valley allowing growth of peat behind rock barrier. Younger age of Sample 5-130 is explained by later inundation of N locality.

Faninpass series, Graubünden, Switzerland

Sec. in bog at Faninpass (46° 51′ N Lat, 9° 44′ E Long), alt 2212 m, between Prättigau and Schanfigg, near Peist, Graubünden (Grisons), Switzerland. Investigated within general program of phytopaleontologic and paleoclimatic studies in NE Switzerland. Core, 260 cm long, taken by Hiller borer. Coll. 1960 and subm. by P. Wegmüller.

B-901. Faninpass, 118 cm — **4740 ± 100** / **2790 B.C.**

Sphagnum peat from 105 to 130 cm depth.

B-902. Faninpass, 168 cm — **5740 ± 100** / **3790 B.C.**

Sphagnum peat from 155 to 180 cm depth.

B-903. Faninpass, 190 cm — **6230 ± 130** / **4280 B.C.**

Sphagnum peat from 180 to 200 cm depth.

B-904. Faninpass, 218 cm — **7300 ± 110** / **5350 B.C.**

Sphagnum peat from 205 to 230 cm depth.

B-905. Faninpass, 240 cm **8200 ± 130**
6250 B.C.

Sphagnum peat and gyttja from 230 to 250 cm depth.

General Comment (M. Welten): series dates most detailed of 3 profiles and pollen diagrams between Prättigau and Schanfigg. Organic sedimentation began between 9000 and 8000 B.P. Invasion of *Picea* took place ca. 7000 B.P. Younger peat layers seem absent.

St. Moritz series, Graubünden, Switzerland

Sec. S of Lake of St. Moritz (46° 29′ 17″ N Lat, 9° 50′ 29″ E Long), at ca. 1770 m alt, Graubünden (Grisons), Switzerland. Two borings 30 m long in sediments of fluvio-glacial origin. Purpose of investigation was dating glacier advance (H. Zoller, ms. in prep.); succession of pollen horizons appears disturbed (H. Zoller, 1968, written commun.). Coll. 1966 by C. Schindler, Geotechn. Büro von Moos, Zürich, Switzerland; subm. by H. Zoller, Bot. Inst., Univ. of Basle, Switzerland.

B-875. St. Moritz 1-220 **5600 ± 120**
3650 B.C.

Peat and silt from 220 cm depth in Boring 1. *Picea* dominance, increase of *Alnus viridis.*

B-876. St. Moritz 1-250 **3660 ± 150**
1710 B.C.

Peat and silt from 250 cm depth in Boring 1. *Pinus* dominance, rich in NAP.

B-877. St. Moritz 2-247 **4450 ± 200**
2500 B.C.

Peat and silt from 247 cm depth in Boring 2. *Picea* dominance, rich in *Alnus viridis.*

General Comment: first and last samples date appearance of *Alnus viridis* in locality at 5500 to 5000 B.P., as usual in Swiss profiles. Second date seems too young and is not accepted by submitter. Dates show ca. 25 m river sediments accumulated in High Engadin valley during last 5000 yr.

Suossa series, Graubünden, Switzerland

Sec. in Suossa (46° 26′ 36″ N Lat, 9° 12′ 10″ E Long) S of San Bernardino pass at ca. 1700 m alt, near San Bernardino, Graubünden, Switzerland. Studied for pollen analysis, profile gives good general view of Late Glacial climatic changes. Samples obtained by adding material from several analyzed cores. Coll. 1967 and subm. by H. Zoller.

B-868. Suossa I **6400 ± 100**
4450 B.C.

Bryophytic peat from 520 to 523 cm depth in Cores 3-6. Begins *Picea* dominance (Atlanticum).

B-869. Suossa II **7080 ± 250**
5130 B.C.

Bryophytic peat from 568 to 570 cm depth in Cores 1, 2, 3, and 5. *Abies* maximum, immigration of *Picea* (transition Older/Younger Atlantic).

B-870. Suossa III **8030 ± 250**
6080 B.C.

Bryophytic peat from 715 to 718 cm in depth in Cores 1-4. Presence of *Abies*, increase of *Acer* and *Fraxinus* (Boreal).

B-871. Suossa IV **10,430 ± 250**
8480 B.C.

Clay gyttja with some sand from 905 to 910 cm depth in Cores I, K-N. Increase of *Betula* (end of Younger Dryas).

B-872. Suossa V **11,300 ± 250**
9350 B.C.

Sandy clay gyttja from 921 to 926 cm depth in Cores I, K-N. Pioneer phase of Allerød with much *Pinus*. Underlain by sediments rich in NAP (Older Dryas).

B-873. Suossa VI **11,600 ± 200**
9650 B.C.

B-873a. Suossa VIa **10,960 ± 200**
9010 B.C.

Sandy clay gyttja from 931 to 936 cm depth in Cores B-F and H. *Comment*: both Samples VI and VIa, from same horizon, agree within statistics but seem young according to pollen analysis which indicates pioneer phase of Older Dryas with much NAP.

B-874. Suossa VII **13,010 ± 200**
11,060 B.C.

Clayey gyttja from 943 to 948 cm depth in Cores A-H. Pioneer phase of Bølling with *Pinus* pollen underlain by sediments without pollen.
General Comment: dates show general early retreat of glaciers S of Alps and prove (1) retreat of branch of Rhine glacier from San Bernardino pass before Bølling, (2) San Bernardino basin free of glacier ice since Bølling.

Forest appeared at locality at end of Younger Dryas. Compared with dates (H-unpub.) from lower localities at same region as Pian di Signano (Zoller, 1960) it is concluded that *Picea abies* immigrated from N into Misox valley (Ticino) across San Bernardino pass. Calculated mean sedimentation rate is ca. 8.3 cm/100 yr.

Gola di Lago series, Ticino, Switzerland

Sec. in Gola di Lago bog (46° 6′ 13″ N Lat, 8° 58′ 3″ E Long), ca. 970 m alt in pass between Isone and Cassarate valleys, (Camignolo) near Tesserete, Ticino (Tessin), Switzerland. Studied to compare vegetational development S and N of Alps since Late Glacial. Samples obtained by adding material from several analyzed cores 4.5 m long, taken with Dachnowsky sonde. Preliminary description of pollen profile, interpretation and discussion of Post-Atlantic part, by Zoller and Kleiber (1967). Coll. 1966 and subm. by H. Zoller.

B-800. Gola di Lago IV **4420 ± 120**
2470 B.C.

Sandy-clayey gyttja from 145 to 150 cm depth. 1st distinct increase of *Fagus silvatica* (Sub-Boreal).

B-799a. Gola di Lago IIIa **12,580 ± 90**
10,630 B.C.

Clay gyttja from 360 to 370 cm depth. *Comment*: strong *Pinus* increase interpreted as middle of Pre-Boreal. C^{14} result seems 2000 to 3000 yr older than expected from pollen analysis.

B-798. Gola di Lago II **12,330 ± 200**
10,380 B.C.

Clay gyttja from 385 to 388 cm depth. Strong *Betula* increase (Older Dryas).

B-797. Gola di Lago I **12,610 ± 200**
10,660 B.C.

Sand and clay gyttja from 389 to 393 cm depth. Poor AP (> 60% NAP) with brief increase of *Betula* pollen (Bølling).

General Comment: dates of deepest samples (I and II) show, (1) retreat of Ticino (Tessin) glacier into Lugano basin before Bølling, (2) appearance of forest ca. 12,000 B.P. (Allerød), compare Lago Origlio series (Zoller, 1960, p. 76; Radiocarbon, 1961, v. 3, p. 17); (3) importance of *Larix* during pioneer phases.

Upper sample dates delayed appearance of *Fagus* in Ticino (Zoller and Kleiber, 1967) compared with profile at same lat in Italy, Lago di Ledro (Beug, 1964), but synchronous with that at N of Alps (Wegmüller, 1966). Forests with *Fagus* at N of Alps formed 1000 yr earlier than at Ticino. Time discrepancy in extension of *Abies* and *Fagus* is 2000 yr in Lago di Garda and 5000 yr in Ticino. Delay of *Fagus* is thought to be caused by *Abies* occupation of forest belt. Calculated average sedimentation rate is ca. 3 cm/100 yr.

Boniger See series, Valais, Switzerland

Several secs. from lake of Bonig (Boniger- or Böhnig-See) (46° 15′ 33″ N Lat, 7° 50′ 35″ E Long), at 2095 m alt, near Törbel, Visp valley, Valais (Wallis), Switzerland. Swampy lake of Bonig lies on Moosalp terrace at ca. 10 km NW of Grächen, driest place in Switzerland (50 cm annual precipitation), near present timber-line with *Pinus cembra* and *Larix*. Staub (1927) considered Moosalp terrace to be pre-glacial valley bottom. Present lake originates from dead ice left by retreat of Visp glacier which overflowed terrace up to 2200 m alt in N slope of Augstbordhorn Mt. Cores taken with Hiller borer. Description of present and former vegetation, and palynologic interpretations pub. by Markgraf (1969). Coll. 1965-66 and subm. by V. Markgraf, Syst.-Geobot. Inst., Univ. Bern, Switzerland, and M. Welten.

a) Late and Post Glacial vegetational history

6030 ± 100
B-785. Boniger See 1-485 **4080 B.C.**

Detritus gyttja with leaves of *Larix* and *Pinus* (id. by V. Markgraf) from Core 1 at 460 to 500 cm depth. Core 1 is 614 cm long reaching oldest sediments of site; from inner margin of swampy island. *Comment*: dates immigration of *Abies alba* in Valais, generally accepted as 6000 B.P. for that area (Welten, 1958a).

4460 ± 100
B-787. Boniger See 4-169 **2510 B.C.**

Peat with *Sphagnum* and *Drepanocladus* from Core 4 at 150 to 180 cm depth. *Picea* increase. Core 4 is 210 cm long, from S shore which is usually dry in late summer. *Comment*: considered to be transition Younger Atlantic/Sub-Boreal.

7140 ± 120
B-788. Boniger See 4-189 **5190 B.C.**

Peat with *Sphagnum* and *Drepanocladus* from Core 4 at 180 to 200 cm depth. Pollen shows *Abies* maximum of Atlantic period. *Comment*: compared with overlying sample (4-169, see above) hiatus of nearly 3000 yr is seen, probably due to disturbing effect of dead ice as late as Atlantic time. Date pub. in description of sec. must be altered.

7990 ± 110
B-784. Boniger See 1-545 **6040 B.C.**

Algae gyttja with *Pediastrum* and some clay from Core 1 at 525 to 550 cm depth. Increase of mixed oak forest, *Corylus* and *Betula*, decrease of *Pinus cembra* pollen. *Comment*: pollen spectrum indicates slightly wetter but warm climate (transition Boreal/Older Atlantic). In Central Europe, usually dated to 7500 B.P. among others by Wegmüller (1966) and Zoller (1968), but in N Europe to 8200 B.P. (Nilsson, 1964) in agreement with present date.

10,430 ± 150
B-782. Boniger See 1-597 **8480 B.C.**

Algal gyttja with clay and some *Pediastrum* from Core 1 at 591 to 620 cm depth. Decrease of *Betula*, increase of *Pinus cembra*, Chenopodiaceae, and *Ephedra* pollen. *Comment*: pollen analysis indicates younger and drier part of Younger Dryas.

General Comment (Markgraf): samples date development of vegetation belts for area: during Allerød, timber-line with *Betula* and *Pinus cembra* was between 1800 and 2000 m, concluded from present growth of *Juni-*

perus shrubs and alpine meadow plants at 2200 m alt; in Younger Dryas time, timber line was pushed further downwards and steppe-like vegetation expanded; timber line returned to that altitude in Pre-Boreal time, indicated by presence of pollen of rich, tall herb vegetation (*Heracleum sphondylium, Geranium* sp., *Chaerophyllum hirsutum*, etc.) at 2200 m; during Boreal, *Larix* immigrated into area and since then formed forest in sub-alpine zone together with *Pinus cembra*, accompanied by *Abies* since 6000 B.P. Subsequent development was influenced by man (see *c*, below).

b) Peat development and sedimentation rate

B-846. Boniger See 2-180 **2700 ± 150**
750 B.C.

Wet peat with leaves of *Drepanocladus* and *Sphagnum* from Core 2 at 170 to 190 cm depth. Core 2, 570 cm long, from 50 m E of Core 1, on E margin of floating island. Pollen analysis shows general tree pollen (AP) decrease at every vegetation belt; herb pollen (NAP) increase, especially cultural indicators (cereals, *Plantago, Cannabis)*; and appearance of *Juglans* pollen. *Comment*: analyses interpreted as dating transition Sub-Boreal/Sub-Atlantic, generally 2600 B.P.

B-847. Boniger See 2-250 **3230 ± 120**
1280 B.C.

Peat with *Sphagnum* and some *Drepanocladus* and *Cyperaceae* rootlets from Core 2 at 230 to 295 cm depth. Dominance of *Pinus cembra* with more *Picea* and less *Abies* than in Sample 2-350 (see below). *Comment*: interpreted as older part of Sub-Boreal. Relatively fast peat growth-rate of 13 cm/100 yr (3200 to 2700 B.P.) was caused by high water level of lake.

B-848. Boniger See 2-350 **4840 ± 120**
2890 B.C.

Peat with *Sphagnum, Drepanocladus*, and fungal hyphae from Core 2 at 320 to 375 m depth. End of *Abies* expansion in *Pinus cembra* forest at 2200 m alt. Appearance of *Picea* and agricultural indicators. *Comment*: considered transition Younger Atlantic/Sub-Boreal. Calculated peat growth-rate, 6 cm/100 yr (4800 to 3200 B.P.).

B-849. Boniger See 2-435 **5715 ± 120**
3765 B.C.

Detritus gyttja with leaves of *Larix* and *Pinus* from Core 2 at 425 to 450 cm depth. Oldest *Abies* maximum in *Pinus cembra* forest. First traces of *Fagus*. *Comment*: calculated sedimentation rate during Younger Atlantic, 10 cm/100 yr (5700 to 4800 B.P.).

B-850. Boniger See 2-490 **7600 ± 150**
5650 B.C.

Algal gyttja from Core 2 at 475 to 500 cm depth. Immigration of *Abies* in Rhône valley. Pollen shows well developed tall herb vegetation (*Adenostyles alliariae, Lilium martagon, Heracleum sphondylium,* etc.) in *Pinus cembra-Larix* forest of sub-alpine zone. *Comment*: sedimentation rate during younger part of Older Atlantic at transition from gyttja to peat, 3 cm/100 yr (7600 to 5700 B.P.).

B-851/2. Boniger See 2-522 **8370 ± 150**
6420 B.C.

Algal gyttja with *Pediastrum* from Core 2 at 505 to 550 cm depth. Decrease of *Betula* and *Corylus*, increase of *Pinus* and mixed oak forest pollen. *Comment*: considered transition Boreal/Older Atlantic. Sedimentation rate during Older Atlantic, 4.5 cm/100 yr (8300 to 7600 B.P.). Date pub. in description of sec. must be altered.

General Comment: sedimentation rate in lake, of different organic materials, varies, ca. 3 cm/100 yr during Older Atlantic, 10 cm/100 yr during Younger Atlantic, and 14 cm/100 yr during Sub-Boreal. Development of lake vegetation started late (Markgraf, 1969) ca. Atlantic time, probably delayed by influence of dead ice in bottom of lake causing sedimentation disturbances. At beginning of Older Atlantic, dense *Potamogeton alpinus* layer with *Menyanthes* and *Sparganium* covered lake, forming rhizome networks able to collect mud. At beginning of Younger Atlantic time, peat growth started on that layer with *Drepanocladus* moss later followed by *Sphagnum* sp. Up to beginning of Sub-Atlantic, peat growth expanded over lake. Then organic development stopped, probably due to sudden rise of water level. Only central part of peat layer could then lift and start to grow again forming floating island.

c) Human influence on vegetation

B-791. Boniger See 3-30, charcoal **4170 ± 100**
2200 B.C.

B-794. Boniger See 3-30, soil with charcoal **3810 ± 110**
1860 B.C.

Two portions of black soil with microscopic wood charcoal pieces from Cut 3 at 31 to 32 cm depth. B-791 consists of charcoal particles (> 0.2 mm) selected by sieving. Cut 3 is 120 cm long, opened at N margin of lake which is surrounded by 50 cm high rim originating from erosion by water level changes during Sub-Atlantic. Soil cut shows 3 wood charcoal horizons (id. by F. Schweingruber, Syst.-Geobot. Inst., Univ. Bern): at 31 to 32 cm (*Abies*), from 50 to 71 cm (*Pinus cembra*), and at 85 cm depth. Pollen analysis shows sharp decrease of AP, and 80% Gramineae. *Comment*: considerable pollen variations were found in charcoal horizons, indicating woods clearing by fire and subsequent natural reforestation by shrubs (*Corylus, Betula*) and trees. Date B-794 pub. in description of sec. must be altered.

B-790. Boniger See 3-60, charcoal **5300 ± 100**
3350 B.C.

5070 ± 100
B-792. Boniger See 3-60, soil with charcoal 3120 B.C.

Two portions of black soil with microscopic wood charcoal pieces (*Pinus cembra*, see comment to B-794, above) from Cut 3 at 50 to 71 cm depth. Sample B-790 consists of charcoal particles (> 0.2 mm) selected by sieving. Pollen shows reforestation indicators (*Pinus* increase after *Betula* and *Corylus* maximum). *Comment*: from differences in these pairs of dates (see soil samples 3-30 and 3-60) pure charcoal horizons seem to be ca. 300 yr older than soil with charcoal. Relative proportions of humus and charcoal in soil were not determined. As humic extracts have not been dated, legend "humus" in Profile 3 (Markgraf, 1969, p. 63) must be changed to "soil with charcoal".

4830 ± 100
B-789. Boniger See 3-69, soil with charcoal 2880 B.C.

Soil with charcoal pieces from Cut 3 at 68 to 71 cm depth, bottom layer in main charcoal horizon of Sample 3-60 (see above). *Comment*: sample dates beginning of clearing. Date is coincident within statistics with date of main layer (50 to 71 cm) (B-792, above). Charcoal itself would probably date to ca. 5200 B.P. if relative proportion of humus and charcoal is similar in present sample to previous (3-30 and 3-60, above).

4740 ± 100
B-786. Boniger See 1-385 2790 B.C.

Peat with *Sphagnum, Drepanocladus,* and fungal hyphae, from Core 1 at 370 to 400 cm depth. Strong increase of *Picea* and decrease of *Abies*. *Comment*: indicators of agriculture appear, showing human influence.

4870 ± 100
B-793. Boniger See 13-250 2920 B.C.

Peat with *Sphagnum, Drepanocladus,* and Cyperaceae rootlets from Core 13, at 220 to 290 cm depth. Core, 505 cm long, is from outer N margin of floating island. *Picea* increase. *Comment*: pollen diagram, not described by Markgraf (1969), is similar to that of Core 1 but compressed. *General Comment*: (Markgraf, 1969) dates indicate human activity (agriculture) and synchronous wood clearings by fire from 5300 to 3700 B.P. Natural fire is excluded for 2 reasons, (1) although possibilities of fire during earlier period with drier climate were greater, no evidence was found in cores from site; (2) cereal pollen, indicators of important agricultural activity, appear in the charcoal horizons. Vegetation changes at 5000 B.P. were greater than known variations in climate (Frenzel, 1966) might cause, and are considered mainly due to human influence. Expansion of *Picea* was probably related to clearings (V. Markgraf, ms. in prep.) because during reforestation *Picea* is favored in competition with *Abies* and *Pinus cembra,* which grow slower, especially where cattle graze.

Belalp II series, Valais, Switzerland

Sec. in bog at Belalp below and SW of Tyndall-Stein (46° 23′ 6″ N Lat, 7° 59′ 2″ E Long), alt 2290 m, N of Brig-Naters, near Naters, Valais (Wallis), Switzerland. Investigated within the general program (Welten, 1958a) of paleoclimatic studies in region of Aletsch Glacier. Compare Greicheralp and Eggen series (this list), Aletschwald series (Radiocarbon, 1959, v. 1, p. 136), and Bitsch-Naters series (Radiocarbon, 1959, v. 1, p. 136; 1961, v. 3, p. 17-18). Present core (145 cm length), taken with Hiller borer near previous boring (see Belalp series: Radiocarbon, 1961, v. 3, p. 18; 1963, v. 5, p. 305). Coll. 1968 and subm. by M. Welten.

3240 ± 100
B-981. Belalp II, 55 cm **1290 B.C.**

Hypnaceous and cyperaceous peat from 45 to 65 cm depth.

5700 ± 100
B-982. Belalp II, 80 cm **3750 B.C.**

Hypnaceous and cyperaceous peat from 70 to 90 cm depth.

6360 ± 100
B-983. Belalp II, 129 cm **4410 B.C.**

Hypnaceous and cyperaceous peat from 119 to 139 cm depth.

General Comment: apparent hiatus in sedimentation during Sub-Boreal (approx. between 5000 to 2500 B.P.), considered important for paleoclimatologic evaluation and correlation of diagrams from high alts.

Greicheralp series, Valais, Switzerland

Sec. in Greicheralp (46° 22′ 40″ N Lat, 8° 1′ 50″ E Long) bog at 1915 m alt, E of Hotel Riederalp, above Mörel, Valais (Wallis), Switzerland. Taken to study vegetational history since Post-Glacial and compare with other profiles in region, esp. Aletschwald series (Radiocarbon, 1959, v. 1, p. 136-137). See also Belalp series (this list) and refs. Pollen anal. by M. Welten (ms. in preparation). 440 cm core taken with Hiller borer. Coll. 1956 by M. Welten and B. Seddon; subm. 1969 by M. Welten.

3530 ± 90
B-2002. Greicheralp 92 cm **1580 B.C.**

Cyperaceous peat, strongly humified, from 92 cm depth.

3940 ± 100
B-2003. Greicheralp 178 cm **1990 B.C.**

Cyperaceous peat, weakly humified, from 178 cm depth.

4830 ± 120
B-2004. Greicheralp 240 cm **2880 B.C.**

Hypnaceous peat, from 240 cm depth.

B-2005. Greicheralp 340 cm **5420 ± 230**
3470 B.C.

Hypnaceous peat, from 340 cm depth.

B-2006. Greicheralp 413 cm **5630 ± 100**
3680 B.C.

Hypnaceous clayey peat, from 413 cm depth.

Eggen series, Valais, Switzerland

Sec. in Eggen (46° 22′ 13″ N Lat, 7° 59′ 22″ E Long) 1650 m alt, N of Blatten, Valais (Wallis), Switzerland. Bog deposit near moraine sampled to study sedimentation and vegetational history in relation to climatic effects of Aletsch Glacier. Present samples continue previous series (Radiocarbon, 1961, v. 3, p. 18; 1963, v. 5, p. 305; Welten, 1958a). Coll. 1956 and subm. by M. Welten.

B-970. Eggen 190 cm **3490 ± 120**
1540 B.C.

B-971. Eggen 290 cm **5840 ± 120**
3890 B.C.

Hellelen B series, Valais, Switzerland

Sec. in bog at Hellelen (46° 17′ 3″ N Lat, 7° 50′ E Long), 1510 m alt, Zeneggen, Valais (Wallis), Switzerland. New boring 840 cm long, with Hiller borer, at Hellelen-Zeneggen locality (Radiocarbon, 1966, v. 8, p. 25). Description and interpretation of pollen analyses by M. Welten (ms. in preparation). Coll. 1968 and subm. by M. Welten.

B-916. Hellelen 445 cm **8780 ± 120**
6830 B.C.

Dy from 445 cm depth (Pre-Boreal).

B-917. Hellelen 455 cm **9430 ± 120**
7580 B.C.

Dy from 455 cm depth (Pre-Boreal).

B-918. Hellelen 521 cm **12,310 ± 150**
10,360 B.C.

Clayey gyttja from 521 cm depth (beginning of Allerød).

Vidy series, Vaud, Switzerland

Three secs. W of road Vidy-Lausanne, at water-works excavation (46° 31′ 18″ N Lat, 6° 35′ 27″ E Long), ca. 380 m alt, in Vidy, Lausanne, Vaud (Waadt), Switzerland. Several borings made in lower deltaic terrace of La Chamberonne R. to determine chronology of sedimentation of Lake of Geneva (Lac Léman) and Vidy terraces. All plant remains id. by collector. Pollen analyses and interpretation by Villaret and Burri (1965). Coll. 1962-63 and subm. by P. Villaret, Inst. Botan. Syst. et Geobot., Univ. Lausanne, Switzerland.

12,100 ± 250
10,150 B.C.

B-752. Vidy Pb-55

Wood (*Pinus* sp., 32 annual rings) from 55 cm depth in Boring A, in calcareous sand interspersed with several layers of "fumier lacustre" (similar composition to B-751, below) where pollen was analyzed. *Pinus* dominant. *Comment*: from pollen and geologic analyses of sediments, considered to date Pre-Boreal (Villaret and Burri, 1965).

12,750 ± 200
10,810 B.C.

B-751. Vidy EMSE 2

"Fumier lacustre" (abundant twigs, leaves, fruits, and scales of *Betula nana*, some leaves of *Dryas octopetala*, leaves and seeds of *Juniperus communis* ssp. *nana*, numerous seeds of Caryophyllaceae, fruits of *Helianthemum* sp., *Armeria* sp., *Onobrychis* sp., *Thalictrum* sp., etc.), from 120 cm depth in Boring C, in calcareous loam. NAP dominance with 15% *Betula nana* pollen. *Comment*: date corresponds to Older Dryas age in contradiction to expected age (Villaret and Burri, 1965), Oldest Dryas.

12,400 ± 200
10,450 B.C.

B-753. Vidy 02

Wood (*Betula* sp., ca. 50 annual rings) from 10.5 cm depth in core taken near Boring B, in chalky loam. Pollen analysis shows intersection of *Pinus* and *Betula* curves. *Comment*: dates beginning of *Allerød.*

General Comment: dates and pollen analyses show deepest layers belong to Oldest Dryas, indicating sedimentation until Allerød and gap until Sub-Boreal time, attributed to (1) regression of lake, of (2) erosion by lake water during Boreal and Atlantic, later (Sub-Boreal) covered by river sediments. Estimated dates for B-752 and B-753: 1000 yr older than expected from comparison with analyses from site at 35 km, La Tourbière (Wegmüller, 1966, p. 29-31, pl. 1; Radiocarbon, 1963, v. 5, p. 307).

B. Austria

Dobramoos series, Kärnten, Austria

Sec. in Dobramoos raised bog (46° 45′ 50″ N Lat, 14° 12′ 30″ E Long), alt 902 m, St. Urban, near Klagenfurt, Kärnten (Carinthia), Austria. Pollenanalytically investigated to study chronology of vegetation in SE Alps. Description and interpretation of analyses pub. by Bortenschlager (1966). Kärnten region was also studied by Schmidt (1965, 1970) and Fritz (1967). See also Schwarzer Moor I, Keutschachersee II, and Kohlenmoos series (this list). Two cores taken with Hiller borer. Coll. 1963 by S. Bortenschlager, Inst. für Botan. Syst. und Geobot., Univ. Innsbruck, Austria; subm. by M. Welten.

B-613. Dobramoos IV-D **5860 ± 100**
3910 B.C.

Sphagnum peat from Core IV at 70 to 80 cm depth. Boring IV (3 m long) at ENE border of bog. Oldest *Fagus* maximum and immigration of *Abies*. *Comment*: considered Atlantic time.

B-614. Dobramoos IV-E **9000 ± 120**
7050 B.C.

Cyperaceous peat from Core IV at 160 to 170 cm depth. *Pinus* decrease and NAP increase (Younger Dryas).

B-593. Dobramoos V-180 **9360 ± 140**
7410 B.C.

Cyperaceous peat from Core V at 180 to 190 cm depth. Boring V (4.20 m long) ca. 50 m from Boring IV toward center of bog. Slight increase of NAP during minor dip in broad *Pinus* maximum. *Comment*: may correspond to Younger Dryas.

B-594. Dobramoos V-230 **9550 ± 150**
7600 B.C.

Cyperaceous peat from Core V at 230 to 240 cm depth. Onset of *Pinus* increase. *Comment*: pollen analysis indicates warm phase thought to be Allerød. Date is > 1000 yr too young if horizon is synchronous with Central Europe sequence.

B-615. Dobramoos IV-F **10,820 ± 150**
8870 B.C.

Cyperaceous peat from 210 to 220 cm depth in Boring IV. Strong *Pinus* pollen increase above marked NAP maximum. *Comment*: considered Older Dryas.

B-595. Dobramoos V-310 **12,610 ± 180**
10,660 B.C.

Cyperaceous peat from 310 to 320 cm depth in Boring V. Slight dip in broad NAP maximum. *Comment*: considered to be of Bølling age.

B-617. Dobramoos V-340 **12,280 ± 200**
10,310 B.C.

Cyperaceous peat from 340 to 350 cm depth in Boring V. NAP broad maximum. *Comment*: interpreted as Oldest Dryas. This date is not mentioned by Bortenschlager (1966); result not statistically different from Dobramoos V-310.

General Comment: preliminary chronology of vegetational history in Kärnten based on present dates resembles S Central Europe. Main similarity is simultaneous reforestation in both regions by *Pinus* and *Betula* during Allerød, although Dobramoos IV-F seems ca. 1000 yr too young (Bortenschlager, 1966). According to Fritz (1967) correlation of Central Europe with E Alps vegetational situation is questionable.

Recognition of Bølling and Older Dryas is difficult probably due to short length of Bølling and relatively large separation between successive pollen samples. Mean sedimentation rates are 2.7 cm/100 yr (Core IV) and 4 cm/100 yr (Core V).

Kohlenmoos series, Kärnten, Austria

Sec. in Kohlenmoos wet raised bog (46° 47′ 0″ N Lat, 13° 34′ 30″ E Long), at 846 m alt, between Lake Millstätt and Drau valley, N of Winkl, Kärnten, Austria. Pollenanalytically investigated by Schmidt (1965, 1970) to study vegetational history of outer E Alps; especially in comparison with Schwarzer Moor I and Keutschachersee II series (see below) which have less continental climate than Kohlenmoos. 870 cm core taken at N of bog with Hiller borer. Coll. 1964 by H. Schmidt, Stethaimerstr. 15, Salzburg, Austria; subm. by M. Welten.

2570 ± 100
B-618. Kohlenmoos 1 **520 B.C.**

Sphagnum peat, greatly decomposed, from 200 to 225 cm depth. *Comment*: pollen indicates increased human activity; deduced from presence of cereals and sharp decrease of *Fagus* and *Abies*.

5120 ± 100
B-619. Kohlenmoos 2 **3170 B.C.**

Cyperaceae peat of varying density, from 395 to 405 cm depth. *Comment*: *Fagus* and *Abies* horizon with cereals pollen.

General Comment: dates indicate immigration of *Fagus, Picea,* and *Abies* earlier than at N of Alps, maximum of *Fagus* extension during Atlantic and end of *Fagus* dominance at beginning of Sub-Boreal. Comparable vegetational development is reported for locality at 15 km, Lengholz (Fritz, 1967) and for Dobramoos (Bortenschlager, 1966, this list, above). Lower sample dates appearance of agriculture as far back as 5120 B.P.

Schwarzer Moor I, Kärnten, Austria

Sec. in wet raised bog Schwarzer Moor (46° 34′ 30″ N Lat, 14° 23′ 20″ E Long) at 770 m alt, E of Sattnitz Mts., SE of Klagenfurt, Kärnten (Carinthia), Austria. Pollen profile by Schmidt (1965), to study vegetational history of Sattnitz region. Pollen analyses of related localities in Kärnten reported by Schmidt (1965, 1970), Bortenschlager (1966), and Fritz (1967). Core at center of bog, 930 cm long, taken with Hiller borer. Coll. by H. Schmidt; subm. by M. Welten.

2490 ± 100
B-620. Schwarzer Moor I-3 **540 B.C.**

Cyperaceae peat, largely dry and decomposed, from 300 to 325 cm depth. Brief decrease of *Fagus* and *Abies*, NAP increase with indicators of human influence (cereals and *Plantago*).

B-621. Schwarzer Moor I-4 **5760 ± 120**
3810 B.C.

Detritus gyttja, dark brown, from 545 to 555 cm depth. *Abies* expansion and decrease of *Picea, Fagus,* mixed oak forest (*Ulmus* decrease) and *Corylus,* due to extensive human influence.

B-622. Schwarzer Moor I-5 **8785 ± 150**
6835 B.C.

Detritus gyttja, dark brown, from 745 to 755 cm depth. *Corylus* increase and mixed oak forest maximum. *Comment*: considered Boreal. At depth 720 to 550 cm (ca. 8200 to 5800 B.P.) pollen spectrum shows dominance of *Corylus* and *Picea* (Atlantic). In younger part of Atlantic, *Fagus* immigration and expansion; compare similar date, B-597: 6120 ± 100 B.P., for Keutschachersee (see below).

General Comment: as in Kohlenmoos and Dobramoos series (above), and in Keutschachersee series (below), immigration and extension of *Fagus, Picea,* and *Abies* have been dated. Transition from *Picea* dominance to *Fagus* increase occurs earlier in more oceanic parts of Kärnten (W) than in those more continental (E) as Kohlenmoos (above) (Schmidt, 1965, 1970). Calculated sedimentation rate is ca. 7.2 cm/100 yr.

Keutschachersee II series, Kärnten, Austria

Sec. in Keutschachermoor bog (46° 35′ 15″ N Lat, 14° 10′ 30″ E Long), at 508 m alt, at E of lake of Keutschach, S of Lake Wörth, in W part of Sattnitz Mts., Kärnten (Carinthia), Austria. Vegetational history of outer part of E Alps was pollen analytically investigated by Schmidt (1965, 1970), Bortenschlager (1966), and Fritz (1967). Core, 940 cm long, from center of hydrosere on E of lake, taken with Hiller borer. Coll. 1964 by H. Schmidt; subm. by M. Welten.

B-597. Keutschachersee II, KC VIII-1 **6120 ± 100**
4170 B.C.

Cyperaceae peat partly with "braunmosses" and *Eriophorum* leaves, from 200 to 225 cm depth. Decrease of *Picea* and increase of *Abies, Fagus,* and *Alnus. Comment*: considered end of Atlantic.

B-598. Keutschachersee II, KC VIII-2 **6910 ± 100**
4960 B.C.

Phragmites peat with scattered rests, strongly humified, from 360 to 370 cm depth. Onset of *Picea* maximum, decrease of *Ulmus* and *Tilia.* Very strong increase of spores of *Pteridium* and *Dryopteris* (from ca. 1% to > 200%) and increase of NAP (from 10% to 40%). *Comment*: considered transition Boreal/Atlantic.

General Comment: dates establish immigration of *Fagus, Picea,* and *Abies* earlier than at N of Alps, maximum extension of *Fagus* during Atlantic, and end of its dominance at beginning of Sub-Boreal (compare series at Kohlenmoos, Schwarzer Moor, and Dobramoos, this list) (Schmidt, 1965).

Profile shows detailed Late Glacial development from Oldest Dryas onwards, in clay from 940 to 715 cm and in chalk from 715 to 520 cm depth. Subsequent Post-Glacial development shows succession ranging from mixed oak forest to *Corylus-Picea* phase. Start of Post-Glacial appears delayed ca. 2000 yr compared to Schwarzer Moor (see above). Fern increase, at beginning of Atlantic (Sample KC VIII-2), may be related to forest clearance (Bastin, 1964) but is considered by collector to be due to wetter climate (Schmidt, 1965). Post-Atlantic development is synchronous with Schwarzer Moor (see above).

9040 ± 130
B-963. Höll, Block IV, Oberösterreich, Austria 7090 B.C.

Wood from 50 cm depth in clay of former lake now covered by rock-fall material, at Höll (47° 38′ N Lat, 14° 28′ E Long), alt ca. 1300 m, near Linzerhaus, Spital am Pyhrn, Totes Gebirge Mts., Kirchdorf a.d. Krems, Oberösterreich, Austria. Coll. 1968 by E. Ebers, D-8121 Haunshofen, Kr. Weilheim, W Germany; subm. by V. Markgraf. Locality in 500 m long and 90 m broad widening of Teichl valley at foot of steep walls of Stubwieswipfel Mt. within subalpine *Picea* forest belt, in former lake covered by rock-fall material with numerous engravings of primitive design (Ebers, 1969). Several cuts were pollen analytically investigated by V. Markgraf to date rock-fall and engravings. *Comment*: engravings seem to date from several archaeologic times, partially related to paintings of different epochs: e.g., W France megalithic and Bronze and Iron ages (Burgstaller, 1961). At level of present date in pollen digaram, analysis shows transition from *Pinus* dominance to *Picea* increase (V. Markgraf, written commun., 1970) which corresponds well to previously dated diagrams from Austria (Fritz, 1967; Bortenschlager, 1966, 1967), where this transition ranges from 10,000 to 9000 B.P. Date agrees with dated diagrams of Seemoos and Dobramoos (this list) but erroneously pub. and interpreted as Allerød by Ebers (1969).

Seemoos series, Salzburg, Austria

Sec. in Seemoos raised bog (47° 5′ N Lat, 13° 45′ 30″ E Long), ca. 1700 m alt, in pass on Schwarzenberg Plateau, Bezirk Tamsweg in Lungau, Salzburg, Austria. Pollen analytic investigation of forest history and immigration of vegetation in glaciated valleys of E Alps (see Dobramoos, Schwarzer Moor I, Keutschachersee II, and Kohlenmoos series, this list) by Bortenschlager (1967). Human influence since Roman times is indicated. Core (8.50 m long) was taken with Hiller borer. Coll. 1963 by S. Bortenschlager; subm. by M. Welten.

880 ± 100
B-596. Seemoos I-100 A.D. 1070

Sphagnum peat from 100 to 125 cm depth with 1 cm thick charcoal horizon. Increase of NAP and indicators of human activity (cereals, *Plantago*, and *Rumex*). *Comment*: dates transition Older/Younger Sub-

Atlantic. Variations in *Picea* and *Pinus* pollen ratio interpreted as probable clearing by fire for pasture purposes. Age derived from calibration curve (see Introduction) between A.D. 1010 to A.D. 1210.

B-616. Seemoos I-650 **7580 ± 120** **5620 B.C.**

Cyperaceous peat from 650 to 675 cm depth. Increase of *Picea* with simultaneous decrease of *Pinus*. *Comment*: interpreted as transition Boreal/Older Atlantic.

General Comment: C^{14} dates agree with chronology inferred from pollen analyses.

II. ARCHAEOLOGIC SAMPLES

A. Switzerland

Vinelz series, Bern, Switzerland

Two samples from Vinelz (ca. 47° 2′ N Lat, ca. 7° 4′ E Long), at ca. 440 m alt, in late Neolithic site on SE branch of lake of Biel (Bieler See), SE of Erlach, canton Bern, Switzerland. Samples from cultural layer overlain by 1.5 m of sand, assoc. with potsherds with food remains. Should represent small regional Lüscherz group, perhaps related to Horgen culture. Chronologic setting not completely determined; expected younger than Cortaillod culture (see Seeberg Burgäschisee-Süd series: Radiocarbon, 1959, v. 1, p. 140-142; 1961, v. 3, p. 23-24) and older than *Schnurkeramik* culture (see Auvernier series: Radiocarbon, 1967, v. 9, p. 30; (Strahm, 1965-1966, 1970). Coll. 1960 and subm. by C. Strahm, Inst. für Ur- und Frühgeschichte, Univ. Freiburg, W Germany.

B-778. Vinelz 1 **4170 ± 250** **2220 B.C.**

Wood charcoal. *Comment*: date, derived from calibration of C^{14} scale with tree rings (see Introduction), is 3400 B.C. to 2600 B.C.

B-779. Vinelz 2 **4460 ± 120** **2510 B.C.**

Seeds, nutshells, and charred acorns. *Comment*: date, from mentioned curve, is 3380 B.C. to 2980 B.C.

General Comment: both dates are coincident and agree with expectations.

La Baume d'Ogens series, Vaud, Switzerland

Site 1 km E of Ogens (46° 43′ N Lat, 6° 44′ E Long), at 672.90 m alt, in dist. of Moudon, ca. 13 km SE of Yverdon, Vaud (Waadt), Switzerland. Discovered 1955 (Egloff, 1965; Wyss, 1968) in a fault S oriented facing Augine R., is 1st reported Mesolithic rock shelter from Molasse formation in Jura; contains 6 Epipaleolithic hunter-gatherers occupation levels alternating with sand layers. Assoc. finds are largely similar to those of lower levels in Birsmatten-Basisgrotte (Bandi, 1964; Radiocarbon, 1961, v. 3, p. 23). Stone artifacts (sieved out with mesh 2 mm) correspond to microlithic types made out of silex, quartzite, radiolarite, and rock-crystal, from nearby moraine. Finds include triangles, scrapers, backed bladelets, and punches. Artifacts of bone are smoothers, fragments of boar tusks, and perforated deer grandles. Similar lithic industry later discovered at Abri de la Cure in Baulmes (Egloff, 1966-67, 1967). Fauna remains, id. by P. Strinati (mainly *Cervus elaphus, Capreolus capreolus, Sus scrofa, Meles meles, Vulpes vulpes,* and *Martes*). No pollen has been conserved, but in charcoal layer are found macroscopic plant remains, id. by M. Villaret, Mus. Bot. Lausanne (*Quercus, Corylus avellana, Sorbus torminalis, Fraxinus,* scarce *Pinus,* and *Cornus sanguinea*); considered to represent younger part of Boreal (M. Villaret, 1970, written commun.).

Stratigraphic excavation 1964-66 and coll. 1964-65 by M. Egloff, Mus. Cantonal Archéol., Neuchâtel, Switzerland; subm. by R. Kasser, Univ. of Geneva, Switzerland.

B-764. La Baume d'Ogens 1 **8530 ± 100**
6580 B.C.

Charred wood and nutshells from Layer 4b (penultimate occupation level) at +25 cm from ref. level.

B-765. La Baume d'Ogens 2 **8735 ± 150**
6785 B.C.

Small pieces of charcoal from Layer 13, oldest occupation level at −50 cm from ref. level.

General Comment: dates agree with previous radiocarbon dates for similar archaeologic material (Radiocarbon, 1961, v. 3, p. 23; Gfeller, 1964) but seem somewhat older than Younger Boreal (compare: Zoller, 1968, p. 29) suggested by macrofossils analyses above.

B. Egypt

Kellia series, Beheira, Egypt

Four samples from Qouçoûr' Isâ Sud I, complex ca. 75 m × 70 m, with > 100 chambers and 2 basilicas, in Kellia (30° 45′ N Lat, 30° 22′ E Long), coptic monasteries site at E border of Libyan desert, some km from Nile Delta in Marquaz, Dilingat, prov. of Beheira, Egypt; was rediscovered in 1964. More than 1200 constructions with walls made of unburnt bricks covered with mortar have been found in area (12 km × 3.5 km). Most common type of monastery has yard (average 20 m × 30 m) with water well, garden, and basins, limited by rectangular wall. At W, cells, prayer rooms, and kitchen. Assoc. finds consist of abundant ceramics, numerous wall decorations and inscriptions, and some coins; sculpture rarely present. Organic rests consist of bones and wood charcoal. Main purpose of research was to date ceramics and glass-ware, and study architectural evolution of site; 9 other dates are known from same site (Hv-unpub., M. A. Geyh, 1969, written commun.) and are discussed below. Site described by Kasser (1967) and Daumas and Guillaumont (1969). Subm. by D. Weidmann, Fouilles Coptes, Univ. Geneva, Switzerland.

B-802. Houçour 'Isâ Sud I, Pit 1, Layer 3 **1950 ± 100 A.D. 1**

Wood charcoal from Layer 3, ca. 3.50 m depth in Refuse Pit 1 assoc. with ceramics, glass-ware and kitchen trash. Constantine coin (A.D. 379 to 395) gives expected date for sample. Coll. 1966 by R. Kasser, Fac. of Letters, Univ. Geneva, Switzerland. *Comment*: date derived from calibration curve (see Introduction) is 140 B.C. to A.D. 100, considered too old by collector, who attributes discrepancy to fossil resin or bitumen in sample. Deeper Layer 10 (see below) was dated somewhat younger.

B-803. Qouçour 'Isâ Sud I, Pit 1, Layer 10 **1650 ± 100 A.D. 300**

Wood charcoal from Layer 3, in Pit 1; ca. 4.50 m depth. Expected contemporary with dated sample of charcoal at 4 m depth in Pit 2 (Hv-2388: 1585 ± 60 B.P., = A.D. 400 to A.D. 510 after conversion to calendar yr), and not older than A.D. 379 (see comment, above, to Layer 3). Coll. 1966 by R. Kasser. *Comment*: corresponding date derived from calibration curve(see Introduction) is A.D. 180 to A.D. 450, agrees with expectations.

B-804. Qouçour 'Isâ Sud I, Tomb 5 **1310 ± 120 A.D. 640**

Human bone at 2 m depth in cemetery with ca. 200 tombs. Skeletons are found buried in sand without any dated object. Cemetery believed in use until ca. A.D. 700 above ruins of part of abandoned monastery (from date of S.50, below). Coll. 1966 by D. Weidmann. *Comment*: date corrected for secular variations in C^{14} (see Introduction) is A.D. 600 to A.D. 840, agrees with expectations. Correction for isotopic fractionation would make age from 90 to 270 yr older depending on C^{13}/C^{12} ratio (Radiocarbon, 1967, v. 9, p. 114, 116, 117; 1969, v. 11, p. 351).

B-988. Qouçour 'Isâ Sud I, S.50 **1530 ± 100 A.D. 420**

Large wood charcoal pieces from ca. 1 m depth in kitchen, assoc. with abundant ceramics (pots, amphorae). Date expected not older than A.D. 610, based on assoc. with Heraclius coin. Coll. 1967 by D. Weidmann. *Comment*: corrected C^{14} date (see Introduction) is A.D. 310 to A.D. 580. Another charcoal sample from same kitchen was dated (Hv-2390): 1295 ± 75 B.P. (converted to A.D. 630 to A.D. 820 by use of calibration curve). Coin and present radiocarbon date do not disagree if a 2σ interval is taken. Preferred explanation is that wood was re-used from older churches, as suggested by traces in charcoal pieces.

General Comment: dates 2 phases of occupation: (1) construction of monastery with large trash pits containing abundant and typical pottery, glass-ware, and refuse (bones, fish-bones, vegetables, etc.) dated to 1st half of 5th century A.D. by Samples B-803 (this series) and Hv-2388 (charcoal in Pit 2): 1585 ± 60 B.P., Hv-2619 (charcoal at base of tower, S.64):

1565 ± 55 B.P., B-802 (this list) and Hv-2617 (fish-bone in amphora, S.65): 3305 ± 245 B.P., should be contemporary according to assocs.; (2) last occupation of Qouçoûr 'Isâ Sud I and perhaps whole site Kellia. Dated in kitchen ovens of 3 different constructions between end of 7th and beginning of 8th centuries A.D., by samples B-988 (this series) and Hv-2390: 1295 ± 75 B.P. (charcoal in kitchen, S.50) Hv-2389: 1310 ± 45 B.P. (charcoal in kitchen from Building 6), and Hv-2621: 1335 ± 60 B.P. (charcoal from Kitchen SO in Building 366). Most recent date from inscription in Kellia is A.D. 739; arabic sources comment that site was in ruins and almost uninhabited in 9th century A.D., thus agrees with Hv-2622: 1010 ± 50 B.P. dating charcoal in ruins (Room B, Building 366) assoc. with atypical ceramics and arabic (moslem) coins younger than A.D. 644. Standard deviation is too large for other 2 samples (Hv-2618: 1685 ± 265 in ashes and charcoal from Kitchen S.82, and Hv-2620: 1810 ± 255 in ashes and charcoal from Site S.48) which could provide information about development during middle occupation period.

C. Alaska

Kodiak Island series, Alaska, U.S.A.

Two samples from 2 sites in Anton Larsen Bay (57° 52′ N Lat, 152° 40′ W Long), arm of Kizhuyak Bay, at NE of Kodiak I., Alaska. Sites are ca. 500 m from each other. First sondage in 1959 with subsequent exposure allowed study of artifacts by Clark (1964). Sites provide information about change of Kachemak tradition to Eskimo Koniag phase (Clark, 1964, 1966, 1968, 1970). Present dates belong to general Kodiak I. series (Radiocarbon, 1966, v. 8, p. 367-369). Coll. 1964 to 1966 by D. W. Clark, Dept. Anthropol., Univ. Wisconsin, U.S.A.; subm. by H. Müller-Beck.

1100 ± 100
B-835. Crag Point, Site 241 A.D. 850

Charred material, probably sea mammal oil, scraped from potsherds in upper part of site. Expected to date end of site occupation with unsuccessful attempt to introduce pottery into area. Sherds considered not intrusive from re-occupations. *Comment*: date derived from C^{14} calibration curve (see Introduction) is A.D. 770 to A.D. 1050, agrees with expectation to date end of occupation and early changes to Eskimo Koniag phase between ca. A.D. 1050 and 1100. Deeper sample of same site gave reasonable, older date, P-1057 (Radiocarbon, 1966, v. 8, p. 369): 2033 ± 52 B.P.

600 ± 100
B-836. Kizhuyak, Site 240 A.D. 1350

Small charcoal particles from lower midden layer, 3 m thick. Expected to provide early date for Koniag phase, and to differ 100 to 200 yr from Crag Point sample (see above). *Comment*: date derived from calibration curve (see Introduction), is A.D. 1270 to A.D. 1420, thus agrees with expectation. This is oldest of 6 charcoal dates (Radiocarbon, 1966, v. 8, p. 368) from Koniag phase.

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BIRMINGHAM UNIVERSITY RADIOCARBON DATES IV

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Measurements have continued with both the 1 L and 6 L counters. Results are not corrected for C^{13} fractionation. Errors quoted refer only to the standard deviation calculated from a statistical analysis of sample and background count rates and the Libby half-life of 5570 ± 30 yr. Pretreatment has been continued as described previously (Shotton, Blundell, and Williams, 1969).

SAMPLE DESCRIPTIONS

I. BRITISH FULL-GLACIAL

Birm-32. Stretton-under-Fosse, Warwickshire **>26,000**

Wood (*Ulmus*) in Lower Wolston Clay from 15.5 m depth in Borehole 1285 Midland Connection Motorway near Stretton-under-Fosse, Warwickshire (52° 26′ N Lat, 1° 19′ W Long, Grid. Ref. SP463813). Coll. 1967 and subm. by A. Horton. *Comment*: measurement helps confirm stratigraphic interpretation.

Birm-74. Four Ashes, Staffordshire **>43,500**

Plant fragments and twigs from fine gray silt ca. 1 m depth (Site 20) in Four Ashes Gravel at Four Ashes, Staffordshire (52° 40′ 13″ N Lat, 2° 07′ 24″ W Long, Grid. Ref. SJ916082). Coll. 1968 and subm. by Anne Morgan. *Comment*: fauna in sample included *Lepidurus* and many exclusively N insect species, indicating cold conditions.

Birm-114. Trysull, Staffordshire

(a) 34,250 +1550 −1300
32,300 B.C.
(b) >25,000
(c) >34,000

Inner (a) middle (b) and outer (c) fractions from shells (Opercula of *Bithynia tentaculata*) sieved from calcareous silty clay at ca. 2 m depth overlying coarse kame gravel and sand at Church Lane Pit, Trysull, Staffordshire (52° 33′ 0″ N Lat, 2° 13′ 25″ W Long, Grid Ref. SO848946). Coll. 1968 and subm. by A. V. Morgan. *Comment*: stratigraphy and contained fauna suggest figures are minimum ages. Probably Ipswichian.

Birm-157. Farm Wood Quarry, Chelford, Cheshire **47,000 +2300 −1800**
45,050 B.C.

Wood (*Pinus sylvestris*) from main organic horizon at 10 m depth in quarry sec. in Chelford Sands formation at Farm Wood Quarry, Chelford, Cheshire (53° 15′ N Lat, 2° 17′ W Long, Grid Ref. SJ812731). Coll. 1967 and subm. by P. Worsley. *Comment*: sample from deposit previously dated at >52,000 (GrN-1292) and subsequently by isotopic enrichment at 60,800 ± 1500 (GrN-1475) (Vogel and Zagwijn, 1967). Deposit believed to have unique and critical position in Early Devensian (Weichselian) of England and to be equivalent to Brörup Interstadial (Simpson and West, 1958; Worsley, 1967; Evans, 1968, p. 213). Sample subm. by Worsley to Hannover lab gave values (Hv-1978, 32,850 ± 480, unpub.) and (Hv-1979b, 26,200± 390, unpub.) for humate extract. Birmingham date done on another piece of same trunk subm. to Hannover, measured after 4 successive NaOH treatments to remove possible contamination. Counter reading of activity slightly exceeded 4σ after atmosph. pressure correction. If this experimentally obtained coefficient is only slightly inaccurate, result might have been more correctly expressed as >47,000. General conclusion is that Hannover date is too young, as result of contamination, and that there is no case for substantial alteration of Groningen figures.

25,780 ± 870

Birm-113. Thrapston, Huntingdonshire **23,830 B.C.**

Twigs from organic-silt lens containing mature tundra assemblage of coleoptera ca. 5 m depth in terrace gravels of R. Nene, Thrapston, Huntingdonshire (52° 24′ 40″ N Lat, 0° 32′ 50″ W Long, Grid Ref. JP988805). Coll. 1967 and subm. by G. R. Coope.

(a) 36,300 $^{+2160}_{-1700}$

Birm-161. Scandal Beck, Westmorland **34,350 B.C.**

(b) >25,800

Sample after alkali pretreatment (a) and humate extract (b) from peat from lower of 2 organic horizons in sandy silt overlain by 1.5 m till at ca. 3 m depth on W bank Scandal Beck, 64 m SSW Brunt Hill Farm, Ravenstonedale, Westmorland (54° 25′ N Lat, 2° 24′ W Long, Grid Ref. NY743024). Coll. 1969 and subm. by G. A. L. Johnson. *Comment*: indicates late Devensian (Weichselian) till upon deposits of Upton Warren interstadial.

Birm-93. Kilmaurs, Ayrshire **>40,000**

Collagen fraction from antler of *Rangifer tarandus* from gravel ca. 12 m deep below till 5 m thick (part of V 5187, Fig. 1b, p. 4, Gregory and Currie, 1928) at Woodhill Quarry, Kilmaurs, Ayrshire (55° 38′ N Lat, 4° 32′ W Long, Grid Ref. NS410410). Coll. 1865 by J. Bryce; subm. by W. D. Rolfe and W. W. Bishop. *Comment*: although long stored in museum, antler was free from preservative. Date contrasts with 13,700 $^{+1700}_{-1300}$ (GX-0634, unpub.) on mammoth tusk from same deposit (Sissons, 1967).

Birm-165. Ballymakegoge, Co. Kerry, Ireland **>42,500**

Laminated peat exposed below high tide level at Ballymakegoge, near Tralee, Co. Kerry, Ireland (52° 16′ N Lat, 9° 48′ W Long). Coll. 1969 and subm. by G. F. Mitchell. *Comment*: determination supports Mitchell's interpretation as Hoxnian.

Birm-166. Derryvree, Co. Fermanagh, Ireland **30,500 $^{+1170}_{-1030}$** **28,550 B.C.**

Plant debris in laminated sand lens at 3.5 m depth between upper and lower tills (upper in drumlin form) at Derryvree, near Maguire's Bridge, Co. Fermanagh, Ireland (54° 18′ N Lat, 7° 27′ W Long, Grid Ref. H361390). Coll. 1969 by E. Colhoun; subm. by G. F. Mitchell. *Comment*: 2 tills are separated by interstadial deposits of Upton Warren date containing cold climate plants and beetles consistent with this dating.

II. BRITISH LATE-GLACIAL AND HOLOCENE

Church Stretton series, Shropshire

Samples from borehole near sewer manhole MH 60 at Church Stretton, Shropshire (52° 32′ 30″ N Lat, 2° 48′ 10″ W Long, Grid Ref. SO456941). From 1.65 m clay, silt, and peat, underlying 1.3 m solifluction gravel and overlying 1.32 m+ pebbly clay and gravel upon till. Coll. 1967 by P. J. Osborne; subm. by F. W. Shotton.

Birm-148. **11,000 ± 200** **9050 B.C.**

Plant fragments from gray clay, 0 to 0.2 m below solifluction gravel.

Birm-158. **12,135 ± 200** **10,185 B.C.**

Plant fragments from peat between 1.02 and 1.29 m below solifluction gravel.

Birm-149. **13,555 ± 620** **11,605 B.C.**

Plant fragments washed from gray clay between 1.29 and 1.45 m below solifluction gravel. Sample small, hence high standard deviation. *General Comment*: dates confirm evidence (plants and coleoptera) that sequence covers Zones II and I, setting limiting dates to overlying solifluction gravels and underlying till. Birm-148 differs appreciably from NPL-81 (11,790 ± 140, Callow, Baker, and Hassall, 1965) which refers to an intermediate between 148 and 158 horizon in adjacent trench sec.

10,300 ± 170
Birm-92. Rodbaston Hall, Staffordshire **8350 B.C.**

Peat from core ca. 2 m depth in borehole, Rodbaston Hall, Staffordshire (52° 41′ 40″ N Lat, 2° 06′ 30″ W Long, Grid Ref. SJ928110). Coll. 1966 by C. H. S. Sands; subm. by A. C. Ashworth. Sample from horizon where extreme N coleoptera disappeared from faunal spectrum.

11,580 ± 140
Birm-118. Penkridge, Staffordshire **9630 B.C.**

Plant material from sandy peat at 2.8 m depth in gravels overlying Keuper Sandstone at Penkridge, Staffordshire (52° 43′ 35″ N Lat, 2° 06′ 45″ W Long, Grid Ref. SJ924143). Coll. 1968 and subm. by A. V. Morgan.

11,660 ± 250
Birm-131. Pillaton Hall, Staffordshire **9710 B.C.**

Plant material from base of sandy peat overlying sand at ca. 3 m depth in peat bog, at Pillaton Hall near Penkridge, Staffordshire (52° 42′ 52″ N Lat, 2° 05′ 12″ W Long, Grid Ref. SJ941130). Coll. and subm. by A. V. Morgan. *Comment*: dates beginning of organic filling of hollow of kettle form.

13,490 ± 380
Birm-150. Borehole 12, Stafford **11,540 B.C.**

Plant fragments from dark gray silt at 15.6 m depth in Borehole 12 of Inner Relief Rd., Stafford (52° 48′ 24″ N Lat, 2° 06′ 30″ W Long, Grid Ref. SJ927233). Coll. 1969 and subm. by A. V. Morgan. *Comment*: dates base of unusually thick peaty silts resting on 9 m fluvioglacial deposits.

9030 ± 200
Birm-135. Fladbury, Worcestershire **7080 B.C.**

Roots (probably sedges) from silty peat beneath 1.5 m red clay-sand and above 4 m gravel of Avon No. 1 terrace at Fladbury Lower Moor, Worcestershire (52° 06′ 45″ N Lat, 2° 01′ 45″ W Long, Grid Ref. SO 981461). Coll. 1969 by P. Buckland; subm. by F. W. Shotton. *Comment*: 1st date from this terrace, lowest of Avon series.

2060 ± 170
Birm-153. Bransford, Worcestershire **110 B.C.**

Wood imbedded at 5.1 m depth in alluvial gravel of R. Teme with remains of *Cervus elaphus*, at New House Farm, Bransford, Worcestershire (52° 10′ 30″ N Lat, 2° 18′ W Long, Grid Ref. SO798533). Coll. 1969 and subm. by G. R. Coope.

11,730 ± 770
Birm-82. Orleton, Herefordshire **9780 B.C.**

Moss fragments hand picked from laminated calcareous silt lens in outwash gravels of Wye glacier at Orleton, Herefordshire (52° 18′ 20″

N Lat, 2° 44′ 30″ W Long, Grid Ref. SO497677). Coll. 1967 by P. Cross; subm. by G. R. Coope. *Comment*: no alkali pretreatment because sample small. Modern roots known to penetrate sample so no guarantee that all contamination removed. Date older than previous determination of bulk sample (5020 ± 130) but must be regarded as minimal age only.

11,250 ± 100
Birm-105. Northmoor, Oxfordshire **9300 B.C.**

Peat from silt lens containing coleoptera ca. 1.5 m depth in terrace gravel at Brown's Pit ca. 1.2 m NNW of church, Northmoor, Oxfordshire (51° 44′ 00″ N Lat, 1° 23′ 35″ W Long, Grid Ref. SP419041). Coll. 1968 by H. P. Powell; subm. by J. M. Edmonds.

2170 ± 280
Birm-123. Rockingham, Northamptonshire **220 B.C.**

Charcoal fragments from old soil B horizon disturbed by slipped mass of Upper Lias clay at Gretton Wood, Rockingham, Northamptonshire (52° 31′ N Lat, 0° 41′ W Long, Grid Ref. SP883923). Coll. 1968 and subm. by R. J. Chandler. *Comment*: provides lower limit to date of landslip.

11,900 ± 540
Birm-106. Oaze Deep, River Thames **9950 B.C.**

Shells (mainly *Cardium* and *Mytilus*) in laminated silty clay from core at −19 m alt, 6.7 m below bed of Thames Estuary at Oaze Deep (51° 32′ 25″ N Lat, 1° 08′ 10″ E Long). Coll. 1966 by George Wimpey and Co.; subm. by R. J. Maddrell. *Comment*: because of small sample, measurement made on whole sample.

5670 ± 170
Birm-167. Lewes Brooks, Sussex **3720 B.C.**

Plant fragments from silty peat between 6.7 and 6.9 m depth (ca. −4 m alt) in Borehole B 117 at Lewes Brooks, Lower Ouse Valley, Sussex (50° 52′ N Lat, 0° 0′ Long, Grid Ref. TQ413092). Coll. 1969 and subm. by A. Thorley and D. K. Jones.

6290 ± 180
Birm-168. Lewes Brooks, Sussex **4340 B.C.**

Plant material from silty peat at 9.5 to 9.8 m depth (ca. −5.6 m alt) underlying silt, in Borehole B 123 at Lewes Brooks, Lower Ouse Valley, Sussex (50° 42′ N Lat, 0° 0′ Long, Grid Ref. TQ413013). Coll. 1969 and subm. by A. Thorley and D. K. Jones. *Comment*: with Birm-167 dates events in Holocene vegetational history of SE England and provides limiting dates to marine transgression in Lower Ouse Valley.

Red Moss series, Lancashire

Peat samples from borehole at Red Moss, near Horwich, Lancashire (53° 35′ 23″ N Lat, 2° 34′ 36″ W Long, Grid Ref. SD632102). Coll. 1968 and subm. by A. C. Ashworth.

Birm-124.

(a) 9800 +700 −650
7850 B.C.

(b) 8390 ± 100
6440 B.C.

Sample after alkali pretreatment (a) and humate extract (b) from base of woody peat layer above gray silty clay.

Birm-128. **10,850 ± 120**
8900 B.C.

Sample from top of peat layer, immediately underlying gray silty clay, 0.3 m below Birm-124.

Birm-127. **12,160 ± 140**
10,210 B.C.

Sample from base of peat layer 0.35 m below gray silty clay and 0.55 m below sample Birm-124.

General Comment: sec. contains coleopterous fauna studied by A.C.A. Fauna of Birm-127 does not indicate cold climate, Birm-128 marks incoming of cold species, and Birm-124 dates disappearance of arctic stenotherms.

Heysham series, Lancashire

Plant material from sedge peat beneath marine clay and sand, overlying sand and boulder clay in offshore boreholes drilled 1967 near Heysham, Lancashire (54° 02′ N Lat, 2° 56′ W Long). Coll. 1968 by A. Ashworth; subm. by F. W. Shotton.

Birm-139. Borehole M1 **9195 ± 155**
7245 B.C.

Sample at −16.4 m alt, Grid Ref. SD395599.

Birm-140. Borehole M2 **8925 ± 200**
6975 B.C.

Sample from −15.8 to −16.3 m alt, Grid Ref. SD394599.

Birm-141. Borehole M3 **9270 ± 200**
7320 B.C.

Sample from −17.6 m alt, Grid Ref. SD393599.

General Comment: series gives evidence for Post Glacial rise of sea level in Morecambe Bay.

Birm-147. Holcombe Moor, Lancashire **3540 ± 120**
1590 B.C.

Twigs (*Betula*) at 0.9 m depth in 0.25 m thick basal layer of peat bog at Holcombe Moor, Lancashire (53° 38′ N Lat, 2° 20′ W Long, Grid

Ref. SD777169). Coll. 1969 and subm. by J. H. Tallis. *Comment*: sample helps give time scale for moorland peat accumulation.

Birm-120. Greenock, Renfrewshire **9890 ± 160**
7940 B.C.

Shells (*Mya truncata*) in silty sands exposed at −1.4 m alt in excavations for Garvel Graving Dock, Greenock, Renfrewshire (55° 56′ N Lat, 4° 43′ W Long, Grid Ref. NS307752). Coll. 1962 and subm. by W. W. Bishop.

Birm-121. Greenock, Renfrewshire **10,560 ± 180**
8610 B.C.

Shells (*Astarte sulcata*) from shelly brown-gray silt at −3.5 m alt above varved clay and till in excavation for Garvel Graving Dock, Greenock, Renfrewshire (55° 56′ N Lat, 4° 43′ W Long, Grid Ref. NS307752). Coll. 1962 and subm. by W. W. Bishop. *Comment*: this and Birm-120 coll. to establish age of Clyde Valley Late Glacial sediments.

Birm-122. Wester Fulwood, Renfrewshire **(a) 12,650 ± 200**
10,700 B.C.
(b) 13,020 ± 220
11,070 B.C.

Inner (a) and outer fraction (b) of shells (*Arctica islandica*) from Paisley Clay underlying terrace gravels of R. Gryfe at Wester Fulwood, Renfrewshire (55° 52′ N Lat, 4° 31′ W Long, Grid Ref. NS432669). Coll. 1962 and subm. by W. W. Bishop. *Comment*: figures suggest no isotopic replacement. Dates early Late Glacial sea in Clyde Valley.

Birm-134. Sgor Mor, Aberdeenshire **4130 ± 110**
2180 B.C.

Wood (*Pinus sylvestris*) at base of hill peat, ca. 1 m thick on bed rock at Sgor Mor, Aberdeenshire (57° 10′ N Lat, 3° 38′ W Long, Grid Ref. NO004908). Coll. 1968 and subm by N. V. Peers. *Comment*: provides additional evidence dating Scottish deforestation and change of tree line.

III. MISCELLANEOUS GEOLOGIC SITES

Birm-169. Herquemoulin, France $\mathbf{28{,}070^{+1650}_{-1370}}$
26,120 B.C.

Wood from compressed peat on foreshore at Herquemoulin, Manche, France (49° 39′ N Lat, 1° 52′ W Long). Same peat layer visible in adjacent cliff beneath 14 m of head and resting on low marine platform. Coll. 1969 by F. W. Shotton; snbm. by A. Larsonneur. *Comment*: date much older than Gif-370, 15,020 ± 400 (Delibrias, Guillier, and Labeyrie, 1969) given to same deposit at closely adjacent locality (Delibrias and Larsonneur, 1966, p. 1023).

Sorgfjord series, Vestspitsbergen

Samples coll. in Sorgfjord region, Vestspitsbergen to help give rate of isostatic uplift. These form series together with Birm-37 (Shotton, Blundell, and Williams, 1968, p. 204) and Birm-68 (Shotton, Blundell, and Williams, 1969, p. 266). Coll. 1965 by G. S. Boulton and M. Rhodes; subm. by G. S. Boulton.

Birm-33. **1000 ± 370**
A.D. 950

Moss fragments from base of push moraine by W lake Dunerbreen (79° 40′ N Lat, 16° 50′ W Long). Large error due to small sample.

Birm-67.
(a) **10,000 ± 300**
8050 B.C.
(b) **9840 ± 290**
7890 B.C.

Inner (a) and outer (b) fractions of shell (*Mya arctica*) in 25 m raised beach, Sorgfjord (79° 50′ N Lat, 16° 50′ E Long). *Comment*: figures suggest no isotopic replacement.

Birm-73.
(a) **8550 ± 310**
6600 B.C.
(b) **8150 ± 360**
6200 B.C.
(c) **8400 ± 370**
6450 B.C.

Inner (a), middle (b), and outer (c) fractions of shell (*Mya*) at 1.5 m depth in 30 m raised beach at head of Sorgfjord (79° 50′ N Lat, 16° 50′ E Long). *Comment*: figures suggest no isotopic replacement.

Birm-53. Lake Katwe, Uganda **11,200 ± 600**
9250 B.C.

Sedge from base of varved marl 1 m thick, 90 m E of E shore Lake Katwe, Uganda (0° 08′ S Lat, 29° 53′ E Long, U.T.M. Grid Ref. RK1885). Coll. 1967 and subm. by W. H. Morton. *Comment*: sample represents early stage in evolution of lake prior to precipitation of sodium salts.

Birm-84. Lake Katwe, Uganda **0 ± 440**
A.D. 1950

Wood from mud layer in salt crust 0.6 m depth in pit 120 m from SW side Lake Katwe, Uganda (0° 08′ S Lat, 29° 53′ E Long, U.T.M. Grid Ref. RK1885). Coll. 1967 and subm. by W. H. Morton. *Comment*: not separable from present.

Birm-125. Sao Miguel, Azores **3240 ± 90**
1290 B.C.

Wood buried in 2nd ash layer of 5 overlying 1 containing Birm-35 (4670 ± 100, Shotton, Blundell, and Williams, 1968, p. 204) and Birm-90 (4435 ± 99, Shotton, Blundell, and Williams, 1969, p. 266) from rd.

sec. on N side Agua de Pau volcano 1.5 km NE of Lombadas, Sao Miguel, Azores (37° 47′ N Lat, 25° 27′ W Long). Coll. 1968 and subm. by G. P. L. Walker.

1200 ± 70
Birm-126. Faial, Azores **A.D. 750**

Charcoal from 2nd from top of 11 ash beds from summit caldera of Faial, Azores, exposed in rd. sec. 2.5 km N of edge of caldera (38° 36′ 30″ N Lat, 28° 42′ 30″ W Long). Coll. 1968 and subm. by G. P. L. Walker.

18,390 ± 360
Birm-156. Tuitts' Ghaut, Montserrat, W Indies **16,440 B.C.**

Charcoal from base of ca. 50 m thick pumice flow believed assoc. with formation of English's Crater and in upper part of Soufriere Hills pyroclast flow succession at Tuitts' Ghaut, Montserrat, W Indies (16° 44′ 33″ N Lat, 62° 09′ 20″ W Long). Coll. 1967 and subm. by W. J. Rea.

+2800
37,900
−2100
Birm-115. King Point, Yukon, Canada **35,950 B.C.**

Wood at +8 m alt imbedded in 25 m thick unconsolidated sand and silt underlying sand and gravel exposed in vertical coastal cliff 1.6 km W of King Point, Yukon, Canada (69° 07′ N Lat, 138° 01′ W Long, Grid Ref. 117A/East). Coll. 1968 by D. McIntyre; subm. by D. Naylor. *Comment*: overlying gravel, dated at 6000 (unpub.), lies unconformably (Naylor, unpub.) or is overthrust (Mackay, 1959) upon earlier sediments here dated.

880 ± 120
Birm-96. Monte Amargo, Chile **A.D. 1070**

Collagen fraction from bone of medium-size herbivore in dry marsh on S bank R. Copiapó, near Monte Amargo, Chile (27° 22′ S Lat, 70° 43′ W Long). Coll. 1967 and subm. by C. Mortimer. *Comment*: dates a time in pluvial period that preceded desiccation of low-level terrace of Rio Copiapó.

1430 ± 470
Birm-17. Marian Cove, King George Island **A.D. 520**

Seaweed from ca. 2.7 m depth in bedded gravels underlying raised beach at +5 m alt E of South Spit S shore Marian Cove, King George I., Antarctica (62° 14′ S Lat, 58° 48′ W Long). Coll. 1966 by D. E. Sugden; subm. by B. S. John. *Comment*: sample should be older than modern seaweed, Birm-16 1223 ± 81 (Shotton, Blundell, and Williams, 1968, p. 203) but result inconclusive. Large error due to small sample.

2600 ± 100
Birm-145. Tongariro, North Island, New Zealand **650 B.C.**

Carbonized branch imbedded in Wanganui pumice gravel S side rd. sec. State Hwy. 47 at Tongariro, North I., New Zealand (39° 3′ 40″ S Lat, 175° 35′ E Long). Coll. 1969 and subm. by C. A. Fleming. *Comment*: duplicate sample sent to Inst. Nuclear Sci., New Zealand, for dating. Confirms that this ash shower antedates Taupo Ash (Healy, Vucetich, and Pullar, 1964).

IV. ARCHAEOLOGIC SAMPLES

A. British

2140 ± 180
Birm-58. Wadden Hill, Dorset **190 B.C.**

Charcoal from ca. 1.5 m depth in pit at Roman Fort occupied A.D. 45 to 60 (Webster, 1965) at Wadden Hill near Stoke Abbott, Dorset (50° 48′ N Lat, 2° 47′ W Long, Grid Ref. 450015). Coll. 1968 and subm. by G. Webster. *Comment*: indicates problem of dating charcoal when it may be derived from wood of old trees.

1541 ± 80
Birm-109. Tamworth, Staffordshire **A.D. 409**

Oak plank ca. 4 m deep in filling of main Saxon defensive ditch of Tamworth (52° 38′ N Lat, 1° 42′ W Long, Grid Ref. SK206038). Coll. 1968 by C. S. Young; subm. by P. A. Rahtz. *Comment*: maximum date, since plank probably comes from timber structure assoc. with defenses.

Hereford series

Charcoal samples from excavations at Hereford (52° 04′ N Lat, 2° 44′ W Long, Grid Ref. SO508404). Coll. 1968 and subm. by P. A. Rahtz.

1189 ± 83
Birm-111. **A.D. 761**

Charcoal from pit of corn-drying oven beneath rampart of Birm-110.

1335 ± 67
Birm-110. **A.D. 615**

Charcoal residue of large structural timbers at ca. 2 m depth in major defensive rampart of Saxon town.

(a) 700 ± 220
Birm-159. **A.D. 1250**
(b) 1330 ± 200
A.D. 620

Sample after alkali pretreatment (a) and humate extract (b) of charcoal residue from large structural timbers at ca. 1 m depth in major defensive rampart.

289 ± 79
A.D. 1661

Birm-112. Metchley Camp, Birmingham

Brushwood at ca. 0.7 m depth at base of trench which cuts all Roman structures at Metchley Camp, Birmingham (52° 27′ 0″ N Lat, 1° 56′ 20″ W Long, Grid Ref. SP042836). Coll. 1968 and subm. by T. Rowley. *Comment*: last trench cutting complex of Roman structures, hopefully dating end of Roman occupation, but proving to be recent.

2473 ± 84
523 B.C.

Birm-119. South Barrule, Isle of Man

Charcoal assoc. with pottery, from upper hearth level of hut in hill-fort (Gelling, 1963) on South Barrule, Isle of Man (54° 09′ N Lat, 4° 40′ W Long, Grid Ref. SC258759). Coll. 1968 and subm. by P. S. Gelling. *Comment*: proof of early Iron age.

1910 ± 90
A.D. 40

Birm-129. Dorstone, Herefordshire

Charcoal from supposed Neolithic hearth cut by post hole. Later Roman-British occupation of site, Dorstone Hill, Herefordshire (52° 04′ N Lat, 2° 59′ W Long, Grid Ref. SO326423). Coll. 1968 and subm. by W. R. Pye. *Comment*: hearth is part of Romano-British complex.

1850 ± 110
A.D. 100

Birm-130. Rowington, Warwickshire

Charcoal from 1.5 m depth in stake hole of Roman tile kiln at Rowington, Warwickshire (52° 19′ 30″ N Lat, 1° 43′ 30″ W Long, Grid Ref. SP187698). Coll. 1969 and subm. by G. Webster.

2180 ± 110
230 B.C.

Birm-132. Holme Pierrepont, Nottinghamshire

Wood from gunwale of dugout canoe at base of 3 m thick sand and gravel layer overlying Keuper marl at Holme Pierrepont, Nottinghamshire (52° 57′ N Lat, 1° 04′ W Long, Grid Ref. SK630396). Coll. 1969 and subm. by A. G. MacCormick. *Comment*: Iron age date; also useful in dating rate of migration of old course of Trent.

970 ± 290
A.D. 980

Birm-133. Hen Domeu, Montgomeryshire

Charcoal from soil layer buried by rampart of castle, built ca. A.D. 1070, and above pebble floor of pre-rampart building at Hen Domen, Montgomeryshire (52° 34′ N Lat, 3° 09′ W Long, Grid Ref. SO214981). Coll. 1968 and subm. by P. A. Barker.

978 ± 170
A.D. 972

Birm-138. Stafford

Wooden dish found at ca. 1 m depth in stream bed, originally drainage ditch, at Stafford (52° 47′ N Lat, 2° 06′ W Long, Grid Ref. SJ928214). Coll. 1966 by G. Turner; subm. by P. H. Robinson. *Comment*: dates artifact otherwise nndatable.

Midsummer Camp series, Herefordshire

Samples assoc. with successive building of 17 gates throughout long period of defense of hill fort, Midsummer Camp, Eastnor, Herefordshire (52° 02′ N Lat, 2° 21′ W Long, Grid Ref. SO761374). Coll. 1967 and subm. by S. C. Stanford.

Birm-142. **2370 ± 190**
420 B.C.

Wood from quarry ditch floor at 1 m depth, W of S gateway, assoc. with 1st gate.

Birm-143. **2000 ± 100**
50 B.C.

Carbonized grain at 1 m depth, E side S gateway, assoc. with destruction of 8th gate.

Birm-144. Croft Ambrey, Aymestry, Herefordshire **3000 ± 200**
1050 B.C.

Carbonized grain from 1 m depth in quarry-ditch behind main rampart of Croft Ambrey Hill Fort, Aymestry, Herefordshire (52° 18′ N Lat, 2° 49′ W Long, Grid Ref. SO445668). Coll. 1962 and subm. by S. C. Stanford. *Comment*: date anomalously old.

Birm-151. Sandyden Gill, Mayfield, Sussex **2170 ± 120**
220 B.C.

Charcoal from closely packed slag and burnt clay at 0.7 m depth at Saudyden Gill Bloomery, Mayfield, Sussex (51° 03′ 16″ N Lat, 0° 15′ 44″ E Long, Grid Ref. TQ586309). Coll. 1969 and subm. by C. S. Cattell.

Birm-152. Long Gill, Mayfield, Sussex **1400 ± 240**
A.D. 550

Charcoal from closely packed slag and burnt clay at 0.5 m depth at Long Gill Bloomery, Mayfield, Sussex (51° 02′ 30″ N Lat, 0° 16′ 0″ E Long, Grid Ref. TQ589294). Coll. 1969 and subm. by C. S. Cattell. *General Comment*: Birm-151 and 152 help establish time scale for ancient Wealden iron industry.

B. Non-British

Veneto series, Italy

Excavations in Rivoli region established threefold sequence for Neolithic of Veneto: (1) Quinzano, (2) Chiozza, and (3) Rivoli Rocca. Samples subm. by L. H. Barfield.

Birm-102. Quinzano **3810 ± 80**
1860 B.C.

Collagen fraction of bone (*Homo sapiens*) from Quinzano type Neolithic burial remains, Vela, Trento, Italy (46° 14′ N Lat, 11° 07′ E Long). Coll. 1960 by G. Tomasoni.

5520 ± 120
Birm-103. Chiozza **3270 B.C.**

Collagen fraction of bone (*Bos*) in pit assoc. with Chiozza phase at Monte Rocca, Rivoli, Italy (46° 00′ N Lat, 10° 50′ E Long). Coll. 1967 by L. H. Barfield.

5670 ± 130
Birm-104. Rivoli Rocca **3720 B.C.**

Collagen fraction of mixed bone (mainly *Bos* and *Sus*) from storage pit assoc. with Rivoli Rocca phase, Monte Rocca, Rivoli, Italy (45° 50′ N Lat, 10° 50′ E Long). Coll. 1967 by L. H. Barfield.

Molino Casarotto series, Italy

Charcoal and wood samples from site of early Neolithic occupation at Molino Casarotto, Arcugnano, Vicenza, Italy (45° 28′ N Lat, 11° 36′ E Long). Coll. 1969 and subm. by L. H. Barfield. Nine other samples from site subm. to Rome for radiocarbon dating.

6240 ± 100
Birm-172. Sample 10 **4290 B.C.**

Charcoal fragments in body of shell midden lying on lake marl, below peat and ca. 0.5 m thick clay, in Sqs. 38 N, O and P, Site 4.

6290 ± 150
Birm-173. Sample 11 **4340 B.C.**

Charcoal fragments contained in shell midden lying on marl and below peat in Sq. 41A, Site 4.

6350 ± 140
Birm-174. Sample 12 **4400 B.C.**

Charcoal from bottom horizon of multilevel hearth in center of wooden house, Sq. 38L, Site 4.

6450 ± 110
Birm-175. Sample 13 **4500 B.C.**

Wood from 3rd layer of cross set timbers in platform, preserved in peat below ca. 0.5 m clay, assoc. with Neolithic artifacts, from Trench 2, Site 3.

6470 ± 150
Birm-176. Sample 14 **4520 B.C.**

Wood from beam forming part of substructure of wooden house, underlying hearth of Birm-174, from Sq. 37K, Site 4.

6125 ± 150
Birm-177. Sample 15 **4175 B.C.**

Peat from deposit surrounding hearth and wooden house, belonging to final phase of settlement, from Level 3, Site 4.

2330 ± 90
Birm-107. Apliki Mine, Cyprus **380 B.C.**

Wood (*Pinus brutia*) saturated in sulphide copper ore at +291 m alt from Apliki Open Pit 4 km S of Lefka, Cyprus (34° 00′ N Lat, 32° 20′ E Long). Coll. 1967 and subm. by M. J. Bishop. *Comment*: date confirms antiquity of mines.

3090 ± 180
Birm-116. Gressvannet, Nordland, Norway **1140 B.C.**

Charcoal assoc. with quartzite arrowheads, of Younger Stone age culture from base of peat deposit, Gressvannet, Nordland, Norway (66° 03′ N Lat, 14° 30′ E Long). Coll. 1968 and subm. by D. P. S. Peacock.

6990 ± 120
Birm-117. Gressvannet, Nordland, Norway **5040 B.C.**

Charcoal assoc. with crude scrapers of older stone age culture in sandy soil underlying peat bed containing sample Birm-116, Gressvannet, Nordland, Norway (66° 03′ N Lat, 14° 30′ E Long). Coll. 1968 and subm. by D. P. S. Peacock.

707 ± 92
Birm-154. Dumpo Quarter, Brong/Ahafo, Ghana **A.D. 1243**

Charcoal ca. 0.8 m deep at top of Spit 4 in occupation mound at Dumpo Quarter, Brong/Ahafo, Ghana (7° 56′ 30″ N Lat, 2° 26′ 0″ W Long). Coll. 1967 and subm. by R. D. Mathewson.

250 ± 150
Birm-155. Dumpo Quarter, Brong/Ahafo, Ghana **A.D. 1700**

Charcoal from ca. 0.5 m depth at base of latest burial level in Spit 2 of occupation mound at Dumpo Quarter, Brong/Ahafo, Ghana (7° 56′ 30″ N Lat, 2° 26′ 0″ W Long). Coll. 1967 and subm. by R. D. Mathewson. *Comment*: this and Birm-154 continue series started by Birm-71, 79, and 80 (Shotton, Blundell, and Williams, 1969, p. 269). Results inconsistent with earlier dates, as both underlie Birm-71, 931 ± 158. Both samples alkali pretreated and figures suggest disturbed stratigraphy.

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BERLIN RADIOCARBON MEASUREMENTS IV

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This list includes selected dates of archaeologic samples from DDR, Czechoslovakia, Hungary and the Soviet Union made between 1966 and 1969. As in previous lists the major portion of dates are concerned with Neolithic and Early Bronze age period in Middle and SE Europe.

The dating method, counting technique, and equipment is the same as described in Berlin III (Radiocarbon, 1969, v. 11, p. 271-277). Ages are given relative to A.D. 1950 and the half-life of 5568 ± 30 yr has been assumed. Age errors include counting errors of samples, background, and standard, and error in the half-life of C^{14}. Errors smaller than 100 yr have been increased by rounding to that figure as a minimum. Dates are not corrected for isotopic fractionation. The descriptions are based on information supplied to the authors by the submitters and on the publications referred to under each sample or series.

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SAMPLE DESCRIPTIONS

A. German Democratic Republic

Bln-533. Dornburg **4065 ± 80**
2115 B.C.

Charcoal (*Quercus* sp.) from late Neolithic burial mound near village Dornburg (51° 0′ N Lat, 11° 39′ E Long), Jena Co., Gera Dist. Burial mound (nearly 2 m high, base diam. 16 × 18 m) used a built-in wooden structure (mortuary house) surrounded by fascine-revetted stone wall. Sample from burnt remains of wooden structure at depth 1.50 to 1.60 m below mound surface in ash layer under Grave 1 b (Peschel, 1963). Archaeol. dated to Mansfeld group of developed Central German Corded Ware culture. Coll. 1960; subm. by K. Peschel, Inst. for Praehist. Arch. of Fr. Schiller Univ., Jena. *Comment*: Bln-533 appears considerably older than earlier Heidelberg-date from burnt fascine fence of same burial mound (H-2123/1538: 3745 ± 60). As there are no doubts as to the simultaneity of the whole burial complex, the difference may be based on the different sample material (thin tree branches of fascine and compact oak planks of the mortuary house). Other C^{14} dates of the Mansfeld horizon of the Saxonic-Thuringian Corded Ware culture (Etzdorf, Halle/Heide, Forst Leina), are between 1990 and 2200 B.C.

Bln-838. Halle-Dölauer Heide **4105 ± 100**
2155 B.C.

Charcoal detritus and carbonized soil from late Neolithic site at Dölauer Heide (Bischofswiese) near Halle (51° 31′ N Lat, 11° 35′ E Long), Dist. Halle. Sample from 0.40 m deep pit, underlying 1.20 m high Barrow 3 with graves of Corded Ware. Archaeol. assignment to Bernburg group of Funnel Beaker culture. Coll. June 1969; subm. by H. Behrens, Landesmus. f. Vorgeschichte, Halle. *Comment*: Bln-838 is younger than dates of Bernburg group of Aspenstedt (H 210/217: 4560 ± 110) and Pevestorf (Hv-582: 4380 ± 100). Contamination might have occurred by roots of oak forest that were observed down to pit ground.

Bln-550. Löbnitz **3980 ± 125**
2030 B.C.

Charcoal and wood remains (*Quercus* sp.) from an earth-grave of Bell Beaker culture in Löbnitz (51° 51′ N Lat, 11° 42′ E Long), Stassfurt Co., Magdeburg Dist. Sample originates from wooden coffin in grave pit of Tomb 1, 1.58 m below surface (Kaufmann, 1969). Coll. 1966 by B. Schmidt; subm. by D. Kaufmann, Landesmus. f. Vorgeschichte, Halle/S. *Comment*: Bln-550 is older than C^{14} dates of Bell Beaker culture in N Germany and Netherlands.

Bln-817. Zwenkau-Harth **5890 ± 100**
3940 B.C.

Charcoal (*Quercus* sp.) from large Bandkeramik settlement in Harth forest near Zwenkau (51° 14′ N Lat, 12° 21′ E Long), Leipzig Dist. Sample from 0.80 m deep posthole of House II, belonging to late phase of Linear pottery (Quitta, 1958). Coll. 1953; subm. by H. Quitta, Berlin. *Comment*: sample of same house dated by Groningen lab (GrN-1581: 6160 ± 70). Bln-817 agrees very well with many dates of late Linear pottery from Central Germany.

Bln-472. Gnewitz **4250 ± 100**
2300 B.C.

Charcoal (*Quercus* sp.) from Passage Grave 2 SW village Gnewitz (54° 4′ N Lat, 12° 31′ E Long), Rostock Dist. Sample from E end of 8 m long chamber on the floor between skeleton remains. Although very few Neolithic sherds were found, amber beads indicate archaeol. assignment of burials to developed phase of Funnel Beaker culture. Secondary burials belong to Globular Amphorae culture and Single Grave culture (Schuldt and Wetzel, 1967). Coll. 1965; subm. by E. Schuldt, Mus. f. Ur- und Frühgeschichte, Schwerin. *Comment*: Bln-472 agrees with expected age.

Bln-432. Frauenmark **4010 ± 100**
2060 B.C.

Charcoal (*Quercus* sp.) from Passage Grave SE village Frauenmark (53° 47′ N Lat, 11° 47′ E Long), Parchim Co., Schwerin Dist. Sample from E part of 7.70 m long chamber within thin loamy covered chamber floor (Hollnagel, 1967). Archaeol. assignment to Funnel Beaker culture uncertain; no ceramic finds assoc. with construction of monument. Scattered sherds of Single Grave and Bell Beaker culture were found near burial mound. Coll. 1965 by A. Hollnagel, Mus. f. Ur- und Frühgeschichte, Schwerin; subm. by excavator. *Comment*: date significantly differs from Bln-472 (Gnewitz) and other dates from Passage-Grave period; it must be assumed that megalithic tomb was secondarily used in late Neolithic time.

4080 ± 100
Bln-473. Liepen **2130 B.C.**

Charcoal (*Quercus* sp.) from Passage Grave 1 N village Liepen (54° 4′ N Lat, 12° 31′ E Long), Rostock Dist. Scattered charcoal fragments from floor of 6 m long chamber between skeleton remains. Because of no ceramic finds, archaeol. date uncertain. Assoc. with secondary burials, 2 vessels of late Funnel Beaker culture found in passage, which may belong to the end of the middle Neolithic period (Schuldt, 1967). Coll. 1965 by E. Schuldt; subm. by excavator. *Comment*: Bln-473 dates a secondary burial phase and not the construction of megalithic tomb.

Rügen-series

5190 ± 120
Bln-560. Lietzow-Buddelin No. 1 **3240 B.C.**

Charcoal (*Fraxinus excelsior* L.) from cross section at lower W slope of "Buddelin," 1 km E of Lietzow (54° 29′ N Lat, 13° 32′ E Long), Isle of Rügen, Stralsund Dist. Profile section shows following stratification: lowest boulder sands (1), overlain by 20 cm peat (2), topped by a 25 to 30 cm thick cultural layer (3) with numerous artifacts. Over them 10 to 20 cm coarse sand (4) and 30 to 50 cm younger peat layer (5), which in upper profile transitional to humic sands of the meadow ground. Sample from 1.10/1.40 m below surface of cultural layer (3) (Gramsch, 1966). Archaeol. dated on basis of typical flint tools (Kern- und Scheibenbeile) to "Lietzow group" of Ertebölle-Ellerbeck culture. Layers 2 and 3, based on pollen analysis (Lange, Berlin) to be assigned to the younger Atlantic Pollen Zone VIII, after Overbeck; the upper peat (5), to Pollen Zone XI. Coll. 1965; subm. by B. Gramsch, Mus. f. Ur- und Frühgeschichte, Potsdam.

5815 ± 100
Bln-561. Lietzow-Buddelin No. 2 **3865 B.C.**

Charred wood (*Quercus* sp.) from same sec. as Bln-560, from 1.70 to 1.90 m below surface of lowest boulder sands (1). Frequent flint artifacts, worked bone, and antler tools are remains of an older settlement of the Ertebölle-Ellerbeck culture. Some artifacts with slight rolling traces indicate a partially secondary stratification, which may be related to an oscillation of Scandinavian Transgression Phase L/II of Littorina Sea.

The overlying peat (2) and the peat-containing cultural layer (3) had formed in a subsequent regression phase which includes the main settlement of the site (Gramsch, 1966). Coll. 1966; subm. by B. Gramsch.

5455 ± 100
Bln-562. Ralswiek-Augustenhof **3505 B.C.**

Charcoal (*Quercus* sp.) from cross section in Augustenhof low grounds near Ralswiek (54° 29′ N Lat, 13° 29′ E Long), Isle of Rügen, Stralsund Dist. Profile Sec. L III/66 within the shore zone indicates following stratification: lowest marine sands, overlain by 25 cm humic sands, topped by 80-cm-thick layer transitional from muddy peat to peat, which is overlain by sandy-gravelly sediments of 1.25 m high beach wall (Strandwall). Sample from 1.80 to 2.10 m deep horizon with flint artifacts and charcoal remains, including uppermost humic sand and muddy peat layer (Gramsch, 1969). Coll. 1966; subm. by B. Gramsch.

General Comment: studies made by B. Gramsch, H. Kliewe, and E. Lange on Lietzow and Ralswiek (Isle of Rügen) sites for the 1st time provides a correlation of the late Mesolithic/early Neolithic occupation with Holocene sea-level variations in S Baltic coastal region. Measurements correspond with settlement sequence and are in general agreement with other dates of Ertebölle-Ellerbeck culture known from the Baltic Sea coasts of Schleswig-Holstein, Denmark, and S Sweden.

B. Czechoslovakia

Bečov-series

At Bečov (50° 25′ N Lat, 13° 44′ E Long), Most Dist., NW Bohemia, a workplace of Quarzit tools was excavated by J. Fridrich, Archaeol. Inst. Acad. Sci. Prague. Both samples consisted of scattered charcoal fragments from 2 pits, expected to belong to late Paleolithic time (Magdalenian). Coll. 1966 and subm. by excavator.

3480 ± 80
Bln-552. Bečov No. 1 **1530 B.C.**

Charcoal (*Quercus* sp.) from Pit V, depth 2.00 m below surface.

3395 ± 80
Bln-553. Bečov No. 2 **1455 B.C.**

Charcoal (*Quercus* sp.) from Pit I, depth 2.00 m.

General Comment: both dates indicate that charcoal of settlement pits related to a later occupation of the site; datable archaeol. material was not found.

Brno-Líšen-series

Multi-layered hill site "Staré Zámky" near Brno-Líšen (49° 12′ N Lat, 16° 42′ E Long), Brno Dist., Moravia. Cultural layer of thickness up to 3 m shows at lowest part, small finds of Moravian Painted Pottery (Lengyel culture), and above it 3 Eneolithic levels (Líšen III-I), followed by late Bronze age and Slavic occupation (Medunová-Benešová, 1964).

Archaeol. dates to upper Eneolithic level Líšen I with finds of younger Channelled Ware (corresponding transition from Jevišovice C 1 to B period). Coll. 1963; subm. by A. Medunová-Benešová, Archaeol. Inst. ČSSR, Acad. Sci., Brno.

Bln-433. Brno-Líšen 1/63 **3925 ± 150**
1975 B.C.

Charcoal Sample 1/63 (*Quercus* sp.) from level Líšen I, from Area PP-III/1963, 1.50 m below surface.

Bln-434. Brno-Líšen 2/63 **3035 ± 150**
1085 B.C.

Charcoal Sample 2/63 (*Quercus* sp.) from level Líšen I, from Area RR-III/1963, 1.20 m below surface. *Comment*: Bln-434 suggests that this sample, from upper horizon of Líšen I level, should be assigned to overlying late Bronze age settlement.

Chabarovice series

Neolithic settlements, for decades endangered by brown coal open works, on ca. 100 acre loess area between Hrbovice and Chabařovice (50° 40′ N Lat, 13° 57′ E Long), Ústí Dist., NE Bohemia. Rescue excavations of archaeol. Expositur in Most since 1959 furnished evidence for several Bandceramic sites. During those campaigns many settlement pits and several house ground plans, mainly incomplete, were uncovered (Kruta *et al.*, 1966). Coll. 1964; subm. by V. Kruta, Archaeol. Inst. ČSSR, Acad. Sci. Prague.

Bln-438. Chabarovice—48/B **6400 ± 120**
4450 B.C.

Charcoal (*Quercus* sp.) from N part of settlement area, at 0.70 to 0.90 m below surface from lower parts of Pit 48/B which belongs to a more comprehensive pit system at E side of 40 m long house. Archaeol. dated to developed phase of the oldest Linear pottery.

Bln-437. Chabarovice—58/A **5070 ± 200**
4120 B.C.

Charcoal (*Quercus* sp.) from same area at 0.50 to 0.60 m below surface from Pit System 58/A at opposite W side of same house. Archaeol. dated as Bln-438. Pit system, consisting of 4 separate pits (A-D) is disturbed by a shallow pit with Stroke ornamented pottery.

General Comment: Bln-438 fits well with expected radiocarbon age for older Linear pottery (cf. Žopy Bln-57: 6430 ± 100; Eitzum H 1487/985: 6480 ± 210). Bln-437 is considerably younger, which may be caused through contamination with material of Stroke ornamented pottery (Stichbandkeramik) observed in the same pit system.

Bln-304. Horné Lefantovce **5775 ± 140**
3825 B.C.

Charcoal (*Fraxinus* sp.) from a Neolithic settlement in upper Nitra valley near Horné Lefantovce (48° 25′ N Lat, 18° 10′ E Long), Nitra Dist. W Slovakia. Foundations of 13 dome-shaped ovens, partly overlapping and closely grouped were discovered during rescue diggings on site "Na babe". Sample coll. from well-preserved Oven 6 at 0.70 m below surface (Banesz, 1959). Archaeol. assignment of oven system to late phase of Želiezovce group plus isolated sherds of Bükk and stroke-ornamented pottery. Coll. 1958 by L. Bánesz; subm. by J. Pavúk, Archaeol. Inst. Slovakian Acad. Sci., Nitra. *Comment*: Bln-304 appears considerably younger than middle stage of the Želiezovce group in Štúrovo (cf. Bln-558: 6170 ± 100; Bln-559: 6260 ± 100). The actual time range between both stages supposedly is smaller.

Bln-495. Hostim **2005 ± 80**
55 B.C.

Charcoal (*Quercus* sp.) from late Paleolithic site in valley of Berounka R. near Hostim (49° 57′ N Lat, 14° 7′ E Long), Beroun Dist., Bohemia. Sample in depth 0.35 to 0.50 m below surface from basal part of loess layer with burnt clay fragments and flint artifacts belonging to Magdalenian. Coll. 1965 and subm. by Sl. Vencl, Archaeol. Inst. Prague. *Comment* (S.V.): Bln-495 points to a secondary contamination by roots or to possibility, that scattered charcoal, owing to its position near surface, reduced to remains of a later forest-fire.

Bln-302. Krepice **3020 ± 150**
1070 B.C.

Grain (*Hordeum vulgare* L. *polystichum*) from settlement, fortified by palisade ditches, of the Lengyel culture in Křepice (48° 58′ N Lat, 16° 6′ E Long), Znojmo Dist., S Moravia. Sample from nearly destroyed oven in upper part of a 3.50 m deep pit (Object 8) at ca. 0.60 m below surface (Tichý, 1966). Archaeol. dated to older stage of Moravian-Painted-Pottery (Lengyel culture). Coll. 1964; subm. by R. Tichý, Archaeol. Inst. ČSSR Acad. Sci., Brno. *Comment*: Bln-302 appears too recent in view of other chronologic evidence. It is more likely that grain finds, weighing several kgs, from upper horizon of Object 8 are related to late Bronze age occupation, seen in same excavation area.

Bln-556. Podolie **4455 ± 80**
2505 B.C.

Charcoal (*Quercus* sp.) from late Eneolithic settlement in upper Waag valley near Podolie (48° 40′ N Lat, 17° 47′ E Long), Trenčín Dist., W Slovakia. Sample from cross section No. 3 from bottom of palisade ditch at 1.10 m below surface. Archaeol. dated to Bošaca group of the late Channelled Ware. Coll. 1963; subm. by V. Pavúková, Archaeol. Inst. Slovakian Acad. Sci., Nitra. *Comment*: Bln-556 is 300 to 500 yr older than dates of late Channelled Ware in Moravia (Brno-Líšen I, Bln-433: 3925 ± 150), or the corresponding Baden-Kostolac horizon in Yugoslavia (Hissar Bln-351: 4170 ± 120; Pivnica KN-145: 4110 ± 160).

4925 ± 80
2975 B.C.

Bln-482. Postoloprty

Charcoal (*Quercus* sp.) from isolated site in exploitation field of sand quarry Rvenice near Postoloprty (51° 22′ N Lat, 13° 41′ E Long), Louny Dist. NW Bohemia. Sample from ca. 1.40 m deep cylinder-shaped pit which at 0.80 m below surface closed by a burned-loam cover. Pit-filling contained, apart from burned animal bones, ashes, and charcoal remains, a great number of pottery fragments. Since further finds were not observed, the possibility of a cremation burial should not be excluded (Neustupný, 1961). Archaeol. dated to late phase of Baalberg group of Funnel Beaker culture, suggested contemporary with Jevišovice C 2-Sířem type. Coll. 1959 by A. Beneš; subm. by E. Neustupný, Archaeol. Inst. ČSSR Acad. Sci. Prague. *Comment*: Bln-482 in general agreement with other chronologic evidence, that is with dates of latest Lengyel horizon and early Funnel Beaker culture in N Europe.

3845 ± 80
1895 B.C.

Bln-475. Prasklice

Carbonized grain (*Triticum dicoccum* Schrenk, *Triticum monococcum* L., *Triticum aestive-compactum* Schiem.) from early Bronze age site on the "Křeby" hill near Prasklice (49° 16′ N Lat, 17° 11′ E Long), Kroměříž Dist., Moravia. Sample from 1.80 m deep obtuse coned storage pit whose wall and bottom were coated with burned loam. Pit also contains, apart from pottery and a 3 to 4 cm thick layer of charred grain, 3 burials (2 adults, 1 child) on the pit bottom (Ludikovský, 1960). Archaeol. dated to elder phase of Únětic (Aunjetitz) culture. Coll. 1959; subm. by K. Ludikovský, Archaeol. Inst. ČSSR Acad. Sci., Brno. *Comment*: Bln-475 agrees with the relative chronologic position. The late Aunjetitz culture (Leubingen group) in E Germany from Helmsdorf (Bln-248: 3613 ± 160) and in Great Poland from Leki Male (GrN-5037: 3605 ± 40) has accordingly been dated to a younger age.

Stúrovo series

Systematic excavations made by the Archaeol. Inst. Slovakian Acad. Sci., Nitra, have since 1965 discovered a large Neolithic settlement on left bank of Danube R. near Štúrovo (47° 48′ N Lat, 18° 44′ E Long), Nové Zámky Dist., SW Slovakia. Site is on a loess terrace 12 m above Danube level. In subsequent yr ca. 20,000 m² area with more than 30 houses and numerous other settlement objects from various phases of younger Linear pottery and Želiezovce group had been investigated (Pavúk, 1967). All samples are taken from clay-burned storage pits which, on the basis of the pottery and the uniform obtuse coned pit profile, are assigned to middle phase of the Želiezovce (Zseliz) type. Coll. 1966; subm. by J. Pavúk.

Bln-559. Stúrovo—313/66 **6260 ± 100**
4310 B.C.

Charcoal (*Quercus* sp.) from grain finds containing storage pit (Object 313/66) dug 60 to 70 cm deep into loess; ca. 1.00 to 1.10 m below surface.

Bln-558. Stúrovo—229/66 **6170 ± 100**
4220 B.C.

Charcoal (*Quercus* sp.) from storage pit (Object 229/66) similar by shape, depth, and content.

Bln-557. Stúrovo—215/66 **5565 ± 120**
3615 B.C.

Charcoal (*Quercus* sp.) from storage pit (Object 215/66) similar in shape, depth, and content.

General Comment: Bln-557 appears too recent in view of archaeologic chronology and compared to date of late Želiezovce phase from Horné Lefantovce (Bln-304: 5775 ± 140).

C. Hungary

Bln-607. Aszód-Papi földek **5620 ± 100**
3670 B.C.

Charcoal (*Quercus* sp.) from Neolithic site at Aszód-Papi földek (47° 39′ N Lat, 19° 29′ E Long), Aszód Co., Kom. Pest. Sample from settlement Pit XI, depth 1.40 to 1.60 m. Archaeol. date: developed phase of older Lengyel culture. Coll. 1966 by N. Kalicz, Archaeol. Inst., Hungarian Acad. Sci. Budapest; subm. by excavator. *Comment*: although Bln-607 is somewhat younger than dates of same culture in Austria it seems acceptable in view of archaeol. chronology.

Bln-340. Baracs **3735 ± 80**
1785 B.C.

Grain (*Hordeum vulgare* I. *polystichum, Triticum monococcum* L.) and seeds (*Lens* cf. *culinaris* Med.) from multi-layered Bronze age settlement at Baracs (46° 55′ N Lat, 18° 52′ E Long), Dist. Dunaujváros, Kom. Fejér. Sample from lowest stratum on floor of house destroyed by fire, 3.0 m below surface. Archaeol. date: Nagyrév culture of Hungarian early Bronze age. Coll. 1962 by Archaeol. Dept., Univ. Budapest, in cooperation with Dunaujváros Mus.; subm. by I. Bóna, Archaeol. Dept., Univ. of Budapest. *Comment*: Bln-340 in general agreement with expected archaeol. age of Nagyrév culture.

Bln-516. Cserépváralja **415 ± 80**
A.D. 1535

Charcoal (*Quercus* sp.) from rock shelter in valley of Csordás R. near Cserépváralja (47° 56′ N Lat, 20° 32′ E Long) Mezökövesd Dist., Kom. Borsod. Sample derived from burnt wooden structure in a squarechambered niche, cut in Ryolith rock. Assumed medieval beehive. Coll. 1960, subm. by J. Korek, Hungarian Natl. Mus. Budapest. *Comment:* date agrees with expected age.

Deszk series

Rescue excavations by Móra Ferenc Mus., Szeged, uncovered several Neolithic pits on site of oil boring Plant 1 E of Deszk (46° 13′ N Lat, 20° 15′ E Long), Szeged Dist., Kom. Csongrád. Fragments of biconic vessels of Vinča type, solid pedestalled bowls and frequent Barbotine decoration is typical for a development phase of the Körös culture (Trogmayer, 1968). Coll. 1966; subm. by O. Trogmayer, Móra Ferenc Mus., Szeged.

Bln-582. Deszk-Olajkut No. 1 **6260 ± 100**

6390 ± 100

Bln-582a. **Average: 4375 B.C.**

Charcoal Sample 1 (*Quercus* sp.) from Pit 15, depth 1.00 to 1.30 m below surface.

6410 ± 120

Bln-583. Deszk-Olajkut No. 2 **4460 B.C.**

Charcoal Sample 2 (*Quercus* sp.) from Pit 15, depth 2.00 to 2.10 m.

6540 ± 100

Bln-584. Deszk-Olajkut No. 3 **4590 B.C.**

Charcoal Sample 3 (*Quercus* sp.) from Pit 8, depth 1.00 to 1.10 m.

6605 ± 100

Bln-581. Deszk-Olajkut No. 4 **4655 B.C.**

Charcoal Sample 4 (*Quercus* sp.) from Pit 8, depth 1.00 to 1.60 m.

General Comment: Bln-581 to 584 agree with dates for ceramic samples of Hungarian Körös culture at Katalszeg (Bln-86: 6370 ± 100) and Hódmezövásárhely-Kotacpart (Bln-115: 6450 ± 100). Late date of Deszk finds indicated by Vinča elements and more frequent use of Barbotine technique is confirmed. The 200 yr difference between Pits 8 and 15 corresponds to differences in archaeol. material and suggests a longer or repeated occupation of the site.

3505 ± 80

Bln-341. Dunaujváros-Kozider **1555 B.C.**

Grain (*Hordeum vulgare* L. *Polystichum, Hordeum vulgare* L. *polysticum* cf. *var. nudum*) from multi-layered Bronze age settlement at Dunaujváros-Kozider (46° 58′ N Lat, 18° 56′ E Long), Dunaujváros Dist., Kom. Fejér. According to information from I. Bóna, archaeol. date to lowest Nagyrév layer is uncertain. It is possible that grain was found in the overlying middle Bronze age layer and only in Dunaujváros museum together with Nagyrév vessel used for exhibition. Coll. 1951 (unknown rescue excavation by Budapest Natl. Mus.); subm. by I. Bóna. *Comment:*

Bln-341 is much younger than date for Nagyrév culture of Baracs (Bln-340: 3735 ± 80). Sample was probably from level of middle Bronze age (Vatya culture).

Keszthely-Fenékpuszta

Fenékpuszta site with destroyed remains from various periods of the Hungarian Copper age at W point of Lake Balaton, 6 km S of Keszthely (46° 45′ N Lat, 17° 15′ E Long), Keszthely Dist., Kom. Veszprém. Coll. Sept. 1964; subm. by N. Kalisz.

Bln-500. Keszthely-Fenékpuszta No. 1 **4780 ± 80**
2830 B.C.

Charcoal (*Quercus* sp.) from pit (Object 2), ca. 1.50 m deep, S of hydrological station. Archaeol. date: Balaton group of Hungarian Copper age.

Bln-501. Keszthely-Fenékpuszta No. 2 **4890 ± 80**
2940 B.C.

Charcoal (*Quercus* sp.) from large subdivided pit system near reed factory S of Fenékpuszta. Sample from Sector 2 ca. 1 m below surface. Lower part of pit was influenced by ground water. Archaeol. date as under Bln-500, besides fragments similar to Gajáry type. *Comment*: Bln-500 and probably 501 date Transdanubian features of Hungarian Copper age, established by N. Kalisz as so-called Balaton group, genetically related to contemporary Bodrogkeresztur culture.

Bln-609. Kétegyháza **4265 ± 80**
2315 B.C.

Charcoal (*Quercus* sp.) from burial place at Törökhálom near Kétegyháza (46° 33′ N Lat, 21° 11′ E Long), Gyula Dist., Kom. Bekes. Sample from timber beam construction of Grave 4 found in center of 7 m high mound; on the floor of grave pit was a W-E oriented contracted skeleton with ochre traces and perforated animal teeth. The burial mound, at the base nearly 70 m diam., was erected above a settlement of the Bodrogkeresztur culture. Archaeol. assignment to so-called Ocher-grave culture, a variant of the South Russian Pit-grave culture. Coll. 1967; subm. by B. Gazdapusztai, Inst. of Archaeol. and Ancient History, Univ. Szeged. *Comment*: Bln-609 appears somewhat older than Ocher-grave dates from Baja-Hamangia in Rumanian Moldavia (Bln-29: 4090 ± 160; KN-38: 4060 ± 160) and corresponds roughly to earliest Pit-grave horizon at Michailovka I (Bln-630: 4330 ± 100) and dates from same culture in N Caucasian region (Tsatsa UCLA-1270: 4210 ± 80, Ust-man UCLA-1271: 4150 ± 80).

Kisköre

During excavations 1964 to 1966, the Budapest Natl. Mus. discovered at 1200 m² area of Neolithic settlement and 36 burials of the Tisza culture near Kisköre-Gat (47° 30′ N Lat, 20° 30′ E Long), Heves Dist., Kom. Heves. Coll. 1965; subm. by J. Korek, Hungarian Natl. Mus., Budapest.

5890 ± 120
3940 B.C.

Bln-515. Kisköre-Gat No. 1

Charcoal (*Quercus* sp.) from fireplace in pit (XVII,6) 1.60 m deep. Archaeol. date: younger phase of Tisza culture corresponding to finds of Lebö-Alsóhalom and Gorsza.

5995 ± 80
4045 B.C.

Bln-179. Kisköre-Gat No. 2

Sherds of thick-walled, organic-tempered ceramics, from same pit at 0.80 to 1.60 m below surface. Archaeol. date as under Bln-515. *Comment*: both dates, though based upon different material, are in fairly good agreement. Comparison with Lengyel dates from Trans-Danubia and Austria verifies assumed parallel development of early Lengyel culture with younger Tisza-groups in E Hungary.

5460 ± 120
3510 B.C.

Bln-585. Letenye-Szentkeresztdomb

Charcoal (*Quercus* sp.) from site at Szentkeresztdomb hill near Letenye (46° 26′ N Lat, 16° 43′ E Long), Letenye Dist., Kom. Zala. Sample from rescue excavation at 0.60 to 0.90 m below surface in Pit 19. Archaeol. date: late phase of Lengyel culture (with white painting). Coll. Aug. 1965; subm. by N. Kalisz. *Comment*: compared with dates of early Lengyel culture from Austria (Langenzersdorf, Oberpullendorf) Bln-585 corresponds to expected younger radiocarbon age and is in good agreement with equally late Lengyel finds from Zalavar-Mekenye (Bln-502: 5400 ± 80).

5435 ± 100
3485 B.C.

Bln-508. Neszmély-Tekerspatak

Charcoal (*Quercus* sp.) from Neolithic site on S banks of Danube R. near Neszmély-Tekerespatak (47° 43′ N Lat, 18° 23′ E Long), Tata Dist. Kom. Komárom. Sample was 0.80 m below surface from cylinder-shaped storage pit (grain silo) dug into loess soil. Archaeol. date: early phase of Zseliz type of Linear pottery (Bandkeramik). Coll. 1959 by J. Makkay; subm. by Archaeol. Inst., Hungarian Acad. Sci., Budapest. *Comment*: Bln-508 appears too recent in view of relative chronology and does not agree with other dates of the Zseliz (Želiezovce) group in SW Slowakia from Štúrovo (cf. Bln-557 to 559) and Horné Lefantovce (cf. Bln-304). Contamination might have occurred by roots observed at the site down to 0.80 m below surface.

6180 ± 100
4230 B.C.

Bln-549. Ostoros

Sherds of organic-tempered ceramic from Neolithic site near Ostoros village (47° 52′ N Lat, 20° 26′ E Long), Eger Dist., Kom. Heves. Assumed archaeol. assignment, on basis of atypical surface finds and some Macrolithic flint artifacts to an early stage of N Hungarian Neolithic. Coll. 1966; subm. by L. Vertes, Hungarian Natl. Mus., Budapest. *Comment*: Bln-549 establishes location in time of site which could not be dated otherwise. Connection of finds with younger Alföld linear pottery or Bükk culture of similar age appears more likely.

Oszentiván VIII-series

Ószentiván site is situated on small hill in the Tisza-Maros corner SW of present village Tiszasziget (46° 12′ N Lat, 20° 11′ E Long), Szeged Dist., Kom. Csongrád. Samples were taken during rescue excavations of Budapest Natl. Mus. at Site VIII from pits of Baden culture (Pit I a) and Neolithic Banát group (Pit VIII/e). Coll. 1960; subm. by I. Bognár-Kutzián, Archaeol. Inst., Hungarian Acad. Sci., Budapest.

Bln-476. Oszentiván VIII No. 1 **4515 ± 80**
2565 B.C.

Charcoal (*Ulmus* sp.) from Pit I/a, 1.40 to 1.70 m below surface. Archaeol. dated to Baden-Pécel culture with Kostolac elements.

Bln-479. Oszentiván VIII No. 2 **6460 ± 80**
4510 B.C.

Charcoal (*Quercus* sp.) from Pit VIII/e 2, 0.65 to 0.90 m below surface. Archaeol. dated to so-called Banát group, a variant of the early Vinča culture in SE Hungary (Banner and Párducz, 1948).

Bln-480. Oszentiván VIII No. 3 **6050 ± 100**
4100 B.C.

Charcoal (*Quercus* sp.) from Pit VIII/e 3, 0.75 to 1.00 m below surface. Archaeol. dated as Bln-479.

Bln-477. Oszentiván VIII No. 4 **6270 ± 80**
4320 B.C.

Charcoal (*Ulmus* sp.) from Pit VIII/e 4, 1.00 to 1.20 m below surface. Archaeol. dated as Bln-479.

Bln-478. Oszentiván VIII No. 5 **6070 ± 100**
4120 B.C.

Charcoal (*Quercus* sp.) from Pit VIII/e 5, 1.20 to 1.50 m below surface. Archaeol. dated as Bln-479.

General Comment: Bln-476 appears considerably older than dates of Baden-Kostolac similar finds from Hissar IIa (Bln-351: 4170 ± 120) and Kostolac settlement at Pivnica in N Bosnia (KN-145: 4110 ± 160). Although Samples Bln-477 to 480 of Neolithic Banát group originate from same pit, C^{14} values differ remarkably. Result of Bln-478 and 480 appear too recent in view of relative chronologic system.

Tarnazsadány-Sándorrésze

Site repeatedly occupied from Neolithic to early Bronze age is in riverside area near Tarnazsadány-Sándorrésze (47° 39′ N Lat, 20° 9′ E Long), Heves Dist., Kom. Heves. During rescue diggings necessitated by river improvement work, 3 settlement objects were investigated. Archaeol. assignment of finds to Szakálhát group of younger Linear pottery in SE Hungary. Coll. 1963; subm. by N. Kalicz.

6120 ± 100
Bln-506. Tarnazsadány-Sándorrésze No. 1 **4170 B.C.**

Charcoal (*Quercus* sp. from lower part of Pit 1, 1.60 m below surface.

6155 ± 80
Bln-676. Tarnazsadány-Sándorrésze No. 2 **4205 B.C.**

Sherds of organic-tempered pottery from same Pit 1. *Comment*: Bln-506 and 676 are, despite different sample material, nearly identical. They confirm younger dates of Szákalhát group and its parallel development with Zseliz-Želiezovce type (cf. Stúrovo Bln-558-559) in W Karpathian basin.

Tiszapolgár-Csöszhalom series

Excavation by Budapest Natl. Mus. in well-known Eneolithic settlement at Csöszhalom near Tiszapolgár (47° 52′ N Lat, 21° 7′ E Long), Polgár Dist., Kom. Hajdu-Bihar. Site is a Tell settlement with 3.50 m thick cultural layer which can be divided in 6 successive levels (A-F). Archaeol. assignment of all samples to Csöszhalom group (named after discovery site), a local group of Eneolithic painted pottery province in E Hungarian lowlands. Coll. 1957; subm. by I. Bognár-Kutzián.

5575 ± 100
Bln-509. Tiszapolgár-Csöszhalom No. 1 **3625 B.C.**

Charcoal Sample 1 (*Quercus* sp.) from House I/A in uppermost level, 0.30 to 0.40 m below surface.

5871 ± 100
Bln-510. Tiszapolgár-Csöszhalom No. 2 **3925 B.C.**

Charcoal Sample 2 (*Quercus* sp.) from cultural layer in Sec. I/10, 1.85 m below surface.

5775 ± 100
Bln-512. Tiszapolgár-Csöszhalom No. 3 **3825 B.C.**

Charcoal Sample 3 (*Quercus* sp.) from floor of fire-destroyed house (I/F 16 a) in lowest level, 3.05 below surface.

5940 ± 100
Bln-513. Tiszapolgár-Csöszhalom No. 4 **3990 B.C.**

Charcoal Sample 4 (*Quercus* sp.) from lowest level of House I/F, 3.10 to 3.30 m below surface.

General Comment: with exception of Bln-510, date sequence of Csöszhalom series agrees with stratigraphic order. Bln-512 and 513 for lowest Level F further indicate agreement with earlier Groningen data of same complex (GrN-1943: 5845 ± 60).

Bln-505. Tiszavasvári-Keresztfal **6305 ± 100**
4355 B.C.

Charcoal (*Ulmus carpinifolia* Gled.) from Neolithic settlement in Tiszavasvári-Keresztfal (47° 58′ N Lat, 21° 23′ E Long), Tiszalök Dist., Kom. Szabolcs-Szatmár in NE Hungary. Sample from 8 × 3 m large pit (Object III) at 1.60 to 1.80 m below surface. Archaeol. date: developed phase of E Hungarian Alföld linear pottery. Coll. 1963; subm. by N. Kalicz. *Comment*: Bln-505 corresponds to earlier date of Alföld-Bandkeramik of Tarnabod (Bln-123: 6280 ± 100) and is somewhat older than same finds with some painted pottery from Szamossály (Bln-404: 6136 ± 100).

Bln-502. Zalavár-Mekenye **5400 ± 80**
3450 B.C.

Charcoal (*Abies* cf. *alba* Mill.) from Mekenye site, occupied in late Neolithic and Copper age, 1.5 km S of Zalavár (46° 40′ N Lat, 17° 10′ E Long), Keszthely Dist., Kom. Veszprém. Sample from lower part of Pit 13, ca. 1 m below surface. Archaeol. dated to late phase of Lengyel culture, marked by white painting and high proportion of undecorated pottery. Coll. Sept. 1964; subm. by N. Kalicz. *Comment*: Bln-502 agrees with late Lengyel date from Letenye-Szentkkeresztdomb (Bln-585: 5460 ± 120). There is further agreement of dates from periphery groups of late Lengyel horizon in W Central Europe, such as Aichbühl (Lautereck GrN-4666: 5430 ± 40) and Gatersleben (Kmehlen Bln-231: 5360 ± 160).

D. Soviet Union

Bln-631. Čapaevka **4870 ± 100**
2920 B.C.

Charcoal (*Fraxinus* sp.) from late Tripolye site at Čapaevka (50° 26′ N Lat, 30° 30′ E Long), Kiev-Svjatošinskij Rayon, Kiev Dist. Samples from different pits (1/66, 6/66, 12/66, 16/66); average depth in loess is 0.40 to 1.00 m below surface. Archaeol. date: late Tripolye culture, C_I period (T. S. Passek system), or Cucuteni B (Rumanian research), respectively. Coll. 1966; subm. by V. Kruc, Archaeol. Inst., Acad. Sci., Ukrainian SSR, Kiev. *Comment*: Bln-631 acceptable in view of relative Tripolye chronology; general agreement with date of the late Cucuteni B settlement Valea-Lupului in Rumanian Moldavia (GrN-1982: 4950 ± 60).

Bln-629. Majaki **4400 ± 100**
2450 B.C.

Charcoal (*Ulmus* sp.) from Late Neolithic/Early Bronze age settlement at R. Dniestr mouth near village Majaki (46° 10′ N Lat, 30° 8′ E

Long), Beljaevka Rayon, Odessa Dist. Sample from depth 2.8 m from trench made to defend settlement. Archaeol. date: Usatovo group, a local variant of latest Tripolye culture influenced by E steppe cultures (Zbenovič, 1968). Coll. 1964; subm. by V. G. Zbenovič, Archaeol. Inst., Acad. Sci., Ukrainian SSR, Kiev. *Comment*: although Bln-629 agrees with an earlier date for the same site (LE-645: 4340 ± 65), a difference of 500 yr remains between late Tripolye C_I/Cucuteni B settlements of Čapaevka (Bln-631: 4870 ± 100) and Valea Lupului (GrN-1982: 4950 ± 60), with no apparent explanation.

4330 ± 100
Bln-630. Michailovka I **2380 B.C.**

Charred reed (*Phragmites communis* Trin) from a multi-layered settlement at Michaĭlovka (47° 30′ N Lat, 33° 55′ E Long), Rayon Novo Voronzovka, Cherson Dist. Site I is on a terraced plateau of R. Podpol'na (a right tributary to Dniepr) was occupied during transition from Late Neolithic to Early Bronze age (Lagodovskaja *et al.,* 1962). Sample from the burnt roof cover of a 17 × 5 m hut (Zemljanka I) of the lowest cultural layer; depth 1.50 to 2.00 m. Archaeol. date in an early (Pre-Jamna) phase of the Pit-grave culture. Coll. 1952 by E. F. Lagodovskaya *et al.*; subm. by O. G. Šapošnikova, Archaeol. Inst., Acad. Sci. Ukrainian SSR, Kiev. *Comment*: Bln-630 is in general agreement with other dates of the Pit-grave culture; corresponds approx. to Usatovo type of Majaki (Bln-629: 4400 ± 100; LE-645: 4340 ± 65).

Rostov-series

Samples from burial place of Early Bronze age in neighborhood of Rostov/Don (47° 17′ N Lat, 39° 45′ E Long). Coll. 1967 by J. B. Brašinski and A. I. Demčenko, S Don Expedition of Archaeol. Inst., Acad. Sci. USSR, Leningrad. Subm. by P. M. Doluchanov.

3925 ± 160
Bln-693. Rostov Kurgan V/6 **1975 B.C.**

Rotten wood (*Crataegus* sp.) from floor of entrance into secondary Grave 6 of Barrow V. Archaeol. dated to N Caucasian Catacomb Grave culture.

4215 ± 100
Bln-694. Rostov Kurgan VI/12 **2265 B.C.**

Charcoal (*Ulmus* sp.) and carbonized remains from vessel in Grave 12 of Barrow VI. Archaeol. dated to Don variant of Catacomb Grave culture.

4005 ± 100
Bln-696. Rostov Kurgan I/5 **2055 B.C.**

Rotten wood (cf. *Aesculus hippocastanus*) from floor of entrance into Grave 5 of Barrow I. Archaeol. dated as Bln-694.

Bln-697. Rostov Kurgan VI/11 **4065 ± 120**
2115 B.C.

Rotten wood (*Ulmus* sp.) from floor of entrance into Graves 11/12 of Barrow VI. Archaeol. dated as Bln-694.

General Comment: Bln-694 is somewhat older than expected. Other dates in good agreement with LE-624: 3880 ± 90 from Rostov Kurgan VII/3 and a Catacomb Grave date from Kuban area in Kudinov (UCLA-1273: 3860 ± 80).

Bln-590. Novye-Rusešty I **5565 ± 100**
3615 B.C.

Charcoal (*Fraxinus* sp.) fror 3-layered Neolithic settlement near Novye-Rusešty (46° 53′ N Lat, 28° 45′ E Long), Rayon Kotovsk, Moldavian SSR. Site I, on lower terrace of R. Botna, was already occupied during time of Linear pottery, following in stratigraphic order, a late phase of Tripolye A period and above it a layer with finds of the Tripolye B_I (after T. S. Passek system). Sample from 1.20 to 1.50 m below surface of Zemljanka 2. Archaeol. date: end of Tripolye A (Pre-Cucuteni) with elements as a transition to Tripolye B_I (Cucuteni A). Coll. 1964; subm. by V. I. Markevič, Archaeol. Dept., Inst. of Hist., Acad. Sci. Moldavian SSR, Kišinev. *Comment*: Bln-590 is in general agreement with other chronologic evidence; fits well with dates of early phase of Gumelniţa culture (cf. Bln series from Cascioarele) and the younger Cucuteni A_3 settlement in Habasesti (GrN-1985: 5330 ± 80).

Soroki series

Samples from 2 neighboring early Neolithic sites on the right Dniestr bank, a few km downstream of Soroki (48° 11′ N Lat, 28° 19′ E Long), Rayon Soroki, N of Moldavian SSR. During the open field work carried out by the Moldavian Archaeol. expedition, V. I. Markevič discovered a number of multi-layered settlements in Middle-Dniestr-region, which necessitated study of the origin of the Neolithic in NW Black Sea region. This mainly applies to the stratigraphic evidence of aceramic (post-Mesolithic) layers, in which the beginning neolithization is recognized in the osteologic material (pig domestication). Neolithic development starting from the proto-Neolithic phase in the 2nd half of the 6th millennium, can be followed up via 4 successive phase of the Bug-Dniestr-culture (earlier called Southern Bug culture) up to the beginning Tripolye period at the end of the 5th millennium (Markevič, 1965 and 1969). All samples coll. 1964 to 1966, and subm. by V. I. Markevič, Acad. Sci. Moldavian SSR, Kišinev.

Bln-588. Soroki-Trifauckij les 2/III **7515 ± 120**
5565 B.C.

Charcoal (*Fraxinus* sp.) from a multi-layered site at lower terrace of R. Dniestr 2.5 km downstream from Soroki. The 3 Neolithic layers between 3.3 and 4.7 m depth, are separated by ca. 25 cm thick intermediate layers of sandy loam, overlain by 3 m thick fluviatile sediments. Sample was taken 1964 from pit within lowest Layer III; depth 4.6 to 4.7 m below surface. Archaeol. date: post-Mesolithic or aceramic phase of early Neolithic, respectively.

7420 ± 80
Bln-587. Soroki-Trifauckij les 2/II 5470 B.C.

Charcoal (*Ulmus* sp.) from same settlement and with same data as Bln-588. Coll. 1965 from pit within middle Layer II; depth 3.8 to 4.1 m. Archaeol. date: same as Bln-588.

6825 ± 150
Bln-586. Soroki-Trifauckij les 2/I 4875 B.C.

Charcoal (*Fraxinus* sp.) from same settlement and with same data as Bln-588. Coll. 1964 from pit within upper Layer I; depth 3.3 to 3.5 m. Archaeol. date based on ceramic finds: Sokolecka phase of Bug-Dniestr culture.

6495 ± 100
Bln-589. Soroki-Trifauckij les 5 4545 B.C.

Charcoal (*Fraxinus* sp.) from mono-layered settlement; geog. position same as Soroki 2 site, 500 m apart. Coll. 1966 from fireplace at 2 m depth. Above cultural layer is 1.5 m thick sterile loam, turning upwards into humic forest soil. Archaeol. date: Savran phase of the late Bug-Dniestr culture.

General Comment: Samples Bln-586 to 588 from Soroki-Trifauckij les 2 site agree with stratigraphic position. The aceramic proto-Neolithic layers are of older radiocarbon age than the early Neolithic of the Starčevo/Körös/Karanovo I type. This, in connection with the other archaeol. finds in the N Black Sea and Azov region, suggests a level of incipient domestication and cultivation largely independent of SE Europe, which might possibly have been influenced from the Aralo-Caspian area. Dates for 2nd (Sokolecka) and 5th (Savran) phase of the Bug-Dniestr culture (Bln-588 and 589) likewise correspond to the relative chronology. Relation to the neighboring Körös (Cris) culture in Rumainian Moldavia—indicated in the ceramics of the Sokolecka phase—are confirmed by comparison with early Neolithic Bln-dates from Hungary and Yugoslavia.

620 ± 100
Bln-712. Murat-Uzun Kul' A.D. 1330

Charcoal from the Mesolithic-Neolithic site Murat on the banks of Lake Uzun Kul', S Ural (53° 52′ N Lat, 58° 44′ E Long) Rayon Belorezk, Bashkir ASSR. Site, sounded first in 1963, is a multi-layered settlement whose oldest phase with microlithic tools might be dated back to the Mesolithic. Overlying a number of horizons with chiefly Comb and Pit-marked Pottery indicate cultural development in S Ural region in Neolithic and Eneolithic times (Matjušin, 1965). Sample was in Sonde 3/66 (Area V3-G3) taken from the upper level at 0.29 to 0.39 m immediately below upper surface humus. Archaeol. date: S Ural-Eneolithic period. Coll. 1966 and subm. by G. N. Matjušin, Archaeol. Inst., Acad. Sci. USSR, Moscow. *Comment*: Bln-712 does not agree with expected archaeol. age in 3rd millennium. If sample cannot be related to a later medieval settlement of the site, a secondary contamination must be assumed owing to its position near the surface.

1375 ± 100
Bln-713. Davlekanovo **A.D. 575**

Charcoal from multi-layered Neolithic site at Davlekanovo (54° 10′ N Lat, 55° 6′ E Long), ca. 80 km SW Ufa, Bashkir ASSR. Sample consisted of charcoal fragments from a layer near surface. Expected archaeol. date: Belaja-Kama group of Comb and Pit-marked Pottery complex. Coll. 1967 and subm. by G. N. Matjušin. *Comment*: see Bln-712.

4640 ± 100
Bln-769. Sarnate **2690 B.C.**

Peat from Neolithic bog settlement near Sarnate (57° 8′ N Lat, 21° 26′ E Long) Ventspils Ray., Latvian SSR. Sample from Holocene peat layer containing cultural remains in depth 0.60 to 0.70 m below surface. Archaeol. date to Comb and Pit-marked Pottery complex. Coll. 1968 by P. M. Doluchanov and L. V. Vankina, Historical Mus. Riga. Subm. by P. M. Doluchanov, Archaeol. Inst. Leningrad. *Comment*: Bln-769 agrees with dates of the same cultural layer (TA-24: 4490 ± 250, TA-26: 4700 ± 250, LE-814: 4510 ± 110).

Altyn-Depe series

The settlement mound Altyn-Depe (36° 53′ N Lat, 60° 26′ E Long), systematically investigated since 1965, is at N margin of the Kopet-Dag Mts. near Meana in S of Turkmenian SSR. Previous excavations on the ca. 110 acre and 20 m high tell settlement covered upper layers of middle (Namazga V) and early Bronze period (Namazga IV) at center of mound as deep as 12 to 14 m. Buildings of an old monumental architecture influenced by Mesopotamia were discovered for the first time in 1967, indicating that the Altyn-Depe was a large urbanized center (Masson, 1967 and 1968). Archaeol. date: Namazga V period (Anau III culture). Coll. 1967 and subm. by V. I. Sarianidi, Archaeol. Inst., Acad. Sci. USSR, Moscow.

4120 ± 100
Bln-716. Altyn-Depe No. 1 **2170 B.C.**

Charcoal sample from Sonde 7/67, from front of the 6.5 m high tower platform built by air-dried bricks, ca. 1.5 m below surface.

4025 ± 100
Bln-717. Altyn-Depe No. 2 **2075 B.C.**

Charcoal from Sonde 7/67, from fireplace in Building 3, ca. 0.60 m below surface.

General Comment: Bln-716 and 717 are about same radiocarbon age, as are dates of the late Namazga IV type from Altyn-Depe Level 4 (LE-664: 4070 ± 50) and Ulug-Depe (cf. Bln-714 and 715).

4710 ± 100
Bln-720. Geoksjur 1 **2760 B.C.**

Charcoal (Saliceen wood) from an Eneolithic settlement in Geoksjur oasis (37° 24′ N Lat, 60° 46′ E Long) at SE margin of the Karakum, 20 km to the E of Tedžen in S Turkmenian SSR. Geoksjur 1 site, for the first time investigated by the S Turkmenian Archaeol. Expedition in 1956, belongs to a group of 9 settlement mounds. In 10 m high Mound 1 a continuous occupation was found from the late Namazga I to the early Namazga III period. The sample was in the central part of the Tell on the floor of a building made of air-dried bricks (No. 54) ca. 1 m below surface (Chlopin, 1964; Sarianidi, 1965). Archaeol. date: Namazga III period. Coll. 1964; subm. by V. I. Sarianidi, Archaeol. Inst., Acad. Sci. USSR, Moscow. *Comment*: Bln-720 appears somewhat older than Leningrad date of the same Building 54 (LE-647: 4440 ± 180) and agrees with date of Namazga III period of Kara-Depe (RUL-2: 4700 ± 120). The horizon Namazga III—Hissar IB/C—Sialk III/4-7—Late Uruk indicated by archaeol. connections across central Iranian plateau, however, suggests it is probably 400 to 600 yr older.

Togolok-Depe series

Neolithic mound Togolok-Depe (38° 7′ N Lat, 57° 57′ E Long) at S margin of the Karakum near Geok-Tepe R. R. Sta., ca. 45 km NW of Aŝchabad in Turkmenian SSR. Investigation started 1967 covers 3 subsequent layers with painted Neolithic ceramics. Also discovered were several small houses with domestic rooms surrounding them. Samples were taken from cultural layers within the settlement (Berdyev, 1968). Archaeol. date: Jeitun culture, a Neolithic period preceding Anau I A and Namazga I (Anau I B). Coll. 1967; subm. by V. Sarianidi.

6890 ± 100
Bln-718. Togolok-Depe No. 1 **4940 B.C.**

Charcoal samples from Level 2, ca. 0.5 m below surface.

7320 ± 100
Bln-719. Togolok-Depe No. 2 **5370 B.C.**

Charcoal sample from Level 3, ca. 0.8 m below surface. *Comment*: Bln-718 and 719 correspond to stratigraphic sequence and confirm antiquity of the Central Asian Neolithic. The Anau IA period, following

Jeitun culture, from Čagylly-Depe (Meana-Čaača Rayon) indicates a radiocarbon age of 7000 ± 100 B.P. (LE-592).

Ulug-Depe series

Ulug-Depe mound (37° 10′ N Lat, 60° 5′ E Long), occupied from the Eneolithic up to Achamendic period is in lower lands of Kopet-Dag Mts. near Dušak R. R. Sta., ca. 180 km SE of Ašchabad, in S Turkmenian SSR. The settlement mound investigated in 1967 covers ca. 25 acre area and 30.5 m height. Soundings at 3 places in upper parts of Tell indicate 3 Bronze age levels with buildings and by potter's wheel made ceramic of Namazga V (upper level Ulug-Depe 1) and Namazga IV type (Ulug-Depe 2 and 3) (Sarianidi, 1968). Archaeol. date: Namazga IV period (corresponds to early Anau III culture). Coll. 1967; subm. by V. I. Sarianidi.

4095 ± 100
Bln-714. Ulug-Depe Level 2 **2145 B.C.**

Charcoal (Ulmaceen wood) from Sonde 1, from Level 2, 1.5 m below surface.

4140 ± 100
Bln-715. Ulug-Depe Level 3 **2190 B.C.**

Charcoal (Juglandaceen wood) from Sonde 1, from Level 3, 2.00 m below surface. *Comment*: Bln-714 and 715 are consistent and comparable with date of late Namazga IV period from Altyn-Depe Level 4 (LE-664: 4070 ± 50).

5115 ± 160
Bln-698. Woznesenovka **3165 B.C.**

Charcoal from multi-layered Neolithic settlement near mouth of Chungari R. to Amur at hill site Stary Stanok N of Woznesenovka (50° 4′ N Lat, 136° 54′ E Long), Rayon Komsomol'sk, Chabarovsk Dist. Sample from loamy layer with early Neolithic ceramic (red-burnished and comb-decorated pottery), overlain by fluviatile sediments; depth 2.00 to 2.25 m below terrace surface. Expected age 3/4 millennium B.C. (Okladnikov, 1967). Coll. 1966 by Far Eastern Archaeol. Expedition, dir. by A. P. Okladnikov, Siberian Dept. Acad. Sci. USSR, Novosibirsk. Subm. by excavator.

3875 ± 120
Bln-699. Malyševo-na-Amure **1925 B.C.**

Charcoal from Neolithic site on right bank of Amur R. downstream Chabarovsk near village Malyševo-na-Amure (48° 45′ N Lat, 135° 40′ E Long), Dist. Chabarovsk. Sample 2.10 m below surface from cultural layer in 3rd terrace of R. Amur. Expected age 2/3 millennium B.C. Coll. and subm. as Bln-698. *Comment*: Bln-699 is somewhat older than date from same site in Leningrad Lab. (LE-663: 3590 ± 60).

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GIF NATURAL RADIOCARBON MEASUREMENTS V

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The list given below contains the C^{14} dates obtained for only archaeologic samples, during 1966 and 1967; for the study of the geologic samples dated during the same period, cf. our previous list Gif-III (Radiocarbon, 1969, v. 11, p. 327-344). The same instruments and techniques have been employed.

Dates were calculated on the basis of a C^{14} half-life of 5568 yr and 95% of NBS oxalic acid as a modern standard.

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SAMPLE DESCRIPTIONS

I. FRANCE

A. Southwest France

3210 ± 200
Gif-394. Saliés-de Béarn, Basses Pyrénées 1260 B.C.

Charcoal from circular hearth, Saliés-de-Béarn (43° 28′ N Lat, 0° 55′ W Long), Basses Pyrénées; found with potsherds similar to others of sites of Late Bronze Age, in Aquitaine. Coll. by M. Gauthier and subm. 1965 by J. Coupry, Dir. des Antiquités Historiques d'Aquitaine, Bordeaux. *Comment*: these circular hearths were used for industrial extraction of salt. Result confirms Late Bronze age indicated by pottery.

9150 ± 1000
Gif-395. Saint-Martin de Caralp, Ariège 7200 B.C.

Bones of fossil reindeer (*Rangifer tarandus*) in a stalagmitic layer in the Bernard Cave, at Saint-Martin de Caralp (43° N Lat, 1° 32′ E Long), Ariège. Coll. and subm. 1965 by J. Bouchud, CNRS, Paris. *Comment*: extracted collagen was quite short and diluted with "dead" CO^2 to bring sample to usual counter pressure. Date not acceptable for fossil reindeer which, according to submitter, definitely left France ca. 12,000 B.P. (Bouchud, 1964).

2150 ± 150
Gif-376. Lectoure, Gers 200 B.C.

Charcoal from pottery kilns, at Lectoure (43°56′ N Lat, 0° 38′ E Long), Gers. Some kgms of Roman coins have been found in each one. Coll. by M. Larrieu and subm. 1965 by E. Thellier, Inst. de Physique du

Globe, Paris. *Comment*: dated from Late Roman period by coins and by average magnetic measurements obtained on the burnt clay of 4 kilns. Either C^{14} date is aberrant or sample is not representative.

2110 ± 120
Gif-322. Bordeaux, Gironde **160 B.C.**

Wood from piles extracted during foundation diggings in the city of Bordeaux (44° 50′ N Lat, 0° 34′ W Long), Gironde. Coll. and subm. 1964 by B. Vermeylen, Soc. Archéolog. de Bordeaux. *Comment*: because of the source of sampling, depth is difficult to determine; but piles were probably under a mosaic level, dated 4th century A.D.; give earlier date than believed for foundation of city, which probably was, at first, a town built on pilings.

460 ± 100
Gif-332. Chassang, Chamboulive, Corrèze **A.D. 1490**

Charcoal from a souterrain at Chassang, Chamboulive (48° 26′ N Lat, 1° 42′ E Long), Corrèze. Coll. and subm. 1964 by H. Boudrie, Uzerche, Corrèze. *Comment*: this kind of building, which is found in different French regions, seems to have been not only a refuge during disturbed times of history, but also a cultural site.

1420 ± 120
Gif-392. Faycelles, Lot **A.D. 530**

Human bones from tombs found in barrow at Faycelles (44° 34′ N Lat, 1° 59′ E Long), Lot. Coll. and subm. 1965 by P. Delbos, Caussade, Tarn et Garonne. *Comment*: tombs seem to have been sunk in the barrow, which is surely older. Assoc. pottery is very rough and its age could not be appreciated exactly. This necropolis was believed to be from a Pagan, isolated people in the Merovingian age; date agrees with this interpretation.

Gif-212. Grotte de Saint-Géry, Loze, **1060 ± 120**
Tarn et Garonne **A.D. 890**

Charcoal of archaeologic layer of the Grotte de Saint-Géry (44° 30′ N Lat, 1° 35′ E Long), Loze, Tarn et Garonne. Coll. 1961 and subm. 1963 by A. Cavaillé, Mus. d'Histoire Nat. de Montauban. *Comment*: does not agree with archaeologic data; construction of a wall through the layer can explain pollution due to the introduction of more recent charcoals. Expected age: la Tène II Iron age.

3270 ± 150
Gif-442. Grotte des Cascades, Creissels, Aveyron **1320 B.C.**

Charcoal from a Chalcolithic level in the Grotte des Cascades, Creissels, (44° 05′ N Lat, 3° 04′ E Long), Aveyron. Coll. 1964 by G. Costantini and subm. 1966 by J. Maury, Rodez, Aveyron. *Comment*: does not agree very satisfactorily with the well-dated Chalcolithic furniture found in site (Costantini, 1965). Expected age: 2000 to 2200 B.C.

Grotte de Sargel series, Saint-Romé de Cernon, Aveyron

Charcoals from archaeologic levels of the Grotte de Sargel, Saint-Rome de Cernon (44° 01′ N Lat, 2° 57′ E Long), Aveyron (Soutou, 1966). Coll. 1965 and subm. 1966 by J. Maury and A. Soutou.

Gif-444. Grotte I de Sargel, Level VI **4500 ± 150**
2550 B.C.

Level VI, with transition between Chassean and early Chalcolithic industries.

Gif-445. Grotte I de Sargel, Level X **4570 ± 150**
2620 B.C.

Level X, with pure Chassean Neolithic industry.

Gif-328. Grotte I de Sargel **3710 ± 180**
1760 B.C.

From Chalcolithic level of Cave I, Sargel. *Comment*: fits very well with type of pottery assoc.

General Comment: corresponds nicely to expected ages.

Gif-443. Grotte des Salzets, Mostuéjouls, Aveyron **8770 ± 200**
6820 B.C.

Charcoal from a unique archaeologic level, 30 cm thick, in the Cave of Salzets, Mostuéjouls (44° 13′ N Lat, 3° 09′ E Long), Aveyron. Coll. 1964 and subm. 1966 by J. Maury. *Comment*: agrees with geometric microlithic industry and a fauna with a primitive ox-deer found in the cave (Maury and Lacas, 1965). Similar date obtained for Rouffignac considered classic Sauveterrian site.

Gif-446. Grotte de Puechmargues, La Roque-Sainte-Marguerite, Aveyron **6420 ± 180**
4470 B.C.

Charcoal found under a Chalcolithic ossuary in a Tardenoisian level, Grotte de Puechmargues, La Roque-Sainte-Marguerite (44° 08′ N Lat, 3° 13′ E Long), Aveyron (Maury and Lacas, 1965). Coll. 1964 and subm. 1966 by J. Maury. *Comment*: younger date expected because of Neolithic affinities of tools and presence of pottery. Date is reasonable if compared to dates obtained for early Mediterranean Neolithic, ca. 4500 B.C.

Gif-331. Causse de Méjean, Gorges du Tarn, Lozère **760 ± 100**
A.D. 1190

Charcoal from grave in cave of Causse of Méjean, Gorges du Tarn (44° 14′ N Lat, 3° 12′ E Long), Lozère. Coll. and subm. 1964 by Y. Legoux, Bulles, Oise. *Comment*: not Neolithic as expected.

Gif-219. Mas Saint-Chely, Lozère **2560 ± 200**
610 B.C.

Charcoal from top layer of rectangular dolmen at Mas Saint-Chely (44° 47′ N Lat, 3° 15′ E Long), Causse Méjean, Lozère. Coll. 1962 and subm. 1963 by M. Lorblanchet, Montpellier, Hérault. *Comment*: indicates some re-utilization during Early Iron age of this Neolithic monument, frequent episode in this part of France.

B. South, Southeast, and central France

Palaggiu, Sartene series, Corsica

Charcoals from megalithic site Pallagiu, Sartene (41° 33′ N Lat, 8° 53′ E Long) Corsica (Grosjean, 1967). Coll. 1965 and subm. 1966 by R. Grosjean, Centre de Préhistoire Corse, CNRS, Paris.

Gif-476. Palaggiu, Corsica 1-1965 — **2650 ± 150**, **700 B.C.**

From Funeral Chest A of the alignment of menhirs. Inferior level.

Gif-477. Palaggiu, Corsica 2-1965 — **2680 ± 150**, **730 B.C.**

From a burning level, at foot of N alignment of menhirs.

General Comment: 1000 yr younger than expected. May not date site.

Castello d'Alo, Bilia series, Corsica

Charcoal from Torrean monument of complex site of Castello d'Alo, Bilia (41° 37′ N Lat, 8° 54′ E Long), Corsica (Grosjean, 1966). Coll. 1965 and subm. 1966 by R. Grosjean.

Gif-478. Castello d'Alo, Corsica 3-1965 — **3100 ± 110**, **1150 B.C.**

From central inferior hearth, in E cultural monument.

Gif-479. Castello d'Alo, Corsica 4-1965 — **3500 ± 120**, **1550 B.C.**

From lower burning level, over pavement, in E cultural monument. *Comment*: dates last ritual utilization of monument.

Gif-480. Castello d'Alo, Corsica, 5-1965 — **3820 ± 200**, **1870 B.C.**

From main hearth of C. W. room, in O. monument. *Comment*: typical monument dated older than Torrean civilization. Similar to Gsy-94B: 3865 ± 125 (Radiocarbon, 1966, v. 8, p. 130), Gif-243: 3770 ± 250 (Radiocarbon, 1966, v. 8, p. 86) for similar Torrean sites at Tappa, in Corsica, and in Sardinia.

La "Grotte Murée" series, Montpezat, Basses Alpes

Charcoal from la "Grotte Murée," Montpezat (43° 45′ N Lat, 6° 15′ E Long), Basses Alpes (Courtin 1963; C. H. Lagrand, 1962).

Gif-139. La "Grotte Murée", Layer 4 — **4160 ± 250**, **2210 B.C.**

Lightly sintered at the top. Coll. and subm. by C. H. Lagrand, CNRS, Marseille.

2320 ± 140
Gif-157. La "Grotte Murée", Layer 5 **370 B.C.**

Coll. and subm. 1962 by J. Courtin, CNRS, Marseille.

General Comment: Layer 6 dated at 3960 ± 175 B.P., Gsy-116 (Radiocarbon 1966, v. 8, 74-95). Archaeologic ages: Layer 4, Late Bronze age, Layer 5, Middle Bronze age, and Layer 6, Chalcolithic age. Dates do not agree with supposed stratigraphy: discrepancy cannot be explained by contamination alone.

5225 ± 300
Gif-303. Grotte de Unang, Mallemont, Vaucluse **3275 B.C.**

Charcoal from bottom of Level 9 of Grotte de Unang, Mallemont (44° 03′ N Lat, 5° 09′ E Long), Vaucluse. Coll. 1963 and subm. 1964 by M. Paccard, Velleron, Vaucluse. *Comment*: dates this level of Late Cardial Neolithic, according to stratigraphy.

Gramari series, Methamis, Vaucluse

Site discovered by chance during gravel exploitation on right bank of Nesque R. (44° 01′ N Lat, 5° 13′ E Long), Vaucluse. Excavations uncovered a few campsites and showed a stratigraphy made complex by streaming, human reworking, and torrential drift (Paccard, 1965, 1966). Coll. 1963 and subm. 1964 by M. Paccard.

3420 ± 200
Gif-262. Gramari, Level C3a **1470 B.C.**

Upper level, containing alternated habitation and inundation layers.

5090 ± 300
Gif-263. Gramari, Level C3b **3140 B.C.**

Middle level.

6220 ± 300
Gif-264. Gramari, Level C3c **4270 B.C.**

Lower level.

General Comment: with bones of wild horse and bouquetin, and Sauveterrian artifacts. The dates obtained from these samples are younger than expected.

1540 ± 120
Gif-437. Bridge of Avignon, Vaucluse **A.D. 410**

Fragment of wood under foundations of extreme pillar of Saint-Benezet bridge at Avignon (43° 56′ N Lat, 4° 48′ E Long), Vaucluse. Coll. and subm. 1965 by Centre de Travaux d'Avignon Vallabrèques, Avignon, Vaucluse. *Comment*: as expected, dates famous bridge of Avignon at Gallo-Roman period.

820 ± 100
Gif-452. Dolmen des Fades, Pépieux, Aude **A.D. 1130**

Charcoal found in Late Neolithic, Fades' Megalithic tomb, Pépieux (43° 18′ N Lat, 2° 40′ E Long), Aude. Coll. 1965 and subm. 1966 by

J. Guilaine, CNRS, Carcassonne. *Comment*: this site is known to have been used during Iron Age, Gallo-Roman period, and the Middle Ages. Dates latest reutilization.

7140 ± 350
Gif-453. Grotte de Gardouch, Beaucaire, Aude 5190 B.C.

Charcoal from sepulchral grotte de Gardouch, Beaucaire (42° 49′ N Lat, 1° 57′ E Long), Aude. Coll. 1965 and subm. 1966 by J. Guilaine. *Comment*: disagrees with expected Chalcolithic Late Bronze age. Submitter suggests possible utilization of old woods from the "Pinet" peat bog very near site.

3160 ± 200
Gif-483. Le Gaougnas, Cabrespine, Aude 1210 B.C.

Charcoal from Late Bronze age site of Le Gaougnas, Cabrespine (43° 21′ N Lat, 2° 27′ E Long), Aude. Coll. and subm. 1966 by J. Guilaine. *Comment*: in good range of dates for beginning of meridional Late Bronze age.

380 ± 120
Gif-253. Cabane Giry, Nissan, Hérault A.D. 1570

Charcoals of Kiln II, from La Cabane Giry, Nissan (43° 20′ N Lat, 3° 02′ E Long), Hérault. Coll. 1963 by Abbé Giry and subm. 1964 by E. Thellier. *Comment*: dated for comparison with magnetic measurements of burnt clay from Kiln I located near Kiln II. Kilns seem uncontemporaneous.

Gif-450. Les Beaux-Escanin 2, Eyguières, 5000 ± 250
Bouches du Rhône 3050 B.C.

Charcoal from hearth from Les Beaux-Escanin, Eyguières (43° 45′ N Lat, 4° 48′ E Long), Bouches du Rhône. Coll. and subm. 1966 by R. Montjardin, Arles. *Comment*: assoc. with microliths and Chassean ceramics. Dates early provencal Chassean.

3975 ± 200
Gif-451. Beaussement, Chauzon, Ardèche 2025 B.C.

Charcoal from Level 3, Excavation 3, at Beaussement, Chauzon (44° 28′ N Lat, 4° 21′ E Long), Ardèche. Coll. 1965 and subm. 1966 by R. Montjardin. *Comment*: correct date for Chalcolithic of Basse Ardèche (Montjardin, 1967).

2130 ± 150
Gif-250. Le Pègue, Drôme 180 B.C.

Charcoal, S 7 DIII, from Iron age archaeologic layer of le Pègue (44° 24′ N Lat, 5° 04′ E Long), Drome. Coll. and subm. 1963 by M. Samson, Paris.

Gif-704. Sainte-Croix-de-Verdon, Basses Alpes **4100 ± 140**
2150 B.C.

Charcoal from the Chalcolthic Level II A of "Abri du Capitaine," Sainte-Croix-de-Vernon (43° 45′ N Lat, 6° 10′ E Long), Basses Alpes. Coll. and subm. 1966 by J. Courtin, CNRS, Marseille. *Comment*: assoc. with beakers of "campaniform" provencal type.

Avignon series, Vaucluse

Charcoal from Quartier de la Balance sta., Avignon (43° 56′ N Lat, 4° 48′ E Long), Vaucluse, where a complete stratigraphy was established from Chalcolithic age to present. Coll. and subm. 1966 by J. Courtin.

Gif-705. Quartier de la Balance, Avignon, Level 3 **4100 ± 120**
2150 B.C.

Chalcolithic level.

Gif-706. Quartier de la Balance, Avignon, Level 4 **3500 ± 120**
1550 B.C.

Under Level 3, same culture as 705.

General Comment: Gif-705 gives correct age for this Late Neolithic level with "campaniform" beakers, but Gif-706 is contaminated.

Gif-203. Roselet, Lac d'Annecy, Savoie **980 ± 120**
A.D. 970

Pile wood under 2 m of water in Lac d'Annecy at Roselet (1° 32′ N Long, 45° 49′ E Lat). Coll. 1962 and subm. 1963 by M. Lamure, Paris. *Comment*: contemporary with foundation of Abbaye de Talloires and not of the Bronze period as first supposed.

Gif-274. Grotte de Chazelles, Ardèche **2730 ± 150**
780 B.C.

Charcoal from Level 519-536, Layer IV, Area AE50 from Cave of Chazelles (44° 20′ N Lat, 4° 12′ E Long), Ardèche. Coll. and subm. by S. Nikitine, CNRS, Paris. *Comment*: was expected to date settlement just before population of Late Bronze age, but appears to correspond to last period.

Gif-277. Grotte des Crânes, Gard **5200 ± 300**
3250 B.C.

Charcoal from N passage of Grotte des Crânes (44° 16′ N Lat, 4° 08′ E Long), Gard. *Comment*: this human ossuary is Neolithic. It was thought to be either of Neolithic or Bronze age.

Gif-441. Plateau de Ronzières, Puy-de-Dôme **1800 ± 150**
A.D. 150

Charcoal from ruins of Gallo-Roman building, Plateau de Ronzières, (45° 31′ N Lat, 3° 07′ E Long), Puy de Dôme. Coll. and subm. by G.

Fournier, Fac. des Lettres de Clermont-Ferrand. *Comment*: most ceramics of site belong to Late Gallo-Roman period; appears a little older but may be acceptable.

840 ± 120
Gif-425. Linard, Haute-Vienne, LIN-10 **A.D. 1110**

Charcoal from a souterrain, Linard (45° 41′ N Lat, 1° 33′ E Long), Haute-Vienne. Coll. and subm. 1965 by P. Dupuy, Aixe-sur-Vienne. *Comment*: no archaeologic data, but correct for a medieval souterrain. Cf. Gif-332.

1320 ± 120
Gif-426. Sereilhac, Haute Vienne, BAI-10 **A.D. 1110**

Charcoal from a Catalan forge, Sereilhac (45° 47′ N Lat, 1° 5′ E Long), Haute-Vienne. Coll. and subm. 1965 by P. Dupuy. *Comment*: no archaeologic data, but certainly medieval.

Marcilly-sur-Tille series, Côte d'Or

Charcoal from fortified, walled site of Marcilly-sur-Tille, (47° 31′ N Lat, 0° 30′ E Long), Côte d'Or. Coll. and subm. 1963 by E. Planson, Dijon, Côte d'Or.

810 ± 120
Gif-230. Marcilly-sur-Tille, M/CN **A.D. 1140**

In layer containing Neolithic artifacts.

700 ± 120
Gif-231. Marcilly-sur-Tille, M/TP **A.D. 1250**

Interior of rampart, in stake hole.

700 ± 120
Gif-232. Marcilly-sur-Tille, M/FS **A.D. 1250**

At bottom of trench.

510 ± 120
Gif-233. Marcilly-sur-Tille, M/CB **A.D. 1440**

60 cm beneath surface.

2180 ± 150
Gif-270. Hauteroche, Côte d'Or **230 B.C.**

Charcoal from burnt material of Gallo-Roman villa, 30 cm from surface, at Hauteroche (47° 30′ N Lat, 0° 19′ E Long), Côte d'Or; assoc. with ancient coins of 2nd and 3rd centuries A.D. Coll. and subm. 1962 by J. Joly, Dir. Antiquités Préhistoriques de Bourgogne, Paris. *Comment*: date seems too old and probably implies utilization of older wood.

C. Northern France

Alésia series, Côte d'Or

Charcoal from cutting in 2 burnt layers separated by gravel beds, stones, and ground at Alésia (47° 31′ N Lat, 4° 14′ E Long), Côte d'Or. Coll. 1962 and subm. 1965 by Abbé Joly.

Gif-267. Alésia I **1670 ± 120**
A.D. 280

1 m depth.

Gif-268. Alésia II **1240 ± 120**
A.D. 710

1.80 m depth.

General Comment: level archaeologically undated as no furniture has been found up to the present.

Grotte de la Baume de Gonvillars series, N Jura

Charcoal and carbonized cereals from habitat in Grotte de la Baume de Gouvillars, (47° 33′ N Lat, 6° 38′ E Long), N Jura. Coll. 1965 and subm. 1966 by P. Petrequin, Lab. Archéol. de Besançon.

Gif-466. Gonvillars, E3V **5000 ± 250**
3050 B.C.

From Final Bronze II and III level. *Comment*: following excavation verified an intrusion at this depth of inferior Neolithic levels.

Gif-467. Gonvillars, E5b **3430 ± 200**
2480 B.C.

Late Neolithic level. *Comment*: corresponds to Michelsberg culture in region. Similar results in Switzerland.

Gif-468. Gonvillars, E6x **5380 ± 250**
3430 B.C.

Neolithic level. *Comment*: ceramics with Danubian influence; Late Rössen culture.

Gif-469. Gonvillars G10-XI b **6250 ± 300**
4300 B.C.

Middle Neolithic level. *Comment*: seems too old for this Neolithic culture.

Gif-360. Tinqueux, Marne **3910 ± 200**
1960 B.C.

Charcoal from collective tomb, in rock-cut hypogeum, at Tinqueux (49° 14′ W Lat, 3° 59′ E Long), Marne. Coll. 1963 and subm. 1965 by A. Leroi-Gourhan, Centre de Recherches Préhistoriques et Protohistoriques, Paris. *Comment*: assoc. with Late Neolithic industry of Seine-Oise-Marne culture (Bailloud and Brezillon, 1968).

Gif-720. Videlles, Seine et Oise **4740 ± 140**
2790 B.C.

Charcoal from lowest Layer E of settlement of Les Roches, Loc. 5, Videlles (48° 25′ N Lat, 3° 35′ E Long), Seine et Oise. Coll. and subm. 1966 by G. Bailloud, CNRS, Paris. *Comment*: similar dates for same level:

4500 ± 60: GrN-4675, 4500 ± 50: GrN-4676 (Radiocarbon, v. 9, 1967, p. 133); old, if compared to ages of other Late Neolithic sites of Seine-Oise-Marne culture, but corresponds in fact to archaic phase of this culture. Layer D, just above Layer E, was dated 2930 ± 250: Gsy-110 (Radiocarbon, v. 8, 1966, p. 132), but it now seems that this level, was contaminated by upper layers.

Pincevent series, Seine et Marne

Charcoal from hearths of Magdalenian habitation site of Pincevent (48° 23′ N Lat, 2° 53′ E Long), Seine et Marne. Coll. and subm. 1964 by A. Leroi-Gourhan and M. Brezillon.

9840 ± 350
Gif-349. Pincevent, Y 61, Area 9 **7890 B.C.**

40 cm depth, under present soil. *Comment*: date is mean of 2 dates: 9900 ± 350 and 9790 ± 350 B.P. obtained with same sample.

12,300 ± 400
Gif-358. Pincevent, Hearth III, Habitat 1 **10,350 B.C.**

General Comment: other measurements made by Louvain and Groningen labs on hearths of same site have given: Lv-291: 10,920 B.P.; Lv-292: 11,610 B.P.; Lv-293: 11,310 B.P. (Radiocarbon, 1969, v. 11, p. 108), GrN-4383: 10,760 B.P.

Gif-327. Bulles, Oise **⩾30,000**

Charcoal from Merovingian cemetery at Bulles (49° 28′ N Lat, 2° 8′ 30″ S Long), Oise. Coll. and subm. 1964 by Y. Legoux. *Comment*: no significance unless charcoal was found in incinerator where lignite jewelry was burnt?

470 ± 120
Gif-339. Bardouville, Seine Maritime **A.D. 1480**

Bones from sepulchres in Norman sands at Bardouville (49° 26′ N Lat, 0° 51′ E Long), Seine Maritime. Coll. by J. Dastugue and subm. 1964 by J. Graindor, Collège de France, Paris. *Comment*: does not confirm expected Paleolithic age.

Gif-244. La Ferme du Chinchy, **2830 ± 150**
Villeneuve-sur-Fère, Aisne **880 B.C.**

Charcoal of hearth at 40 cm depth, with so-called "Tardenoisian" industry from la Ferme du Chinchy, Villeneuve-sur-Fère (49° 39′ N Lat, 3° 22′ E Long), Aisne. Coll. by M. Hinout and subm. 1964 by H. Alimen, CNRS, Bellevue. *Comment*: not compatible with results for "Tardenoisian" at Coincy, 700 m farther: 3260 ± 200 and 4740 ± 350 B.P. (Gif-132 and Gif-133, Radiocarbon, 1966, v. 8, p. 82). Contamination through sands or disturbed site.

Gif-407. Painting from Musée du Louvre **Modern**

Fragments of cloth from "Greco-Roman" painting. Subm. by M. Hours, Lab. Mus. du Louvre, Paris. *Comment*: as expected, painting is forgery.

D. Western France

Gif-345. Le Curnic, Guisseney, Finistère, Hearth Neo. 64 **5510 ± 250** **3560 B.C.**

Charcoal from a submerged Neolithic hearth, on beach of the Curnic, Guisseny (48° 35′ N Lat, 4° 25′ W Long), Finistère. Coll. and subm. 1965 by C. T. Le Roux and P. R. Giot, Lab. d'Anthropol. Préhistorique, Rennes. *Comment*: confirms presence on this coast of Early Neolithic population, as shown by Gsy-47B (Radiocarbon, 1966, v. 8, p. 134; Giot, 1961).

Ploudalmezeau, Ile Carn series, Finistère

Charcoal from megalithic monuments at Ploudalmezeau, Ile Carn (48° 34′ N Lat, 4° 41′ W Long), Finistère. Coll. and subm. 1965, 1966 by P. R. Giot and C. T. Le Roux.

Gif-414. Ile Carn B 3 **5340 ± 250** **3390 B.C.**

Central tomb of a megalithic cairn. *Comment*: result identical to GrN-1968: 3270 B.C. for same site.

Gif-1362. Ile Carn, S Carn 2 **5390 ± 150** **3440 B.C.**

Room in S dolmen. *Comment*: tomb similar to Gif-414.

Gif-1363. Ile Carn, N Carn **4840 ± 150** **2890 B.C.**

N room in N dolmen. *Comment*: had a longer frequentation than Carn B and S Carn 2, as was expected.

Gif-393. Abbey of Landevennec, Finistère **450 ± 100** **A.D. 1500**

Charcoal from hearth on flagstones, found during excavations in the Landevennec abbey foundations (48° 18′ N Lat, 4° 17′ W Long), Finistère. Coll. and subm. 1965 by M. Ricou, CNRS, Paris. *Comment*: main part of abbey was built between XIth and XIIIth centuries and it was abandoned towards 1790. Corresponds to one of numerous fires which have destroyed this building.

Le Questel series, Concarneau, Finistère

Remains of a Gallo-Roman settlement, probably a praefurnium found in a villa at Le Questel, Concarneau (47° 53′ N Lat, 3° 45′ W Long), Finistère (Sanquer, 1965). Coll. 1964 and subm. 1965 by R. Sanquer, Fac. des Lettres de Brest.

Gif-408. Le Questel **3840 ± 200**
1890 B.C.

Mortar.

Gif-409. Le Questel **1580 ± 120**
A.D. 370

Charcoal.

General Comment: assoc. with sigillated ceramics. It may be seen from Gif-408 that lime used to make the mortar was incompletely decarbonized. Gif-409 should date reutilization of site after destruction by the Saxons ca. 250 to 300 A.D.

Gif-346. Pendreff, Commana, Finistère **2500 ± 180**
550 B.C.

Charcoal from hearth in Rooms III, IV, of an Iron age souterrain at Pendreff, Commana (Le Roux and Giot, 1966) (48° 25′ 12″ N Lat, 3° 57′ 46″ W Long), Finistère. Coll. and subm. 1965 by P. R. Giot and C. T. Le Roux. *Comment*: as for many of Armorican souterrains, some centuries older in regard to ceramics, which here could be expected to date from 350 to 300 B.C. (Giot, 1966, 1967).

Gif-716. Moulin de la Rive, Locquirec, Finistère **1900 ± 100**
A.D. 50

Charcoal from Iron age habitat in sand hill, Moulin de la Rive, Locquirec (48° 41′ N Lat, 3° 42′ W Long), Finistère. Coll. and subm. by P. R. Giot and C. T. Le Roux. *Comment*: perhaps 100 yr too young but fits well with La Tene III age of ceramics (Giot, 1968).

Gif-481. Plouégat, Moysan, N Finistère **2480 ± 110**
530 B.C.

Charcoal from Iron age souterrain, Plouégat, Moysan, Bellevue (48° 34′ N Lat, 3° 37′ W Long), N Finistère. Coll. and subm. 1966 by P. R. Giot. *Comment*: a few centuries older than expected; archaeologic material might be dated to 150 or 100 B.C. (Giot *et al.*, 1965).

Gif-715. Fossé de Catuélan, Erquy, Côtes du Nord **2500 ± 110**
550 B.C.

Charcoal from Late Bronze age oppidum at Erquy (48° 39′ N Lat, 2° 28′ W Long), Côtes du Nord. Coll. and subm. 1966 by P. R. Giot and C. T. Le Roux. *Comment*: corresponds to expected age.

Gif-344. Crec'h Quillé, Saint-Quay, Perros, Côtes du Nord **3740 ± 200**
1790 B.C.

Charcoal from blocking of lateral entrance grave Crec'h Quillé, Saint-Quay-Perros (48° 47′ N Lat, 3° 23′ W Long), Côtes du Nord (L'Helgouach, 1967). Coll. and subm. 1964 by J. L'Helgouach, Fac. des Sci. de Rennes. *Comment*: slightly younger than expected, dates final filling in of tomb, cf. Gif-197C (Radiocarbon, 1966, v. 8, p. 74, Gif-II) (Giot, 1965).

980 ± 100
Gif-487. Plouasme, Le Bourg, Côtes du Nord **A.D. 970**

Wood found under a Middle Age mound at Plouasme, Le Bourg (53° 76′ N Lat, 4° 85′ W Long), Côtes du Nord. Coll. and subm. 1966 by M. Monier, Dinan, Côtes du Nord.

1030 ± 100
Gif-718. Saint Goueno, Côtes du Nord **A.D. 920**

Charcoal from a level of fire of the oppidum of Cap Barré de la Parentelaye, Saint-Goueno (48° 14′ N Lat, 2° 33′ W Long), Côtes du Nord. Coll. and subm. 1966 by C. T. Le Roux, P. R. Giot. *Comment*: dates this important protohistoric oppidum.

2180 ± 100
Gif-717. Guernehué, Monterblanc, Morbihan **230 B.C.**

Charcoal from Iron age souterrain, Guernehué, Monterblanc (47° 45′ N Lat, 2° 40′ W Long), Morbihan. Coll. and subm. 1966 by J. C. Lecornec, Vannes. *Comment*: fits with assoc. ceramics.

2850 ± 110
Gif-719. La Grée Basse, Monteneuf, Morbihan **900 B.C.**

Charcoal from grave incineration at La Grée Basse, Monteneuf (47° 53′ N Lat, 2° 12′ W Long), Morbihan. Coll. and subm. 1966 by M. Orhan, Ploërmel, Morbihan. *Comment*: no archaeologic clue to date site.

Goërem series, Gâvres, Morbihan

Charcoal from angled passage grave of Goërem, Gâvres (47° 41′ 47″ N Lat, 30° 21′ 12″ W Long), Morbihan. Coll. and subm. 1964 by J. L'Helgouach.

3860 ± 200
Gif-329. Goërem I, AW[6] **1910 B.C.**

Comment: dates Chalcolithic (Bell-Beaker) frequentation of site.

2620 ± 200
Gif-330. Goërem II, AW[4]-AW[6] **670 B.C.**

Comment: indicates Iron age intrusion.

4100 ± 140
Gif-768. Goërem III **2150 B.C.**

In room of grave, under broken pavement. *Comment*: presence of so-called ceramics of Kerugou.

3470 ± 120
Gif-769. Goërem IV **1520 B.C.**

Upper hearth in room. *Comment*: hearth in relation with an attempt to penetrate into the sepulchre.

Gif-1148. Goërem IV b **4430 ± 120**
2480 B.C.

From deepest level of filling of the room, separated from Goërem IV by stones. *Comment*: important layer with "Kerigou" and campaniform ceramics.

Gif-482. Saint-Evarzec, S Finistère **3580 ± 200**
1630 B.C.

Charcoal from Bronze Age barrow, Saint-Evarzec, Kerhuel (47° 56′ N Lat, 4° 02′ W Long), S Finistère (Le Roux, 1966). Coll. 1965 and subm. 1966 by G. T. Le Roux. *Comment*: slightly younger date was expected; dates beginning of Middle Bronze age.

Gif-410. Le Boucaud, Préfailles, Loire Atlantique **2700 ± 200**
750 B.C.

Charcoal from brickworks of Late Bronze age, in a shist clift at Le Boucaud, Préfailles (47° 8′ N Lat, 2° 14′ W Long), Loire Atlantique, (Tessier and Gouletquer, 1966). Coll. and subm. 1965 by M. Tessier, Tharon, Loire Atlantique. *Comment*: agrees well with well-dated habitation site of Late Bronze age, at Saint-Brévin l'Océan, Gif-193 (Radiocarbon, v. 8, 1966, p. 80).

La Plaine-sur-Mer series, Loire Atlantique

Charcoal from sites with "augets," pottery salt-pans of Iron age, at La Plaine-sur-Mer, Loire Atlantique (Gouletquer *et al.*, 1967-1969). Coll. and subm. 1965 by P. L. Gouletquer, Lab. d'Anthropol. Préhistorique, Rennes.

Gif-411. La Frenelle, La Plaine-sur-Mer **1940 ± 150**
A.D. 10

(48° 8′ N Lat, 2° 13′ W Long)

Gif-412. La Tarra, La Plaine-sur-Mer **1790 ± 150**
A.D. 160

(47° 10′ N Lat, 2° 15′ W Long)

General Comment: Late Iron age date on archaeologic ground. All salt industry sites of this type found in different regions of Brittany have similar characteristics, *i.e.*, often near the sea, they contain a lot of "augets" often broken, supposedly, while withdrawing salt from mould.

Gif-413. Monzenil, Vendée **1840 ± 150**
A.D. 110

Charcoal from salt industry site at Monzenil (49° 29′ N Lat, 1° 00′ W Long), Vendée. Coll. and subm. 1965 by P. L. Gouletquer.

Semussac series, Charente Maritime

Shells from Peu-Richardien camp of Semussac (45° 36′ N Lat, 0° 55′ W Long), Charente Maritime (Mohen, 1967). Coll. and subm. 1966 by J. P. Mohen, Merignac, Gironde.

Gif-474. Semussac, Level 1 **4690 ± 250**
2740 B.C.

Lowest level, 1.35 m depth. *Comment*: expected age: ca. 2700 B.C.

Gif-475. Semussac, Level 3 **4250 ± 250**
2300 B.C.

Upper level. *Comment*: expected age: ca. 2500 B.C.

La Garenne de Saint-Hippolyte series, Charente Maritime

Samples from Peu-Richard site of La Garenne de Saint-Hippolyte (45° 54′ N Lat, 0° 50′ W Long), Charente Maritime (Gabet and Massaud, 1965, 1966). Coll. 1963 by C. Gabet; subm. 1964, 1965 by J. Massaud, Angoulême.

Gif-313. La Garenne de Saint-Hippolyte, 1964 **4790 ± 250**
2840 B.C.

Charcoal from hearth at bottom of chamber.

Gif-417. La Garenne de Saint-Hippolyte, 1965 **4560 ± 250**
2610 B.C.

Patellae from archaeologic layer.

General Comment: shows antiquity of this culture in this place with regard to more continental sites.

II. AFRICA

Gif-306. R'Fana, R.F. 1, Tebessa, Bône, Algérie **7450 ± 300**
5500 B.C.

Charcoal from snailery of Upper Capsian at R'Fana, Tebessa, Bône (35° 21′ N Lat, 8° 06′ E Long), Algeria. Coll. and subm. 1963 by G. Camps, Centre de Recherches Anthropol. Préhistoriques et Ethnog. Mus. du Bardo, Alger.

Columnata series, Tiaret

Columnata (35° 32′ 30″ N Lat, 1° 30′ 55″ E Long), Tiaret, in central part of Maghreb, is key site for study of Epipalaeolithic and Capsian ages in N Africa. Charcoal coll. 1962 and subm. 1965 by G. Camps.

Gif-307. Columnata, 100 to 130 cm depth **5250 ± 250**
3300 B.C.

Gif-308. Columnata, 160 to 200 cm depth **6850 ± 300**
4900 B.C.

Gif-309. Columnata, 200 to 230 cm depth **6340 ± 300**
4390 B.C.

General Comment: show passage from Upper Capsian (Gif-308 and Gif-309) to a Neolithic with Capsian and Mediterranean traditions. The 130 to 160 level dated 6800 B.P. by MC-154 (Radiocarbon, 1969, v. 11, p. 126; Camps *et al.*, 1968).

Gif-438. Hassi-Mouilah E 10, Ouargla, Algeria **5280 ± 250**
3330 B.C.

Charcoal from Neolithic hearth, Hassi Mouilah E 10, Ouargla (32° 00′ N Lat, 5° 16′ E Long). Coll. and subm. 1965 by M. Trecolle, Ouargla. *Comment*: agrees very well with other dates obtained for the Neolithic age of Caspian tradition.

Gif-365. Hassi Manda, Algeria **6330 ± 300**
4380 B.C.

Charcoal from Neolithic site of Capsian tradition at Hassi Manda on the bank of Es-Roui Erg, NW Sahara (29° 15′ N Lat, 2° 30′ W Long); nondetermined industry; remains of Sudanese fauna. Coll. and subm. 1965 by J. Mateu, CNRS, Paris.

Gif-366. Foum Seida, Algeria **4930 ± 250**
2980 B.C.

Charcoal from Neolithic site of Foum Seita, Beni-Abbès (30° 11′ N Lat, 2° 14′ W Long). Coll. and subm. 1965 by J. Mateu.

Gif-461. Tipasa, Algeria, TPS 1 **2300 ± 150**
350 B.C.

Charcoal from hearth in W necropole, at Tipasa (36° 32′ N Lat, 2° E Long), Algeria. Coll. and subm. 1966 by G. Camps. *Comment*: assoc. with Punic ceramics. Dates Punic settlement.

Gif-462. Medjez II, Setif, E Algeria, MJ21 **6620 ± 300**
4670 B.C.

Charcoal from ashy level, in a snailery, at Medjez (36° 11′ N Lat, 5° 42′ E Long), E Algeria. Coll. and subm. 1966 by G. Camps. *Comment*: industry of this site has been used to define an Upper Capsian facies.

Gif-463. "Bou-Sfer" W Algeria, ESC-1 **6680 ± 300**
4730 B.C.

Charcoal from hearth in ashy archaeologic level, of littoral site of Bou-Sfer (35° 40′ N Lat, 1° 10′ W Long), W coast of Algeria. Coll. 1960 by G. Vuillemot and subm. 1966 by G. Camps. *Comment*: site well-known for its Neolithic ceramics; agrees with dates obtained for similar sites in Spain and Italy.

Gif-464. Tamanrasset, Amekni, Hoggar, AMK 1 **5500 ± 250**
3550 B.C.

Charcoal from hearth in upper archaeologic level, 30 to 60 cm depth, in site of Amekni, Tamanrasset (23° 13′ N Lat, 5° 13′ E Long), Hoggar. Coll. 1965 and subm. 1966 by G. Camps. *Comment*: assoc. with Neolithic ceramics of Sudan tradition.

Gif-357. Tamanrasset, Hoggar **3330 ± 250**
1380 B.C.

Charcoal from the Neolithic burial site near Tamanrasset (23° 10′ N Lat, 5° 35′ E Long), Hoggar. Coll. and subm. 1964 by G. Camps. *Comment*: found with 2 Negroid skeletons accompagnied by rough ceramics and tools. Too young to date site, perhaps dates re-utilization.

Hoggar series

Samples from Pre-Islamic graves, in the Hoggar. Coll. 1910 by P. Reygasse, kept in Mus. du Bardo, Algiers and subm. 1966 by M. C. Chamla, Inst. de Paléontol. Humaine, CNRS, Paris.

Gif-700. Silet, No. 3 **420 ± 100**
A.D. 1530

Charcoal from a stone-barrow at Silet (23° N Lat, 5° E Long).

Gif-701. Tit, No. 4 **650 ± 100**
A.D. 1300

Piece of cloth from a stone-barrow at Tit (23° N Lat, 5° E Long).

Gif-702. Tit, No. 68 **680 ± 100**
A.D. 1270

Piece of cloth from a stone-barrow, at Tit (23° N Lat, 5° E Long).

Gif-703. Coralès I **440 ± 100**
A.D. 1510

Charcoal from hearth in a sand-hill (36° N Lat, 1° W Long).

General Comment: samples date occupation of the Hoggar during protohistoric period.

Gif-465. Tamanrasset, Abouleg I, Hoggar **4600 ± 250**
2650 B.C.

Charcoal from Level I, Abouleg, Tamanrasset (22° 50′ N Lat, 5° 31′ E Long), Hoggar. Coll. by J. P. Maître and subm. 1966 by G. Camps. *Comment*: compare with other dates obtained for Levels I and II: 3140 ± 80 and 4190 ± 80 B.C. (UW-88 and UW-89). (Camps *et al.*, 1968).

Gif-375. Amded Oued, W Hoggar **2160 ± 150**
210 B.C.

Fragment of elephant-tusk found at surface of Amded Oued 150 km W of Tamanrasset (22° 35′ N Lat, 3° 55′ E Long). Coll. and subm. 1965 by C. Arambourg. *Comment*: this result, much younger than expected, is not significant of formation of regs from ancient flow of Amded Oued.

Ennedi series, Tchad

In S W Massif de l'Ennedi, at the limit of the Tchad, more than 500 sites with ruspestral paintings were counted by 1956-1957 CNRS expedition. The "Pebble culture", well-known in Tibesti, is absent in these sites; the lithic industry is too poor to characterize different periods of Neolithic age, but, the ceramic industry is very rich and various. Charcoals coll. 1957 and subm. 1965 by Bailloud, CNRS, Paris.

7200 ± 300
Gif-351. Ennedi, Delebo, 2-III **5250 B.C.**

(17° 12′ N Lat, 21° 15′ E Long), accompanied by wavy line pottery; dates beginning of Neolithic.

6900 ± 300
Gif-352. Ennedi, Delebo, 2 II **4950 B.C.**

(17° 12′ N Lat, 21° 15′ E Long), ceramics show affinity with Sudanese civilization of Esh Shaheinab.

400 ± 120
Gif-353. Ennedi, Tenebyela **A.D. 1550**

(17° 30′ N Lat, 21° 37′ E Long), same archaeologic context as Gif-352. *Comment*: found very near surface: this explains intrusion of recent charcoal into archaeologic layer.

5000 ± 250
Gif-354. Ennedi, Cobé V **3050 B.C.**

(17° 19′ N Lat, 21° 40′ E Long), ceramics of Hohou type from "Middle Neolithic" rougher and simpler decoration than ceramics of 1st Neolithic age.

General Comment: coherent with other dates obtained for Saharian Neolithic.

Tchad series

Charcoal from 3 sites from ancient and middle phases of Sao culture in the Tchad. They are 3 of the 200 sites presently known, between 20 and 30 km N Fort-Lamy (12° 10′ N Lat, 14° 59′ E Long), Tchad, habitation mounds corresponding to remains of ancient villages. Coll. 1963 and subm. 1965 by J. P. Lebeuf, Lab. d'Ethnol. et d'Archéol. Tchadienne, Paris.

Gif-428. Mdaga, VII, 1.10 m depth **Modern**

330 ± 120
Gif-429. Mdaga, VII, 1.50 m depth **A.D. 1620**

1980 ± 180
Gif-432. Amkoundjo, 0.30 to 0.60 m depth **30 B.C.**

1910 ± 180
Gif-433. Amkoundjo, 1 m depth **A.D. 40**

Gif-435. Amkoundjo, 2.60 m depth **2070 ± 180**
120 B.C.

Gif-436. Mound of Messo, 2 to 2.20 m depth **1010 ± 120**
A.D. 940

Gif-374. Madaouela, Nigeria **5520 ± 250**
3570 B.C.

Charcoal from Neolithic surface site, at Madaouela (18° 40′ N Lat, 7° 35′ E Long), ca. 200 km N, NW Agadès, Nigeria. Archaeologic layer, 30 cm depth gave abundant culinary remains (bones, shells, fish bones, pieces of pottery, stone tools, and arrow heads). Site found by uranium prospectors, F. Chantret and R. de Bayle des Hermens, 1968. Coll. and subm. by M. Chantret, Comm. à l'Energie Atomique, Fontenay-aux-Roses, France. *Comment*: agrees with other dates for Neolithic period in Sahara (Chantret and Bayle des Hermens, 1968).

Tiebala series, Mali, W Africa

Charcoal from detritus pit on side of the "Middle Ages" Site F, 3 km N Tiebala (13° 40′ 40″ N Lat, 5° 24′ 20″ W Long), Mali. Site F is ancient mound of dwelling in which were found ceramics of unknown kind. Coll. and subm. 1964 by A. Gallay, CNRS, Paris.

Gif-383. Tiebala, FII 1, 0.5 m depth **1440 ± 120**
A.D. 510

Gif-384. Tiebala, FII 2, 1 m depth **1400 ± 120**
A.D. 550

General Comment: local traditions mention that site was occupied in 13th century. Dates are important references for establishing absolute chronology by ceramics in W Africa.

Mirgissa series, Wadi Halfa, Sudan

Charcoal from Egyptian town of Mirgissa (21° 55′ N Lat, 31° 20′ E Long), dist. of Wadi Halfa, Rep. of Sudan. Mirgissa is 1 of ancient sites of upper valley of Nile which is now submerged, since construction of Aswan dam. Coll. 1963 and subm. 1964 by J. Vercoutter, Fac. des Sci. de Lille.

Gif-295. Mirgissa M.F. 1 **2925 ± 180**
975 B.C.

Charcoal at interior of bricks made of dried silt found in fortress of Mirgissa.

Gif-296. Mirgissa M. VII. 2 **3780 ± 200**
1830 B.C.

Similar to Gif-295.

Gif-297. Mirgissa, M.I., BT. 1 **3020 ± 180**
1070 B.C.

Charcoal from hearth covered by Eolian sand.

Gif-185. Majunga, Madagascar **3780 ± 200**
1830 B.C.

Wood from peat bog at Majunga (15° 40′ S Lat, 46° 20′ E Long), Madagascar. Peat bog is also fossil mammalian site. Coll. 1962 by M. Mahé and subm. 1964 by J. P. Lehman, Inst. de Paléontol., Paris. *Comment*: date seems too young for Malagasy subfossils.

III. OTHER COUNTRIES

Hang Gon, South Viet Nam **2100 ± 150**
150 B.C.

Carbonized deposit on potsherds of burial urns, from site of Hang Gon, near Xuan Loc (10° 48′ N Lat, 107° 15′ E Long), S Viet Nam. Coll. and subm. 1965 by E. Saurin, Fac. des Sci. de Saigon. *Comment*: dates "Sa Huynh" culture. Identical results for charcoal found outside and inside similar burial urns in same place (MC-61, MC-62, Radiocarbon, 1966, v. 8, p. 290).

Biskupin series, ZNIN, Poland

The ancient town of Biskupin, Znin (52° 51′ N Lat, 17° 41′ E Long), Poland is considered as the birthplace of the Lusatian civilization; there is an important controversy about the possible Lusatian origin of Slav people. During the Iron age, a fortified town with ramparts 6 m high, 463 m long, was built in Biskupin. After destruction of the city, a new one was built, according to the same general survey. Samples are pieces of wood from ancient city. Subm. by Z. A. Rajewski, Panstwowe Archaeol., Warsaw.

Gif-224. Biskupin, Area 112 **1635 ± 150**
A.D. 315

Wood from fortifications. Coll. 1959, subm. 1963. *Comment*: age too young; possible mixing of materials from the 2 towns.

Gif-492. Biskupin, fortification **2570 ± 150**
620 B.C.

Subm. 1966.

Gif-493. Biskupin, A2 4c, VII **2570 ± 150**
620 B.C.

85 cm depth, subm. 1966.

Gif-494. Biskupin, 1st settlement **2670 ± 150**
720 B.C.

Subm. 1966.

Gif-495. Biskupin, later settlement **2510 ± 150**
560 B.C.

General Comment: places period of settlement 750 to 550 B.C., during Halstatt C, when it supposedly was of Halstatt D, 550 to 400 B.C. Duration for the 2 settlements, ca. 200 yr, agrees well with archaeologic data.

Gif-66. Zàmeček, Slovakia **2350 ± 150**
400 B.C.

Burnt corn from habitat from Late Bronze age A², Zàmeček, Nitriansky Hràdec, Slovakia. Coll. and subm. by P. R. Giot. *Comment*: too young.

Mallia series, Kriti Island

Charcoal from Mallia (35° 42′ N Lat, 25° 30′ E Long), Kriti I. Coll. 1963 and subm. 1964 by O. Pelon, Ecole Française d'Athènes.

Gif-254. Mallia I **4030 ± 300**
2080 B.C.

Burnt layer, 1.50 m depth, E zone of town. *Comment*: agrees with assoc. ceramics which indicate that level of occupation is latest before construction of palace of Mallia between 2100 and 1900 B.C.

Gif-255. Mallia II **3470 ± 250**
1520 B.C.

2.10 m depth, Sq. A³, W zone of town. *Comment*: level corresponds to mean Minoan III in chronology of Knossos.

Gif-256. Mallia III **3200 ± 250**
1250 B.C.

1.20 m depth, Sq. A⁴, 4 m from Mallia II. *Comment*: too young.

Gif-470. Temple of Bêl, Palmyre, Syria **3420 ± 350**
1470 B.C.

Bones of animals, 1.20 m depth in a tell, Temple of Bêl, Palmyre (34° 35′ N Lat, 38° 17′ E Long), Syria. Coll. 1965 and subm. 1966 by R. du Mesnil du Buisson, CNRS, Paris. *Comment*: coherent with stratigraphy of tell, which appears to go from 12th century B.C. to 22nd century B.C. Bones from lower levels had no more organic matter and could not be dated.

Tureng Tepe series, Gorgan, Iran

Charcoal from Tureng Tepe (36° 55′ N Lat, 54° 35′ E Long), in the steppe, SE Capsian sea, Iran. Coll. 1963 and subm. 1964 by J. Deshays, Fac. des Lettres et Sci. Humaines, Lyon.

Gif-301. Tureng Tepe 2 **4325 ± 250**
2375 B.C.

Remains of wooden post which supported roof of house built of raw bricks, House B, 5 m depth. *Comment*: over House B, another level of destruction with House A, corresponding to Tureng Tepe II B, a civilization similar to Tepe Hissar II B in Mesopotamia. Above House A, a different civilization appears, with construction in pisé, which had commercial relations with Mesopotamia; time of 1st dynasty of Our, ca. 2500 to 2400 B.C.

4090 ± 250
Gif-302. Tureng Tepe 4 **2140 B.C.**

From House F, 6.50 m depth. *Comment*: one of deepest levels of Tureng Tepe II B. This level is surely older than Tureng Tepe 2. Date is too young.

3970 ± 200
Gif-485. Tureng Tepe X **1920 B.C.**

From burning level, 3.50 m depth. *Comment*: corresponds to end of so-called Hissar III B civilization. Archaeologically dated, 4000 B.P.

Suse series, Iran

Ashes mixed with remains of bones from Suse near by Castle of Darius (32° 12′ N Lat, 48° 20′ E Long), Iran. Coll. and subm. by M. Ghirschman, Acad. des Inscriptions et Belles Lettres, Paris.

3175 ± 250
Gif-180. Suse C, No. 1 **1225 B.C.**

On Suse Hill, called "Acropolis", from a habitation level. Supposed to date from end of 4th millennium B.C.

3920 ± 250
Gif-182. Suse, A-XIII, No. 3, Loc. 152 **1975 B.C.**

From excavation in elamite part of town; dated from middle of 2nd millennium B.C. by cuneiform writing tablets.

1750 ± 150
Gif-183. Suse, A-XIII, No. 4, Loc. 117 **A.D. 200**

Similar to Gif-182.

2730 ± 200
Gif-184. Suse, A-XIII, No. 5 **780 B.C.**

Similar to Gif-182.

General Comment: only correct date is Gif-182. Such a disagreement can only be explained by errors of sampling.

300 ± 100
Gif-473. Jerusalem **A.D. 1650**

Bark and alburn of olive tree from hill dominating Garden of Olives at Jerusalem (31° 47′ N Lat, 35° 14′ W Long). Coll. and subm. 1965 by J. Chabanon. *Comment*: not so old as was hoped.

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GRONINGEN RADIOCARBON DATES IX

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INTRODUCTION

This list contains mainly radiocarbon dates for Africa. Some results for samples from the ocean floor and from islands in the Atlantic and Indian oceans, as well as a few series of geophysical samples have also been included. The results are grouped into three categories: geologic, archaeologic, and geophysical, and arranged according to the country of provenance, passing roughly from N to S. Descriptions and comments are based on information supplied by the collectors and submitters and on the publications cited. In several cases insufficient information was available, but since it is improbable that it will be forthcoming, the dates have been included.

Unless otherwise stated, organic material (wood, peat, charcoal, etc.) was pretreated in the usual manner, with dilute acid, alkali, and acid, respectively. The outer layers of shell and other carbonate samples were etched off with dilute acid and the inner carbonate dated. Results are expressed in terms of the conventional C^{14} scale as defined in the Editorial Statement of RADIOCARBON (w.r.t. NBS oxalic acid standard; $t_{1/2} = 5568$ years).

C^{13}/C^{12} ratios of most samples were measured under the supervision of W. G. Mook. Where δC^{13} values are given for organic material (all relative to the PDB standard), results are corrected for deviations from the "normal" value of $\delta C^{13} = -25.0‰$. In the case of shell and limestone, no such corrections are applied since experience shows that this is unnecessary.

Due to secular variations in the initial radiocarbon concentration during the last few hundred years (de Vries, 1958), conventional radiocarbon dates can be in error by as much as 160 years. Based on some 40 tree-ring samples from A.D. 1400 onwards (Lerman, Mook, and Vogel, 1970) a calibration curve for the S hemisphere has been constructed by which the most probable historic date for radiocarbon measurements in this time range can be deduced (Fig. 1). This curve has been used for interpreting the Iron age dates for S Africa given in Section II C.

Thanks are due to all who have assisted in the measurements, especially H. J. Streurman and G. H. Pijpen (C^{14}), and C. Sijbolts (C^{13}) who have performed the analyses during the past few years. Since January 1969, W. G. Mook has assumed responsibility for the laboratory (GrN-5680 onward). A few results measured since then are also included in this list.

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SAMPLE DESCRIPTIONS

I. GEOLOGY AND PALYNOLOGY

A. North and East Africa

Morocco series

Samples coll. by G. Choubert, Rabat, from various sites near Moroccan coast to date emerged beaches. The three youngest marine phases in the region are, with increasing age: Rharbian (sea level slightly higher than present), +2 m Flandrian beach, and Soltanian, during which a red soil was widely deposited. Unfortunately, it was not possible to obtain data on provenance and significance of samples from submitter or collector. Subm. by G. C. Maarleveld, Kerkweg 56, Ede, Netherlands.

280 ± 60
GrN-2198. Dar el Assairia **A.D. 1670**

Charcoal, 2.5 m below gray deposit in black soil formed during the Rharbian at Dar el Assairia (34° 30′ N Lat, 6° W Long) on Beth R., Rharb. *Comment*: pretreated with acid.

1900 ± 30
GrN-5571. Sidi Kacem 2 **A.D. 50**
$\delta C^{13} = -8.0‰$

Shells at 1.5 m depth at M'Saada near Sidi Kacem (34° 15′ N Lat, 5° 49′ W Long) deposited during Rharbian phase.

1950 ± 30
GrN-5572. Sidi Kacem 1 **A.D. 1**
$\delta C^{13} = -7.0‰$

Shells from 2 m depth at Dar Hamancha on Ouerrha R. near Sidi Kacem deposited during Rharbian phase.

5030 ± 35
GrN-5188. Canal du Rharb **3080 B.C.**
$\delta C^{13} = -3.4‰$

Shells from ca. 4 m depth on Rharb canal near Lalla Zorha hills (35° N Lat, 6° W Long) supposed to date Rharbian.

1300 ± 60
GrN-3149. Temara 2 **A.D. 650**

Shells from kitchen midden at Temara near Rabat (34° 02′ N Lat, 6° 51′ W Long) thought to date Rharbian.

5720 ± 50
GrN-2805. Temara 1 **3770 B.C.**

Shells from +2 m on Flandrian terrace at Temara. *Comment*: should provide good approx. date for Flandrian emerged beach.

5330 ± 75
GrN-3153. Ras el Ma **3380 B.C.**

Shells from ca. 2 m depth at Ras el Ma near Fès (34° 05′ N Lat, 5° 00′ W Long) dating from Flandrian phase.

28,300 ± 500
GrN-3156. Côte de Miramar **26,350 B.C.**

Shell in red soil formed between high sea level phases of Flandrian and Tyrrhenian III (Ouljian) from Miramar near Rabat (34° 02′ N Lat, 06° 51′ W Long), intended to date soil formation during Soltanian phase.

32,000 ± 600
GrN-3165. Ain Maarouf **30,050 B.C.**

Shells from 0.3 m depth in fossil soil of Soltanian age at Ain Maarouf near el Hajeb (33° 40′ N Lat, 05° 20′ W Long).

11,360 ± 75
GrN-5570. Oued Charef **9410 B.C.**
$\delta C^{13} = -5.9‰$

Shells from shell bed on road Berguent-Mekame (34° 03′ N Lat, 02° 02′ W Long) thought to be of Rharbian or Soltanian age.

General Comment: 1st 5 dates suggest Rharbian high water (or wet?) phase to date between Roman and Middle ages. Next 2 samples date +2 m Flandrian high sea level to 4th millennium B.C., while last 3 samples suggest red soil perhaps of Denekamp interstadial age. All shell samples treated with dil. acid, shell carbonate dated.

720 ± 75
GrN-5875. Chiccio, Ethiopia, No. 4012 **A.D. 1230**
$\delta C^{13} = -24.9‰$

Small peat sample from 100 to 105 cm depth in boring in Chiccio Valley (7° 44′ N Lat, 36° 26′ E Long) Kaffa Prov., Ethiopia. Coll. and subm. 1967 by E. M. van Zinderen Bakker, Univ. of Orange Free State, Bloemfontein.

Comment: date for bottom of 9 m core is I-2619: $33,500 {}^{+4000}_{-3100}$ B.P.

825 ± 90
GrN-5876. Kilotes, Ethiopia, No. 3824-6, 3880 **A.D. 1125**
$\delta C^{13} = -15.2‰$

Small sample of lake sediment from boring at 180 to 200 cm depth in Lake Kilotes (8° 48′ N Lat, 39° 05′ E Long) Shoa Prov., Ethiopia. Coll. and subm. 1967 by E. M. van Zinderen Bakker. *Comment*: core extends to 1450 cm.

Cherangani Hills series, Kenya

Kaisungor swamp at ca. 2900 m alt in Cherangani Hills in NW Kenya (1° N Lat, 35° 28′ E Long) is filled with sediment containing organic matter and pollen. In 1960 Core A was taken by E. M. van Zinderen Bakker in center of swamp which lies at upper end of a valley within montane forest (van Zinderen Bakker, 1962, 1964). Pollen diagram showed core to cover Late and Post-Glacial times. In 1961, Core B was taken to obtain more and possibly older material (Coetzee and

Vogel, 1967; Coetzee, 1967). Coll. and subm. 1961 by E. M. van Zinderen Bakker.

GrN-3048. Kaisungor A, No. 1686 **12,690 ± 100**
10,740 B.C.

GrN-2423. Kaisungor A, acid only **11,810 ± 140**
9860 B.C.

Organic sediment from 285 to 300 cm depth in Core A in Kaisungor swamp. Pollen diagram shows high percentages of grass and *Alchemilla* (ericaceous belt) representing cold period which is followed by warmer climate at 2.75 to 2.50 m depth equated with Allerød Interstadial in Europe. *Comment*: GrN-3048 fully treated with acid and alkali; GrN-2423, pretreated with acid only, gives too young date. GrN-3048 shows that climatic changes during Late and Post-Glacial were contemporaneous with those in Europe.

GrN-4061. Kaisungor B, 115, No. 2259 **765 ± 135**
A.D. 1185

Plant remains from 112 to 117 cm depth in Core B.

GrN-4071. Kaisungor B, 230, No. 2261 **1520 ± 135**
A.D. 430

Plant remains from 228 to 234 cm depth in Core B.

GrN-4063. Kaisungor B, 250, No. 2262 **1900 ± 70**
A.D. 50

Plant remains from 247 to 253 cm depth in Core B.

GrN-4072. Kaisungor B, 272, No. 2263 **2150 ± 220**
200 B.C.

Plant remains from 270 to 275 cm depth in Core B.

GrN-4062. Kaisungor B, 370, No. 2264 **17,000 ± 300**
15,050 B.C.

Plant remains from 363 to 377 cm depth in Core B.

GrN-4089. Kaisungor B, 462, No. 2265 **27,750 ± 600**
25,800 B.C.

Plant remains from 456 to 468 cm depth in Core B.

General Comment: all samples except GrN-2423 pretreated with acid and alkali. Core B was expected to be similar to Core A, but dates show that it must have struck a gully filled with recent sediment down to at least 275 cm. As is indicated by alpine grassland pollen spectra, material of glacial age is preserved between 328 and 470 cm. At bottom of diagram, spectra show site was in lowest part of ericaceous belt, indicating a climatic amelioration at or before 27,750 yr B.P. Cf. Mt. Kenya series below.

Mount Kenya series, Kenya

Bottom deposits from 2 lakes on Mt. Kenya, Kenya, Lake Rutundu (0° 03′ N Lat, 37° 28′ E Long) at 3100 m alt and Sacred Lake (0° 03′

N Lat, 37° 32′ E Long) at 2440 m alt, both within the montane forest belt (tree line 3350 m). Borings made to study climatic change by means of pollen analysis (Coetzee, 1967). Coll. and subm. by J. A. Coetzee and E. M. van Zinderen Bakker.

GrN-3511. Rutundu 1, No. 1754 **6135 ± 85** **4185 B.C.**

Lake deposit at 410 to 440 cm below bottom in Lake Rutundu. Subm. 1961. *Comment*: pretreated with acid and alkali.

GrN-3526. Rutundu 2, No. 1747 **7330 ± 90** **5880 B.C.**

Lake deposit at 460 to 490 cm below bottom from same core as Rutundu 1. *Comment*: pretreated with acid and alkali. Pollen spectrum at this depth shows favorable climate.

GrN-3615. Sacred Lake 1, No. 2268 **12,960 ± 120** **11,010 B.C.**

Brown lake sediment at 207 to 225 cm below bottom from Core 1 in Sacred Lake. Subm. 1962. *Comment*: pretreated with acid and alkali. Pollen not analyzed.

GrN-3614. Sacred Lake 2, No. 2270 **15,400 ± 180** **13,450 B.C.**

Lake mud at 660 to 670 cm below bottom from Core 2 in Sacred Lake. Subm. 1962. *Comment*: pretreated with acid and alkali. Pollen diagram of this core by Coetzee (1964) shows site, which is at present surrounded by humid montane forest, to have lain in ericaceous belt at this time.

GrN-4195. Sacred Lake 3, No. 2647 **3285 ± 60** **1335 B.C.**

Lake mud at 320 to 330 cm below bottom from Core 3 in Sacred Lake. Coll. and subm. 1963. *Comment*: pretreated with acid and cold alkali.

GrN-4193. Sacred Lake 4, No. 2645 **10,560 ± 65** **8610 B.C.**

Lake mud at 530 to 540 cm below bottom from Core 3. *Comment*: pretreated with acid and cold alkali.

GrN-4194. Sacred Lake 5, No. 2646 **33,350 ± 1000** **31,400 B.C.**

Lake mud at 1185 to 1195 cm below bottom from Core 3. *Comment*: pretreated with acid and cold alkali.

General Comment: between samples Sacred Lake 3 and 5, age increases linearly with depth. Pollen diagram by Miss Coetzee shows site in ericaceous belt at 1190 cm, with climatic improvement between 1150 and 1020 cm or 31,600 B.P. and ca. 27,000 B.P. by interpolation (Coetzee and Vogel, 1967), which corresponds in age with Denekamp (Paudorf) Interstadial in the Netherlands (van der Hammen *et al.*, 1967; Vogel and Zagwijn, 1967), and with evidence from Cherangani Hills series, above.

Pollen spectrum of Core 2 also shows contemporaneity of climatic variations with Europe in Late and Post-Glacial times (Coetzee, 1964).

Naivasha series, Kenya

Bottom deposits from Lake Naivasha, Rift Valley, Kenya (0° 45′ S Lat, 36° 22′ E Long), containing pollen. Coll. and subm. 1961 by E. M. van Zinderen Bakker.

2730 ± 85
GrN-3551. Naivasha 1, No. 1457 **780 B.C.**

Clay from 545 to 560 cm below bottom of crater lake on E side of Lake Naivasha. *Comment*: pretreated with acid only. Gives date of last drying of lake which thus occurred on Sub-boreal-Sub-atlantic border.

680 ± 55
GrN-3517. Naivasha 2, No. 1600 **A.D. 1270**

Clay and organic matter from 130 to 145 cm below bottom in main lake. *Comment*: pretreated with acid and alkali. Much younger than expected.

General Comment: pollen analysis discontinued as J. L. Richardson studied 30 m core from same site.

910 ± 45
GrN-3515. Lake Narasha, Kenya, No. 1729 **A.D. 1040**

Lake deposit from 300 cm below bottom in Lake Narasha (0° 05′ N Lat, 35° 33′ E Long) 2700 m alt, near upper limit of montane forest, E of Timboroa, Kenya. Coll. and subm. 1961 by E. M. van Zinderen Bakker. *Comment*: pretreated with acid and alkali. Indicates rather rapid deposition. Pollen diagram shows no appreciable difference from present-day surrounding vegetation.

380 ± 60
GrN-3510. Yatta Camp, Kenya, No. 1820 **A.D. 1570**

Subfossil stem or root (*Hydnora* rhizomes) from pit, 60 to 74 cm below surface overlain by black clay and fine sandy loam, 1.8 km S of B2 Yatta Camp, Kitui Yatta area (1° 09′ N Lat, 37° 43′ E Long), at 1170 m alt. Coll. by C. G. Trapnell and subm. 1961 by Trapnell and R. M. Scott, E African Agri. and Forestry Org. and E. M. van Zinderen Bakker. *Comment*: pretreated with acid and alkali. Intended to date clay deposit below present soil.

Kilimanjaro series, Tanzania

Deposits in a crater lake on Kilimanjaro (3° 00′ S Lat, 27° 23′ E Long), Tanzania. Cored for pollen analysis 1963 (Coetzee, 1967) and subm. 1964 by E. M. van Zinderen Bakker.

1530 ± 50
GrN-4370. Kilimanjaro 1, No. 2618 **A.D. 420**
$\delta C^{13} = -23.9‰$

Lake mud and plant remains at 145 to 160 cm depth. *Comment*: pretreated with acid.

GrN-4369. Kilimanjaro 2, No. 2615 **4620 ± 50**
2670 B.C.
$\delta C^{13} = -22.0‰$

Lake mud at 235 to 250 cm depth. *Comment*: pretreated with acid. Pumice at 230 to 242 cm shows nearby eruption at this date.

General Comment (J.A.C.): pollen spectrum at 250 cm level indicates warm period comparable with Sub-boreal climatic optimum. Spectrum at 180 cm suggests cooler conditions.

B. Southern Africa

Oranjemund series, South West Africa

Shells from midway down in 3 m deep marine gravel, filling gully and constituting lowest (+2 m) emerged terrace (A) ca. 56 km N of Oranjemund Township (28° 12′ S Lat, 15° 58′ E Long), SW Africa, 70 m from sea. Terrace now covered by ca. 1.5 m dune sand. Coll. and subm. 1965 by N. J. Guest, Consolidated Diamond Mines of SW Africa Ltd., P.O. Box 35, Oranjemund.

GrN-4571. Oranjemund ORU AC1 **38,100 ± 500**
36,150 B.C.
$\delta C^{13} = +0.15‰$

Shell fragments and sand.

GrN-4572. Oranjemund ORU AC2 **35,000 ± 630**
33,050 B.C.
$\delta C^{13} = +1.2‰$

Large mussel shells.

General Comment: samples pretreated with dilute acid to remove outer carbonate and inner carbonate analyzed. Gravels of Terrace A apparently accumulated before Holocene.

Meob series, S.W. Africa

Shells from SW African coast near Meob (24° 30′ S Lat, 14° 35′ E Long) coll. and subm. 1966 by B. L. Oostdam, Millersville State College, Millersville, Maryland, U.S.A.

GrN-4858. Meob 1 **7650 ± 70**
5700 B.C.
$\delta C^{13} = +1.5‰$

Ostrea shell from thin bottom sediment at ca. 23 m water depth offshore from Meob. *Comment*: outer layers etched off with dilute acid and inner carbonate dated. Age indicates little or no sedimentation at site at present. *Ostrea* oysters live in warmer waters today.

GrN-4857. Meob 2 **1610 ± 50**
A.D. 340
$\delta C^{13} = +0.9‰$

Donax shells from thin beds occupying surface between dunes at 30 to 60 m alt on coast ca. 5 km S of Meob. Beds are not in contact with present beach. *Comment*: outer layers etched off with dilute acid and inner carbonate dated. Young age shows that shell beds do not belong to fossil emerged beach, and provenance is unclear. Demonstrates caution necessary in interpreting such shell beds as old beaches.

St. Lucia Lake series, Natal

Borings in St. Lucia Lake (28° 0′ S Lat, 32° 25′ E Long) on Natal coast for sedimentologic and palynologic studies. Core I, 400 m N of Hluhluwe R. mouth, under 1 m water, consists of 7 m gray clay; Core II at Hell's Gate 200 m S of N shore, and under 1.1 m water, consists of 70 cm dark-brown clay followed by gray clay to 8 m. Coll. and subm. 1965 by E. M. van Zinderen Bakker.

GrN-4533. St. Lucia I.1, No. 2802 **2380 ± 80**
430 B.C.
$\delta C^{13} = -14.8‰$

Lake clay at 290 to 300 cm below bottom in Core I. *Comment*: pretreated with acid and cold alkali.

GrN-4535. St. Lucia I.2, No. 2804 **3960 ± 60**
2010 B.C.
$\delta C^{13} = -17.0‰$

Lake clay at 690 to 700 cm below bottom in Core I. *Comment*: pretreated with acid and cold alkali.

GrN-4536. St. Lucia II.1, No. 2866 **1820 ± 85**
A.D. 130

Lake clay at 180 to 190 cm below bottom in Core II. *Comment*: pretreated with acid and cold alkali.

GrN-4538. St. Lucia II.2, No. 2868 **2920 ± 90**
970 B.C.

Lake clay at 780 to 790 cm below bottom in Core II. *Comment*: pretreated with acid and cold alkali.

General Comment (E.M.v.Z.B.): dates give good assessment of sedimentation rate and were thus of value for planning hydrology of area.

GrN-4250. Umfolozi, Natal **4600 ± 60**
2650 B.C.
$\delta C^{13} = -27.8‰$

Piece of wooden log recovered at founding depth of a pier of new bridge over Umfolozi R. (28° 25′ S Lat, 32° 10′ E Long), Natal. Subm. 1964 by Dept. of Transport, Rep. of South Africa. *Comment*: date indicated that river-bed sediment is not recent and probably stable enough for bridge foundation.

Mochlaka series, Lesotho

Boring in peat deposit at Mochlaka-Watuka (29° 20′ S Lat, 27° 15′ E Long) alt: 1700 m, in Lesotho for pollen analysis. Coll. and subm. 1966 by E. M. van Zinderen Bakker.

GrN-4891. Mochlaka 1, No. 3307 — **2920 ± 40**, **970 B.C.**, $\delta C^{13} = -24.1‰$

Peat from 150 cm depth in core. *Comment*: pretreated with acid and cold alkali.

GrN-4890. Mochlaka 2, No. 3306 — **4710 ± 70**, **2760 B.C.**, $\delta C^{13} = -22.0‰$

Peat from 385 to 400 cm depth in core. *Comment*: pretreated with acid and cold alkali.

General Comment: pollen content too low for analysis due to burning of peat on several occasions.

Aliwal North series, Cape Province

Boring in peat and clay formed round mineral spring at Aliwal North (30° 42′ S Lat, 26° 42′ E Long), Cape Province. Pollen diagram covers period between samples and shows several alternations of pure grassveld (Coetzee, 1967). Coll. by J. A. Coetzee and subm. 1962 by Coetzee and E. M. van Zinderen Bakker.

GrN-4012. Aliwal N 1, No. 1931a — **9660 ± 150**, **7710 B.C.**

Peat at 500 to 510 cm depth. Pollen diagram shows warm and dry Karroid vegetation.

GrN-4011. Aliwal N 2, No. 2306 — **12,600 ± 110**, **10,650 B.C.**

Peaty clay at 920 to 940 cm depth. Pollen diagram indicates colder and humid climate with pure grassveld.

General Comment: alterations apparently correlate with Late-Glacial Interstadials in Europe.

GrN-5444. Welgevonden, Cape Province — **49,900 +4100 −2700**, **47,950 B.C.**, $C^{14} = (2.0 \pm 0.8)‰$, $\delta C^{13} = -6.8‰$

Calcrete from 31 m depth in Borehole WV 27 on farm Welgevonden in Postmasburg area (28° 20′ S Lat, 23° 05′ E Long). Coll. by P. J. Smit and subm. 1967 by J. C. Vogel. *Comment*: calcrete at base of Pleistocene "Kalahari Beds", overlain by clay and thick Kalahari sands. Outer layers etched off with dilute acid and inner carbonate analyzed. Date is minimum because contamination by ground water could make date too young.

GrN-5878. Langebaan, Cape Province — **6410 ± 45**, **4460 B.C.**, $\delta C^{13} = 0.0‰$

Oyster dredged from surface of submerged shell bank, S end of Langebaan Lagoon (33° 11′ S Lat, 18° 06′ E Long), 85 km N of Cape

Town. Oysters do not live in lagoon today because Benguela current is too cold. Subm. 1964 by R. R. Inskeep. *Comment*: result suggests warmer water at this date.

Rietvlei series, Cape Province

In recent sediments at Rietvlei (33° 50′ S Lat, 18° 30′ E Long) near Cape Town. H. Schalke made boring of ca. 20 m depth for palynologic study. Samples coll. 1967 and subm. by E. M. van Zinderen Bakker.

Grn-5550. Rietvlei 3 **41,500 +2100 −1800**
39,500 B.C.
$\delta C^{13} = -27.1‰$

Root layer at 4.73 m depth. *Comment*: sample dates to lower Pleniglacial period of Europe. Pretreated with acid only.

GrN-5551. Rietvlei 5 **>43,000**
$\delta C^{13} = -25.5‰$

3.5 g charcoal from 7.01 m depth. *Comment*: pretreated with acid only.

General Comment: pollen analysis done by H. Schalke but no comment available. Since correlation with former sea levels is possible, study of vegetation is most important.

Hangklip series, Cape Province

Between Rooi Els and Cape Hangklip (34° 20′ S Lat, 18° 50′ E Long) W Cape Prov., deep peat deposit occurs on elevated vlei. Cored for pollen analysis by R. R. Inskeep and A. Hall and samples subm. 1964 by Inskeep, Dept. of Archaeol., Univ. of Cape Town.

GrN-4585. Hangklip 1 **360 ± 30**
A.D. 1590
$\delta C^{13} = -28.7‰$

Peat at 45 cm depth. *Comment*: pretreated with acid and alkali.

GrN-4649. Hangklip 2 **2560 ± 35**
610 B.C.
$\delta C^{13} = -28.3‰$

Peat at 75 cm depth. *Comment*: pretreated with acid and alkali.

GrN-4473. Hangklip 3 **6080 ± 50**
4130 B.C.
$\delta C^{13} = -27.5‰$

Peat at 230 cm depth. *Comment*: pretreated with acid and alkali.

GrN-4586. Hangklip 4 **11,140 ± 65**
9190 B.C.
$\delta C^{13} = -28.9‰$

Peat from 360 cm depth. *Comment*: pretreated with acid and alkali.

General Comment: pollen analysis started by Hall in 1964 but not continued. Unfortunate that this continuous record of Holocene flora in W Cape is not being studied.

C. Atlantic and Indian Oceans

Hormuz series, Persian Gulf

Sediment core from Strait of Hormuz (ca. 26° 30′ N Lat, 56° 0′ E Long), Persian Gulf, containing calcium carbonate and organic material (Welte and Eberhardt, 1968). Samples subm. 1965 by D. H. Welte, Univ. of Würzburg, Germany.

GrN-4861. Hormuz 10 cm organic **1940 ± 200**
$\delta C^{13} = -19.5‰$

Organic fraction of core at 10 cm depth extracted with alkali after removal of carbonate with dilute acid.

GrN-4864. Hormuz 10 cm carbonate **7460 ± 145**
$\delta C^{13} = +0.4‰$

Carbonate fraction of above sample.

GrN-4862. Hormuz 150 cm organic **1910 ± 50**
$\delta C^{13} = -19.3‰$

Organic fraction of core at 150 to 160 cm depth, extracted with alkali after removal of carbonate.

GrN-4865. Hormuz 150 cm carbonate **7420 ± 65**
$\delta C^{13} = +0.4‰$

Carbonate fraction of above sample.

GrN-4863. Hormuz 350 cm organic **8760 ± 100**
$\delta C^{13} = -20.4‰$

Organic fraction of core at 350 to 360 cm depth, extracted with alkali after removal of carbonate.

GrN-4866. Hormuz 350 cm carbonate **12,350 ± 145**
$\delta C^{13} = +0.7‰$

Carbonate fraction of above sample.

General Comment: older dates of carbonate fractions imply that calcium carbonate was transported prior to final sedimentation. Organic material, presumably derived from plankton, should give date of sedimentation proper. Predominance of even n-paraffins in range C_{13} to C_{21} observed in this core.

Tananarive series, Madagascar

Two peat cores from moors formed by lava flow in Itasy volcano area, 75 km W of Tananarive (18° 52′ S Lat, 47° 30′ E Long) for pollen analysis (Straka, 1960; de Waard and Straka, 1961). Coll. and subm. 1958 by H. Straka, Botan. Inst., Univ. Kiel, Germany.

GrN-2197. Marais d'Ifanja **4540 ± 80** **2590 B.C.**

Peat at 780 to 800 cm depth in 810 cm core (B 25) in round depression formed in Marais d'Ifanja at 1060 m alt W of Tananarive, S of Sanganore Sud. *Comment*: pretreated with acid only.

GrN-2804. Lake Itasy **8505 ± 90** **6555 B.C.**

Peat at 900 to 930 cm depth in 1050 cm core (B 127) in small bay S of Lake Itasy, E of Soavinandriana at 1230 m alt. *Comment*: pretreated with acid only.

General Comment: pollen analysis still in progress. Dates show 15 cm and 10 cm peat growth, respectively, per century.

GrN-5192. Ampoza, Madagascar, No. M13932 **2365 ± 35** **715 B.C.**
$\delta C^{13} = -21.3‰$

Humerus of extinct giant lemur (*Palaeopropithecus maximus*) from Ampoza (22° 20′ S Lat, 44° 45′ E Long) near Ankazoabo Sud, SW Madagascar. Coll. 1929 by E. I. White and subm. by T. Molleson, British Mus. (Nat. Hist.), London for A. C. Walker, Uganda. *Comment*: bone collagen dated. Maximum date for extinction, see also Mahé (1965).

Vema Seamount series, Atlantic Ocean

Calcareous concretions ca. 6 cm diam., with spherical layering; some with pebble nuclei occurring on surface of Emerson R. Plateau, a wave-cut terrace at −73 m on Vema Seamount (31° 37′ S Lat, 08° 18′ E Long), 900 km NW of Cape Town (Simpson and Haydorn, 1965). Coll. 1964 and subm. 1965 by E. S. W. Simpson, Dept. Geol., Univ. of Cape Town.

GrN-4792. Vema 1 inner **690 ± 50** **A.D. 1260**
$\delta C^{13} = -1.1‰$

Inner 27 g of Ball 1.

GrN-4789. Vema 1 outer **290 ± 40** **A.D. 1660**
$\delta C^{13} = -1.8‰$

Outer 27 g of Ball 1.

GrN-4732. Vema 4 inner **1000 ± 30** **A.D. 950**
$\delta C^{13} = -1.2‰$

Inner 30 g of Ball 4.

GrN-4733. Vema 4 outer **720 ± 45** **A.D. 1230**

Outer 57 g of Ball 4.

General Comment: all samples etched with dilute acid; the carbonate dated. Balls apparently no longer growing. Date of beginning and end of growth depends on whether weight or radius increases linearly with time; derived dates are:

Ball 1 (by radius): 900 to 250 B.P.:650 yr
(by weight): 750 to 200 B.P.:550 yr.
Ball 4 (by radius): 1200 to 650 B.P.:550 yr
(by weight): 1100 to 550 B.P.:550 yr.

Balls thus attain maximum size after ca. 600 yr and are probably younger than terrace.

Marion Island series

Boring in peat mire behind Marion House, close to shore, on Marion I. (46° 55′ S Lat, 37° 50′ E Long) for pollen analysis. Ca. 3 m peat lies on black lava flow at site. Coll. and subm. 1963 by E. M. van Zinderen Bakker.

GrN-4153. Marion 1, No. 2697 **2910 ± 60**
960 B.C.
$\delta C^{13} = -27.1‰$

Peat from 190 to 200 cm depth in boring. *Comment*: pretreated with acid and cold alkali.

GrN-4152. Marion 2, No. 2696 **4000 ± 65**
2050 B.C.
$\delta C^{13} = -26.3‰$

Peat from 280 to 295 cm depth in boring at same site. *Comment*: pretreated with acid and cold alkali. Gives minimum date for lava. Since no glacial or periglacial features have been found on lava, it must be Post-Glacial. Compare K-1063: 3180 ± 120 B.P. for bottom of mire at Junior's Kop.

General Comment: pollen diagram shows vegetation similar to today.

Priuce Edward Island series

Boring in peat deposit on lava on Prince Edward I. (46° 38′ S Lat, 37° 55′ E Long) for pollen analysis. Coll. 1966 by H. Schalke and subm. by E. M. van Zinderen Bakker. Pollen diagram prepared by H. Schalke.

GrN-4893. Prince Edward 1, No. 78-3593 **2530 ± 50**
580 B.C.
$\delta C^{13} = -26.3‰$

Peat at 190 to 200 cm depth in boring, just below upper volcanic ash layer and peak in lowland indicators in pollen diagram. *Comment*: acid pretreatment only.

GrN-4892. Prince Edward 2, No. 80-3595 **5830 ± 70**
3880 B.C.
$\delta C^{13} = -26.2‰$

Peat at 315 to 330 cm depth in boring, dating lowest of 3 volcanic ash layers. *Comment*: acid pretreatment only. Minimum age for lava flow which is apparently early Post-Glacial (compare Marion I. series above.)

General Comment (v.Z.B.): pollen diagram shows no change in vegetation.

II. ARCHAEOLOGIC SAMPLES

Southern Africa

A. Middle Stone Age

Redcliff series, Rhodesia

Sediment-filled cave exposed in NW face of limestone quarry of Rhodesian Iron and Steel Co. at Redcliff (19° 01′ S Lat, 29° 46′ E Long), 13 km S of Que Que, Rhodesia, was excavated 1964 by C. K. Brain and C. K. Cooke (Brain and Cooke, 1967). Large quantities of stone artifacts (Middle Stone age) and bone were recovered from more than 17 m of deposit. Samples subm. 1968 by C. K. Brain, Transvaal Mus., Pretoria.

GrN-5679. Redcliff 1 $\mathbf{41{,}800\ ^{+5000}_{-3000}}$
39,850 B.C.
$\delta C^{13} = -12.7‰$

GrN-5858. Redcliff 2 $\mathbf{40{,}870\ ^{+2300}_{-1800}}$
38,920 B.C.
$\delta C^{13} = -14.2‰$

Two samples of charred bone from Layer W in Sec. VI, 15 ft (455 cm) below datum line in Profile B, near top of Rhodesian Stillbay succession. *Comment*: both samples pretreated as for charred bone and alkali soluble fraction dated. Combining results give $41{,}000\ ^{+2000}_{-1500}$ B.P., in good agreement with Isotopes' dates I-3727: 35,500 ± 2700 B.P. for 14 ft level and I-3728: >39,900 B.P. for 16 ft level, but much older than expected.

GrN-5347. Otjiseva, South West Africa **4940 ± 70**
2990 B.C.
$\delta C^{13} = -2.1‰$

Calcrete incrusation on bone of Boskop-type skeleton found 1964 at 30 cm depth in alluvium on farm Otjiseva (22° 18′ S Lat, 16° 56′ E Long), 40 km N of Windhoek, South West Africa. Coll. and subm. 1967 by W. Sydow, P.O. Box 2475, Windhoek. *Comment*: as no collagen was left in bone, only carbonate could be dated. Result is minimum date for incrustation and skeleton is probably much older. Cranium closely resembles original Boskop skull. No correction for isotope fractionation.

Lion Cavern series, Swaziland

Lion Cavern on S end of steep scarp face of small hematite hill, called Lion Peak, at Ngwenya Iron Mine (26° 12′ S Lat, 31° 02′ E Long), 24 km NW of Mbabane, Swaziland, was excavated 1965 and 1966 by

P. Beaumont. Cavern, 9 m deep, was artificially formed by removal of specularite-rich hematite and floor covered with over 3.3 m deposit which yielded many artifacts belonging to middle stage of Middle Stone age, from 2.4 m to the artificial bedrock (Dart and Beaumont, 1969a). Assemblage contains points formed by convergent flaking and coarse dolerite mining tools. Samples coll. and subm. by P. Beaumont, Bernard Price Inst. for Palaeontol. Research, Univ. of Witwatersrand, Milner Park, Johannesburg.

GrN-5020. Lion Cavern 1 **28,130 ± 260**
26,180 B.C.
δC^{13} = –24.1‰

Charcoal nodules from ash layer at 244 to 290 cm on artificial bedrock, Sq. B.C. 7-11.

GrN-5313. Lion Cavern 2 **43,200 $^{+1350}_{-1200}$**
41,250 B.C.
δC^{13} = –24.8‰

Charcoal nodules from lower level of 90 cm Middle Stone age stratum, at 335 to 410 cm below datum and near bedrock, in Sq. A 8-11; closer to mouth of cavern than Sample 1.

General Comment: dates prove extensive mining for iron ore (red ocher) since 41,000 B.C. Two further dates from same cavern, but farther away from hill face, are Y-1827: 22,280 ± 400 B.P. and Y-1713: 9640 ± 80 B.P. (Radiocarbon, 1969, v. 11, p. 645) indicating that mining continued at this oldest mine in world for over 30,000 yr.

GrN-5314. Sibebe Shelter, Swaziland **22,850 ± 160**
20,900 B.C.

Charcoal from upper levels of 120 cm thick Middle Stone age stratum, underlying 60 cm. Later Stone age stratum, at Sibebe Shelter on crest of Sibebe Hill (26° 19′ S Lat, 31° 15′ E Long), 8 km NE of Mbabane, Swaziland (Cut No. B.P. 27.66). Assemblage includes well-flaked, bifaced points (spear and arrowheads) and represents transitional stage between Middle Stone age and 2nd Intermediate. Coll .and subm. 1967 by P. Beaumont. *Comment*: older than expected for such advanced techniques, as are all dates in this section.

Bushman Rock series, Transvaal

Bushman Rock Shelter (24° 35′ S Lat, 30° 38′ E Long), excavated 1965 near Echo Caves in Ohrigstad dist. yielded ample material for dating. Sequence down to 244 cm (8 ft) divided into 43 layers, containing undisturbed Middle Stone age artifacts from Layers 43 to 28, Later Stone age with derived Middle Stone age artifacts in decreasing quantity from Layers 27 to 7, and mixed Later Stone age and Iron age remains in uppermost layers (Louw *et al.*, 1969). Samples coll. 1965 by A. W. Louw and selected 1966 by Louw, Mason, and Vogel.

GrN-4855. Bushman Rock 41 **>47,500**

Charcoal from Layer 41 at 225 cm depth in Sq. 7B containing Middle Stone age artifacts.

GrN-5116. Bushman Rock 38 **>53,000**
$\delta C^{13} = -23.0‰$

Charcoal from Layer 38 at 200 cm depth in Sq. 7B containing Middle Stone age artifacts.

GrN-4816. Bushman Rock 28a **12,510 ± 105**
10,560 B.C.
$\delta C^{13} = -24.9‰$

Wood from top of gravel layer (Layer 28) at 142 cm depth in Sq. 7C, representing uppermost undisturbed Middle Stone age remains.

GrN-5873. Bushman Rock 28b **12,470 ± 145**
10,520 B.C.
$\delta C^{13} = -24.7‰$

Small wood sample from Layer 28 at 142 cm depth in Sq. 8B.

GrN-4815. Bushman Rock 27 **12,160 ± 95**
10,210 B.C.
$\delta C^{13} = -22.0‰$

Charred wood from Layer 27 (Bed Z2) at 137 cm depth in Sq. 7C. Bottom-most layer containing Later Stone age artifacts.

GrN-4814. Bushman Rock 21 **12,090 ± 95**
10,140 B.C.
$\delta C^{13} = -23.1‰$

Charcoal in soft brown sand, Layer 21, at 99 to 107 cm depth in Sq. 7C containing Later Stone age and derived Middle Stone age artifacts.

GrN-4813. Bushman Rock 12 **9940 ± 80**
7990 B.C.
$\delta C^{13} = -24.9‰$

Charred bones from Layer 12 at 61 to 69 cm depth in Sq. 7C containing Later Stone age and derived Middle Stone age artifacts. *Comment*: pretreated by boiling with HCl and extracting humic material with warm alkali solution.

GrN-4854. Bushman Rock 9 **9510 ± 55**
7560 B.C.
$\delta C^{13} = -23.0‰$

Charcoal from Layer 9 at 30 cm depth in Sq. 7C, containing Later Stone age artifacts.

GrN-5874. Bushman Rock 3 **9570 ± 55**
7620 B.C.
$\delta C^{13} = -24.4‰$

Charcoal from Layer 3 of cemented patch P2 at 15 cm depth in Sq. 7B, containing Later Stone age artifacts and some intrusive objects of Iron age occupation.

General Comment: Later Stone age assemblage from Layers 3 to 27, dated 9540 to 12,160 B.P., resemble Middle Smithfield culture as found at Uitkomst Cave, Bed 1 (Y-1324: 11,250 ± 200 B.P.). Middle Stone age industry has many bifacially trimmed flakes, including well-formed points and also handaxes, and can be assigned to middle stage of Middle Stone age. Results shift this period in Transvaal back to unexpectedly early date of >53,000 B.P. Since no variation in typology is evident between Layers 41/38 and 28, it was suspected that wood of GrN-4816 was intrusive from Later Stone occupation above. Thus second sample from Layer 28 (GrN-5873) was measured, with same result. It, nevertheless, seems more probable that this too was intrusive than that industry existed for over 40,000 yr without change. Since Louw's excavation, artifacts similar to Early Pietersburg assemblage at Cave of Hearths (C-926: 16,811 ± 960 B.P.) have been discovered *below* Layer 43, thus suggesting much earlier date for Early Pietersburg culture.

GrN-4208. Florisbad 1, Orange Free State, No. 2702 >48,900

Sandy clay with few per cent organic matter from bottom dark layer at about 5.60 m depth (Peat I) in 1952 excavation at Florisbad Spring (28° 46′ S Lat, 26° 05′ E Long), 48 km NW of Bloemfontein, Orange Free State. This layer contains chopper tool industry (Florisbad culture) and fossils of extinct animals (Meiring, 1956). Florisbad skull excavated by Dreyer in 1932 came from bottom of small eye below Dark Layer I, sand filling of which was sealed by green sand layer overlying it so that stratigraphic position is uncertain (Dreyer, 1938). Pollen spectrum suggests Karroo vegetation and thus drier climate than today (van Zinderen Bakker, 1955). Coll. and subm. 1963 by E. M. van Zinderen Bakker. *Comment*: 150 g pretreated with acid and cold alkali gave 4 g carbon for analysis. Cf. C-850: >41,000 B.P., L-271 B: >35,000 B.P., Y-103: >44,000 B.P. for same layer.

Montagu series, Cape Province

Two further samples dated from cave ca. 8 km E of Montagu (33° 50′ S Lat, 20° 10′ E Long), Cape Province (cf. Vogel and Waterbolk, 1967). Coll. 1964 by C. Keller and subm. by J. D. Clark, Dept. of Anthropol., Univ. of California, Berkeley.

GrN-5123. Montagu MSA 43

19,100 ± 110
17,150 B.C.
$\delta C^{13} = -24.7‰$

Charcoal and black soil from 175 to 180 cm depth in Sq. G20 between Surfaces 6 and 7, with Late Middle Stone age assemblage (Howieson's Poort industry?).

GrN-5124. Montagu MSA 44 >50,800

Charcoal from 178 cm depth in Sq. F35 just below Surface 7, with Late Middle Stone age assemblage.

General Comment: additional samples measured because MSA 46 (GrN-4728: 45,900 ± 2100 B.P.) gave unexpectedly high age for industry. GrN-5123 in accordance with expectation (cf. I-1844: 18,740 ± 320 B.P. for Howieson's Poort), but other dates suggest Middle Stone age started before 45,900 B.P. and probably before 50,800 B.P. unless MSA 44 derives from underlying Early Stone age levels. Compare other early Middle Stone age dates, above.

Robberg series, Cape Province

Re-excavation of Wagenaar's cave on Robberg peninsula (34° 06′ S Lat, 23° 23′ E Long), Plettenberg Bay, on S coast, by R. R. Inskeep has provided new evidence on cultural material accumulated since Middle Stone age times. Coll. by R. R. Inskeep and subm. 1968 by J. C. Vogel.

GrN-5889. Robberg, C 6 — **18,660 ± 110**
16,710 B.C.
$\delta C^{13} = +4.3‰$

Shell fragments from 180 cm depth in layer containing sparse Middle Stone age artifacts. *Comment*: outer layers removed with dil. acid and inner carbonate dated. Age similar to that for Howieson's Poort (I-1844: 18,740 ± 320 B.P.), but artifacts are nondescript. For accuracy of such shell dates, see Matjes R. series below.

GrN-5702. Robberg, C 8 — **2925 ± 35**
975 B.C.
$\delta C^{13} = -24.2‰$

Charcoal from 60 cm depth in cave mouth shell midden in Later Stone age (Wilton) context with macrolithic quarzite and ground slate industry. *Comment*: due to smallness of sample pretreated with acid only. Because age is not high, contamination cannot be serious.

GrN-5715. Robberg, C 10 — **2540 ± 50**
590 B.C.

Charcoal fragments from 50 cm depth in Later Stone age layer with microlithic points. *Comment*: due to smallness of sample pretreated with acid only. Contamination, however, cannot be serious.

GrN-5703. Robberg, C 11 — **1930 ± 60**
A.D. 20
$\delta C^{13} = -24.2‰$

Charcoal from 40 cm depth, just below 1st pottery in Later Stone age level. *Comment*: due to smallness of sample pretreated with acid only. Provides date for introduction of pottery into area.

GrN-5803. Melkbos C12, Cape Province — $\mathbf{43{,}200^{+2000}_{-1500}}$
41,250 B.C.
$\delta C^{13} = -0.7‰$

Shells from consolidated beach rock assoc. with 4 m emerged beach containing late Middle Stone age artifacts 6 km N of Melkbosstrand (33°

45′ S Lat, 18° 25′ E Long), Table Bay. Coll. and subm. 1967 by R. R. Inskeep. *Comment*: since low C^{14} content (0.46 ± 0.1%) can be due to contamination, date only minimum. In accordance with other dates in sec., Middle Stone age is older than 40,000 B.P.

47,100 $^{+2800}_{-2100}$

GrN-5804. Hout Bay C13, Cape Province **45,150 B.C.**
$\delta C^{13} = -0.2‰$

Whole *mytilus* shells assoc. with apparently post Middle Stone age artifacts in sand overlying ca. 6 m emerged beach and covered by ca. 4 m sand dune just W of harbour at Hout Bay (34° 03′ S Lat, 18° 22′ E Long), Cape Peninsula. Coll. and subm. by R. R. Inskeep. *Comment*: since low C^{14} content (0.29 ± 0.09%) can be due to contamination, date only minimum. Again proving high antiquity of Middle Stone age, see above.

B. Later Stone Age

Rose Cottage series, Orange Free State

Rose Cottage cave, near Ladybrand (29° 15′ S Lat, 27° 30′ E Long), Orange Free State (Malan, 1952) re-excavated 1962 by P. Beaumont, contains 1.4 m Wilton and Pre-Wilton (Later Stone age), 2.1 m sterile and 2.3 m Magosian (terminal Middle Stone age) deposit. Samples coll. by P. Beaumont and subm. 1967 by R. J. Mason, Univ. of Witwatersrand, Milner Park, Johannesburg.

25,640 ± 220

GrN-5300. Rose Cottage 3 **23,690 B.C.**
$\delta C^{13} = -22.3‰$

Charcoal from 176 cm depth in Sq. Jf, 30 cm below Pre-Wilton, in sterile layer overlying Magosian.

6850 ± 45

GrN-5299. Rose Cottage 2 **4900 B.C.**
$\delta C^{13} = -23.3‰$

Charcoal from 36 to 46 cm depth, Sq. Ld, in Wilton Phase 2 layer.

1100 ± 30

GrN-5298. Rose Cottage **A.D. 850**
$\delta C^{13} = -24.0‰$

Charcoal from 20 to 25 cm depth, Sq. Le, in base of Wilton Phase 3 layer which also contained impressed pottery suggesting contemporaneous Iron Age groups.

General Comment: Sample 3 gives unexpectedly high date for Pre-Wilton and Magosian. South African Magosian must thus be much older than at Pomongwe, Rhodesia (SR-11: 15,800 ± 200 B.P., Robins and Swart, 1964) but this is in keeping with other high ages for Middle Stone age, above. Date for Magosian level at 3.8 m of >50,000 B.P. (SR-116) confirms this high dating. Results for Wilton culture as expected.

Matjes River series, Cape Province

Stratigraphic series of shell and charcoal samples from Matjes R. rock shelter (34° 01′ S Lat, 23° 25′ E Long) near Plettenberg Bay, Cape Province, coll. 1964 by R. R. Inskeep and H. and J. Deacon at intersection of 2 existing trenches excavated in 1950's by Louw *et al.* (Louw, 1960). Deposit consists mainly of shell midden in which several Later Stone age horizons were identified. Subm. 1964 by R. R. Inskeep.

GrN-5061. Matjes R. PT 10, shell — **9780 ± 60**, **7830 B.C.**, $\delta C^{13} = +0.23‰$

GrN-5871. Matjes R. PT 10, charcoal — **10,030 ± 55**, **8080 B.C.**, $\delta C^{13} = -25.5‰$

Shell and charcoal from lowest level.

GrN-5886. Matjes R. PT 13, shell — **9450 ± 55**, **7500 B.C.**, $\delta C^{13} = +0.42‰$

GrN-5872. Matjes R. PT 13, charcoal — **9580 ± 85**, **7630 B.C.**, $\delta C^{13} = -23.3‰$

Shell and charcoal from next lowest level.

GrN-5887. Matjes R. PT 17, shell — **7050 ± 45**, **5100 B.C.**, $\delta C^{13} = +0.88‰$

Shell from higher level.

GrN-5888. Matjes R. PT 21, shell — **3555 ± 35**, **1605 B.C.**, $\delta C^{13} = -0.20‰$

Shell from uppermost level.

General Comment: samples cannot be correlated directly with Louw's cultural levels; coll. to check validity of dates on shell from middens and for palaeotemperature work. PT 10 and PT 13 show shell to be 250 and 130 yr too young, respectively, corresponding to 1.3% and 0.7% recent contamination. Thus, although such shells may give slightly too young dates, they can be used with confidence when charcoal is lacking. Shelter was occupied from somewhat before 8100 B.C. to at least 1600 B.C.

GrN-5023. Castle Quarry, Swaziland — **2860 ± 35**, **910 B.C.**, $\delta C^{13} = -24.3‰$

Charcoal from base of deposit in ancient quarry for iron ore (red ocher) at 170 cm depth assoc. with assemblage representing middle phase of Later Stone age near Castle Peak, Ngwenya Iron Mine (26° 12′ S Lat, 31° 02′ E Long), 24 km NW of Mbabane, Swaziland. Coll. and subm. 1966 by P. Beaumont.

GrN-5021. Banda Cave, Swaziland **1650 ± 40**
A.D. 300
δC^{13} = –24.4‰

Scattered charcoal from ca. 38 cm depth in deposit in natural cave at Ngwenya Iron Mine (26° 12′ S Lat, 31° 02′ E Long), 24 km NW of Mbabane, Swaziland. Deposit contained assemblage attributed to early stage of Later Stone age overlain by Iron age remains. Coll. and subm. 1966 by P. Beaumont. *Comment*: much younger than Y-1714: 5890 ± 80 B.P. (Radiocarbon, 1969, v. 11, p. 645) for more localized lower level. Charcoal presumably mostly of Iron age date.

C. Iron Age

Castle Cavern series, Swaziland

Cavern formed by prehistoric mining of specularite-rich hematite (red ocher) near summit of Castle Peak, at S end of Ngwenya Range, Ngweny Iron Mine (26° 12′ S Lat, 31° 02′ E Long), 24 km NW of Mbabane, Swaziland, contained 140 cm Early Iron age deposit, including thick potsherds, some of which show necks with broad horizontal grooves just below rim, and stone mining tools (Dart and Beaumont, 1969b). Excavated 1965 and subm. by P. Beaumont.

GrN-5022. Castle Cavern 1 **1535 ± 30**
A.D. 415
δC^{13} = –24.2‰

Charcoal nodules from hearths at 90 to 120 cm depth in Strips A-B (BP 10.65).

Grn-5315. Castle Cavern 2 **1550 ± 30**
A.D. 400
δC^{13} = –24.7‰

Charcoal nodules from hearths at 60 to 90 cm depth in Strip B (BP 10.65).

General Comment: agrees well with Y-1712: 1550 ± 60 B.P. (120 to 130 cm) and Y-1995: 1430 ± 100 B.P. (30 to 60 cm) (Radiocarbon, 1969, v. 11, p. 644). Earliest dates for Iron age S of Limpopo R.

Eros series, South West Africa

Iron age deposit, 35 to 40 cm, in Eros Shelter, Klein Windhoek (22° 33′ S Lat, 17° 05′ E Long), South West Africa, excavated by H. R. MacCalman. Subm. 1967 by H. R. MacCalman, State Mus., Windhoek.

GrN-5296. Eros 1 **345 ± 30**
A.D. 1605
δC^{13} = –24.0‰

Charcoal (B1541/B2ii) from upper hearth 15 cm below surface.

GrN-5297. Eros 2 **1745 ± 35**
A.D. 205
δC^{13} = –24.2‰

Charcoal (B1541/B2iii) from hearth at 35 cm depth on bedrock.

General Comment: both samples pretreated with acid and alkali. First Iron age dates for South West Africa. From calibration curve (Fig. 1) historical date for Eros 1 can lie anywhere between A.D. 1475 and A.D. 1615.

GrN-5138. Rooiberg, Transvaal **435 ± 45**
A.D. 1515
δC^{13} = –25.6‰

Part of log found by early prospectors in Iron age mine shaft with wooden hafted adze at Rooiberg Tin Mines (24° 40′ S Lat, 27° 40′ E Long). Ca. 70 km W of Nylstroom, Transvaal (Mason, 1962). Coll. ca. 1905 and subm. 1967 by R. J. Mason. *Comment*: de Capelle expedition purchased tin bars on E coast in 1725, possibly from this area. Date is intermediate between those for Mapungubwe in N and Stone Wall culture in S. Historical date derived from calibration curve (Fig. 1) is A.D. 1445 ± 25.

Vergenoegd (Kurrichane) series, Transvaal

In Central and S Transvaal, from Zeerust in W to Lydenburg in E, thousands of stone-walled settlements belonging to Iron age people have been identified (Mason, 1968). This culture was apparently destroyed in 1820's by Moselikatse. Due to fluctuations of atmospheric radiocarbon concentration during the last 500 yr (de Vries, 1958), dating with C^{14} is sometimes not unique. By measuring a stratigraphic sequence, however, most probable historic date can be deduced by successive elimination of different possibilities for each radiocarbon date. This has been attempted at Vergenoegd (25° 40′ S Lat, 26° 10′ E Long), Zeerust Dist., Transvaal, and Olifantspoort (below). Site id. by Seddon (1966) as Kurrichane (or Kaditshwene) visited by Campbell in 1820.

Four samples from increasing depths in ash heap C40-50, leaning against stone wall, excavated 1966 and subm. 1967 by R. J. Mason, were selected for dating.

GrN-5307. Kurrichane 1 **138 ± 30**
A.D. 1812
δC^{13} = –25.0‰

Charcoal from 0 to 15 cm depth.

GrN-5338. Kurrichane 2 **216 ± 33**
A.D. 1734
δC^{13} = –24.3‰

Charcoal from 15 to 30 cm depth.

GrN-5339. Kurrichane 3 **137 ± 32**
A.D. 1813
δC^{13} = –23.9‰

Charcoal from 75 to 90 cm depth.

GrN-5137. Kurrichane 4 **203 ± 44**
A.D. 1747
δC^{13} = –23.35‰

Charcoal from 106 to 122 cm depth. Natural surface at 137 cm.

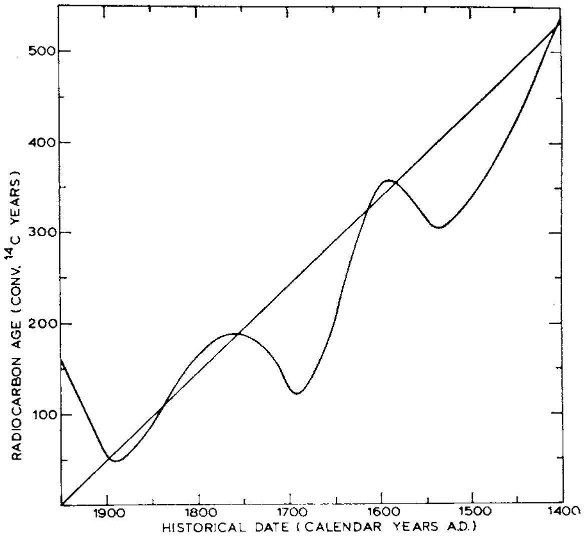

Fig. 1

General Comment: since true age must increase with increasing depth, most probable historic dates for each sample as selected from calibration curve (Fig. 1) are A.D. 1825 ± 25, A.D. 1770 ± 30, A.D. 1700 ± 30, and A.D. 1650 ± 20, respectively.

Olifantspoort series, Transvaal

Extensive stone-walled Iron age settlement on farm Olifantspoort (25° 47′ S Lat, 27° 15′ E Long), Rustenburg dist., Transvaal, produced pottery of Buispoort type (Mason, 1962). Trial trench in refuse heap against 2 m stone wall excavated by Mason and Vogel, 1967, in 15 cm layers to collect stratigraphic sequence of charcoal samples. Heavily abraded stone flakes found in Iron age context during excavation (Mason, 1969). Subm. by R. J. Mason.

105 ± 35
GrN-5304. Olifantspoort 1 **A.D. 1845**
$\delta C^{13} = -24.3‰$

Charcoal from 0 to 15 cm depth.

180 ± 30
GrN-5305. Olifantspoort 2 **A.D. 1770**
$\delta C^{13} = -24.9‰$

Charcoal from 50 to 60 cm depth.

105 ± 25
GrN-5306. Olifantspoort 3 **A.D. 1845**
$\delta C^{13} = -24.8‰$

Charcoal from bottom of ash heap at 90 cm depth.

General Comment: following same method of successive elimination of possible historic dates as for Vergenoegd series above, most probable date for accumulation of deposit is between A.D. 1695 ± 20 and A.D. 1845 ± 30. Of 11 dates for this culture (see also Vogel and Waterbolk, 1967, Kliprivierberg and Waterval) it appears that stone-walled settlements in this area were occupied from at least A.D. 1640 ± 20 to A.D. 1845 ± 30. Latter date in good agreement with historically documented inroad of Moselikatse into Transvaal in 1820's which marked destruction of existing tribal system in area.

III. GEOPHYSICAL SAMPLES

A. Atmospheric carbon dioxide

Groningen series, Netherlands

When nuclear weapon testing was resumed in Sept. 1961, atmospheric CO_2 samples were coll. on top of 30 m VandeGraaff tower of the Physics Lab., Univ. of Groningen in W suburb of city (53° 54′ N Lat, 6° 33′ E Long). Collection by exposing 1.5 L of 0.5 N NaOH in 900 cm² tray for ca. 3 days.

Sample no.	Date	δC^{14}(‰)
GrN-3091	Oct. 31–Nov. 3, 1961	192 ± 6
GrN-3087	Nov. 6–Nov. 9, 1961	138 ± 6
GrN-3129	Nov. 10–Nov. 13, 1961	157 ± 6
GrN-3143	Nov. 16–Nov. 19, 1961	199 ± 5
GrN-3145	Nov. 21–Nov. 24, 1961	120 ± 5
GrN-3123	Nov. 28–Dec. 1, 1961	186 ± 6
GrN-3144	Dec. 4–Dec. 7, 1961	184 ± 6
GrN-3135	Dec. 15–Dec. 22, 1961	135 ± 6
GrN-3146	Jan. 15–Jan. 18, 1962	201 ± 7
GrN-3607	Feb. 16–Feb. 19, 1962	219 ± 7
GrN-3209	Mar. 16–Mar. 19, 1962	239 ± 8
GrN-3207	Apr. 16–Apr. 19, 1962	260 ± 6

Comment: no C^{13} corrections applied, but by comparison with other stations, corrections are small. Apparently all samples coll. here in winter 1961/62 are contaminated by fossil CO_2.

Compare: GrN-3633, Vermunt 5, Dec. 8, 1961, $\delta C^{14} = 216 \pm 7$‰. Atmospheric CO_2 from Vermunt, Schruns (47° 04′ N Lat, 9° 55′ E Long), Voralberg, Austria, supplied by K. O. Münnich, Univ. of Heidelberg, Heidelberg, Germany. Collection, therefore, shifted to Smilde, see below.

Smilde series, Netherlands

Atmospheric CO_2 coll. on 80 m level of television tower at Hoogersmilde (52° 54′ N Lat, 6° 24′ E Long), Prov. of Drente, Netherlands, 15 km from nearest large town (Assen) and 500 m from main road. Contamination considered small, since tower is in relatively thinly populated area and wind frequently strong. Coll. under supervision of H. H. Welling, engineer-in-charge. Method as at Groningen (above). Normalized to $\delta C^{13} = -25$‰.

Sample no.	Date	δC^{13}(‰)	Δ(‰)
GrN-3249	May 5—May 8, 1962	(−26)*	291 ± 8
GrN-3251	July 6—July 9, 1962	(−26)	423 ± 6
GrN-4015	Aug. 6—Aug. 9, 1962	(−26)	423 ± 7
GrN-4019	Aug. 22—Aug. 25, 1962	(−26)	431 ± 6
GrN-4020	Sept. 17—Sept. 20, 1962	(−26)	431 ± 8
GrN-4021	Oct. 1—Oct. 4, 1962	(−26)	355 ± 6
GrN-4022	Oct. 15—Oct. 18, 1962	(−26)	395 ± 8
GrN-4046	Nov. 16—Nov. 19, 1962	−29	383 ± 9
GrN-4047	Dec. 14—Dec. 17, 1962	−24	389 ± 13
GrN-4079	Jan. 15—Jan. 18, 1963	−26	392 ± 10
GrN-4081	Feb. 15—Feb. 18, 1963	−31	409 ± 8
GrN-4082	Mar. 12—Mar. 15, 1963	(−26)	465 ± 8
GrN-4106	Mar. 27—Mar. 31, 1963	−27	488 ± 10
GrN-4107	Apr. 16—Apr. 19, 1963	−25	571 ± 10
GrN-4109	May 21—May 24, 1963	−25	646 ± 10
GrN-4128	July 17—July 21, 1963	−25	897 ± 9
GrN-4129	Aug. 1—Aug. 5, 1963	−25	927 ± 10
GrN-4130	Aug. 12—Aug. 15, 1963	−24	946 ± 9
GrN-4131	Aug. 19—Aug. 22, 1963	−24	1004 ± 7
GrN-4189	Oct. 4—Oct. 7, 1963	−24	952 ± 11
GrN-4190	Oct. 18—Oct. 23, 1963	−25	881 ± 7
GrN-4192	Nov. 8—Nov. 11, 1963	−27	816 ± 11

Comment: data cover main rise in C^{14} to maximum in Aug. 1963 and correspond closely to other pub. values for N hemisphere.

Pretoria series, South Africa

Atmospheric CO_2 coll. at Radioactivity Div., Nat. Physics Research Lab. (25° 50′ S Lat, 28° 20′ E Long), some 15 km E of Pretoria, South Africa, under supervision of W. R. McMurray and C. Verwey. For shipment, samples were precipitated as $BaCO_3$. Site should be reasonably free from contamination by fossil CO_2 although smog from city occasionally can reach lab.

Sample no.	Date	δC^{13}(‰)	Δ(‰)
GrN-4138	Oct. 16—Oct. 19, 1962	−24.3	281 ± 9
GrN-4281	Oct. 29—Nov. 1, 1962	(−23)*	272 ± 6
GrN-4137	Nov. 12—Nov. 15, 1962	−22.6	276 ± 8
GrN-4136	Jan. 7—Jan. 10, 1963	−22.0	282 ± 8
GrN-4142	Apr. 1—Apr. 4, 1963	−25.1	308 ± 8
GrN-4135	Apr. 15—Apr. 18, 1963	−23.8	278 ± 8
GrN-4134	May 13—May 16, 1963	−21.1	308 ± 8
GrN-4283	June 1—June 10, 1963	−22.4	337 ± 6

* C^{13} values in brackets are estimated.

Sample no.	Date	δC^{13}(‰)	Δ(‰)
GrN-4284	July 22—July 25, 1963	−23.9	325 ± 7
GrN-4285	Oct. 14—Oct. 17, 1963	−22.4	444 ± 7
GrN-4286	Mar. 2—Mar. 5, 1964	−22.2	537 ± 6
GrN-4282	Apr. 14—Apr. 17, 1964	−22.3	551 ± 5
GrN-4683	May 5—May 8, 1964	−22.1	521 ± 4
GrN-4684	June 2—June 15, 1964	−21.8	546 ± 3
GrN-4352	July 20—July 23, 1964	−22.7	549 ± 7
GrN-4353	Aug. 3—Aug. 6, 1964	−20.9	542 ± 6
GrN-4354	Aug. 25—Aug. 28, 1964	−23.3	594 ± 4
GrN-4355	Sept. 8—Sept. 14, 1964	−22.3	600 ± 4
GrN-4382	Oct. 6—Oct. 9, 1964	−22.5	624 ± 6
GrN-4472	Oct. 26—Oct. 29, 1964	−23.1	655 ± 3
GrN-4578	Nov. 23—Nov. 26, 1964	−24.2	626 ± 3
GrN-4579	Feb. 22—Feb. 25, 1965	−23.1	645 ± 3
GrN-4687	Mar. 18—Mar. 21, 1965	−22.6	602 ± 4

General Comment: series covers main increase of radiocarbon in S Hemisphere. By Oct. 1964 level had become equal to that in N Hemisphere. Steeper increase during S spring suggests some N-S transport via stratosphere.

B. Surface ocean water

Atlantic Ocean series

Surface ocean water samples coll. during voyage 38 of S.A. Vaal from Southampton, U.K., to Cape Town, South Africa, 23 June—5 July, 1967, by J. C. Vogel with the generous help of Captain N. M. Lloyd, officers and crew. Inorganic carbon extracted from 60 L samples on board by method described by Vogel (1967).

Sample no.	Date	Lat, Long		δC^{13}(‰)	C^{14} (% modern)
GrN-5244	June 24, 1967	44° 50′ N,	8° 55′ W	+0.65	112.9 ± .9
GrN-5301	June 25, 1967	36° 00′ N,	12° 20′ W	+1.43	115.1 ± .6
GrN-5258	June 26, 1967	28° 40′ N,	15° 10′ W	+1.39	116.0 ± .8
GrN-5280	June 27, 1967	19° 40′ N,	18° 00′ W	+1.11	105.2 ± .7
GrN-5331	June 28, 1967	12° 19′ N,	17° 30′ W	+0.79	107.3 ± 1.1
GrN-5259	June 29, 1967	2° 52′ N,	11° 15′ W	+1.21	112.5 ± .7
GrN-5302	June 30, 1967	2° 00′ S,	7° 10′ W	+1.07	107.2 ± .6
GrN-5303	July 1, 1967	8° 45′ S,	1° 50′ W	+1.93	111.4 ± .5
GrN-5260	July 2, 1967	15° 45′ S,	3° 50′ E	+1.79	108.3 ± .6
GrN-5330	July 3, 1967	22° 10′ S,	9° 20′ E	+0.67	108.0 ± .7
GrN-5345	July 4, 1967	27° 40′ S,	14° 30′ E	+0.84	104.9 ± .6
GrN-5245	July 4, 1967	31° 00′ S,	16° 45′ E	+0.29	108.0 ± .7

General Comment: some samples (GrN-5280, 5331, 5345) show low values due to upwelling of deep water near W coast of Africa. Rest show smooth variation with lat. except for unexplained high value of GrN-5303. Remarkable fact is that North Atlantic samples correspond exactly with data of Münnich and Roether (1967) for 1965, suggesting that no further increase of atom bomb C^{14} in surface water took place in those years.

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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES X

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INTRODUCTION†

The laboratory routinely operates two proportional counters; one 2-L (Dyck and Fyles, 1962) and one 5-L (Dyck *et al.*, 1965). CO_2 is used as the counting gas. The 2-L counter is operated mainly at 2 atm. and the 5-L counter mainly at 1 atm. On occasion the 2-L counter is operated at 1 atm. and the 5-L counter at 4 atm. No changes have been made in the CO_2 preparation and purification techniques described in previous GSC dating lists (Lowdon *et al.*, 1969; Lowdon and Blake, 1970).

Age calculations are carried out monthly by a C.D.C. 3100 computer and are based on a C^{14} half-life of 5568 $\pm$ 30 yr and 0.95 of the activity of the NBS oxalic acid standard. Ages are quoted in years before 1950. Age errors include: counting errors of sample, background, and standard; error in the half-life of C^{14}; and an error term to account for the average variation of $\pm 1.5\%$ in the C^{14} concentration of the biosphere during the past 1100 yr. The error assigned to an age is always a minimum of ± 100 yr. Finite dates are based on the 2σ criterion (95.5% probability) and "infinite" dates on the 4σ criterion (99.9% probability). Unless otherwise stated in the sample descriptions, all ages are based on two 1-day counts. Only when testing the age of a sample (especially as a prelude to high pressure work) or if a sample is obviously of a far different age than expected, is a sample counted for less than two days.

Average background and standard counting rates over the past 12 months (October, 1968 to September, 1969) are listed in Tables 1 and 2, respectively. Once again, a slight seasonal variation in background and standard was noticed.

At an operating pressure of 2 atm., the 2-L monthly backgrounds are the average of 4 individual daily counts. During the 11-month period of operation at 2 atm., 1 count was omitted for statistical reasons and 7 different background preparations were used. Operating the 2-L counter at 1 atm. (April), the monthly average background is the average of 5 individual daily counts. No results had to be omitted, and 5 different preparations were used. The 5-L counter backgrounds are the average of 4 daily counts. None were omitted, and 10 different background preparations were used.

For both counters, the monthly standard counting rates consist of the average of 3 individual daily counts. For the 2-L counter operating

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† Prepared by the first author, who operates the laboratory. The date list has been compiled by the second and third authors from descriptions of samples and interpretations of dates by the collectors.

TABLE 1

Monthly Background (c/m) for Period
October 1, 1968 to September 30, 1969

Month	2-L Counter (2 atm)	5-L Counter (1 atm)
October, 1968	1.179 ± .019	2.146 ± .036
November	1.179 ± .018	2.194 ± .050
December	1.177 ± .021	2.221 ± .029
January, 1969	1.221 ± .015	2.230 ± .026
February	1.245 ± .019	2.247 ± .026
March	1.263 ± .021	2.290 ± .026
April	1.124 ± .016*	2.278 ± .026
May	1.207 ± .025	2.208 ± .033
June	1.161 ± .015	2.203 ± .035
July	1.166 ± .015	2.175 ± .025
August	1.151 ± .018	2.196 ± .030
September	1.155 ± .019	2.198 ± .023

* 2-L counter operating at 1 atm.

TABLE 2

Monthly Standard, N_0*, (c/m) for Period
October 1, 1968 to September 30, 1969

Month	2-L Counter (2 atm)	5-L Counter (1 atm)
October, 1968	20.174 ± .100	29.019 ± .125
November	20.182 ± .104	28.905 ± .133
December	20.286 ± .109	28.694 ± .131
January, 1969	20.284 ± .089	28.898 ± .109
February	20.208 ± .095	28.829 ± .115
March	20.105 ± .098	28.729 ± .118
April	9.784 ± .127**	28.637 ± .165
May	20.365 ± .270	28.495 ± .118
June	19.842 ± .120	28.678 ± .165
July	19.699 ± .095	28.797 ± .118
August	19.708 ± .100	28.555 ± .155
September	19.744 ± .098	28.488 ± .149

* N_0 = 0.95 × net counting rate of the NBS oxalic-acid standard.
** 2-L counter operating at 1 atm.

at 1 atm., 2 different oxalic-acid preparations were used, and no counts were omitted. At 2 atm., 5 different oxalic-acid preparations were used, and no counts were omitted. For the 5-L counter, 7 oxalic-acid preparations were used. Two counts were omitted for statistical reasons.

In this date list, where δC^{13} measurements are available, a correction for isotopic fractionation has been applied to the date, and the δC^{13} value is reported. Related to the PDB standard, the "normal" values used for correction are $\delta C^{13} = -25.0‰$ for wood, other terrestrial organic material and bones (terrestrial and marine), and $0.0‰$ for marine shells. All C^{13}/C^{12} ratios reported here were determined by Isotopes Inc. on aliquots of the same sample gas used for age determination.

Archaeologic samples (particularly charcoal) often pose more of a problem to the laboratory than any other type of material supplied for dating. Charcoal samples are often so small that they have to be mixed with "dead" gas for counting purposes, reducing accuracy of results and increasing the archaeologist's problems in correctly interpreting dates. Also, many charcoal samples from archaeologic sites are contaminated by modern rootlets, which, if visible, can be removed by hand-picking, a chore usually overlooked. Nitration and acetone leaching are partially effective in removing roots and similar plant material from charcoal, but considerable loss of sample (50% or more) occurs if used on material which is in part charred wood, rather than being pure charcoal (see Table 3). Thus, initial sample size again poses a problem.

TABLE 3
Pretreatment of Charcoal Samples

Sample no.*	Original sample weight(g)	Pretreatment	Final sample weight(g)	Uncorrected C^{14} age(yr)	δC^{13} (‰)	Corrected C^{14} age(yr)
GSC-927	9.7	Acid leach only; visible rootlets scraped off.	7.9	520 ± 140	−24.5	520 ± 140**
GSC-944	~20.0	Nitration and acetone leaching (as per Haynes, 1966).	4.5	860 ± 140	−25.8	840 ± 140**

* Both determinations were carried out on the same sample material which consisted of charcoal, wood, and charred wood, although the latter 2 materials predominated over charcoal. Detailed description of this geologic sample will appear in a future date list.

** The discrepancy between the dates probably cannot be explained solely by contamination by modern rootlets, as all visible rootlets in GSC-927 were removed. A 40% decrease in age, in this range, would require 20 to 50% contamination by modern material.

The submitter should supply material that is free from visible contamination, and he should assume that the laboratory staff will use only standard pretreatment techniques, as many laboratories are limited by time and personnel. The submitter should also supply enough sample to allow for duplicate analyses, and he should consult the laboratory staff about minimum requirements. Table 4 shows minimum amount of sample to fill the 2-L counter to 2 atm. *without* the necessity of mixing with dead gas. *At least 3 times the minimum amount is desirable.*

TABLE 4

Sample type	Minimum amount required (g) of dry sample
Wood	5-10
Charcoal	5-10
Peat	10-25
Gyttja	10-25
Shell	30
Bone	500-1000
Organic detritus	500-1000

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I. ARCHAEOLOGIC SAMPLES

A. Eastern Canada

GSC-142. Batiscan site, Quebec **390 ± 140**
A.D. 1560

Charcoal from Batiscan site, Champlain Co., Quebec, (46° 29′ N Lat, 72° 15′ W Long). From ca. 2 ft below surface on 35° slope ca. 3.5 ft S of Sq. 0 26. Single component Early Woodland site, yielding diagnostic Vinette 1 pottery. Est. age between 800 B.C. and 1000 B.C. (Levesque *et al.*, 1964). Coll. 1963 and subm. by R. Levesque, Sherbrooke Univ., Sherbrooke (now Quebec City). *Comments* (J.V. Wright*): sample is obviously intrusive and does not pertain to Early Woodland occupation. If sample is archaeologic and not natural, it would pertain to late St. Lawrence Iroquois occupation of area; evidence for this at Batiscan site is lacking; (W.B., Jr.) when sample subm., Levesque noted possibility that carbonized pine roots younger than cultural material might be present; (W. Dyck): 8.5 g best charcoal pieces were selected and all visible rootlets removed.

B. Western Canada

GSC-1219. Swan River, Manitoba **2320 ± 130**
370 B.C.
$\delta C^{13} = -21.2‰$

Animal bone (525 g) from contact zone between peat and underlying lacustrine sediments at toe of Upper Campbell beach, Site FbMi-5, Swan

* All persons referred to as collectors or submitters of samples or cited as sources of data are, unless otherwise specified, with the Natl. Mus. of Man., one of the Natl. Museums of Canada.

R. valley, Manitoba (52° 12′ N Lat, 101° 25′ W Long). Due to disturbance of overlying peat through road construction, depth of sample varied, but was ca. 2 ft; type of deposit described by Ehrlich *et al.* (1962) as "Shallow Peat," ranged from 12 to 36 in. depth. Sample was part of collection of butchered bone fragments from site. Coll. 1968 by L. Pettipas, Univ. of Manitoba, Winnipeg; subm. by R. Klassen, Geol. Survey of Canada. *Comment* (W.B., Jr.): dates occupancy of site and is much younger than Upper Campbell beach, ca. 9500 yr old (Elson, 1967; cf. also Klassen, 1969). Pretreatment included 1-hour NaOH-leach. Sample mixed with dead gas for counting.

4710 ± 150
GSC-1068. Caribou Island site, Alberta, paleosol 2760 B.C.
$\delta C^{13} = -20.4‰$

Humic acid (NMC-96) extracted from paleosol at Caribou I. site (GbOs-100) near Moose Lake, E-central Alberta (54° 15′ N Lat, 110° W Long). From Stratum IV, Sqs. II50 and JJ50 at 20 to 60 cm below surface. Dates period of relatively moist climatic conditions during a longer, more arid phase (Hypsithermal) of sand dune formation. Previous date (uncorrected for isotopic fractionation) on charcoal from same paleosol was 4200 ± 140 yr (GSC-660; Wilmeth, 1969; Radiocarbon, 1969, v. 11, p. 28-29). Coll. 1965 by W. Moore for A. L. Bryan, Univ. of Alberta, Edmonton; subm. by W. N. Irving. *Comments* (A.L.B.): dating of charcoal and humic acid indicates occupation occurred during and/or after soil formation. Paleosol was not well developed; therefore relatively moist phase was probably short. Active sand dune formation preceded and followed soil formation. Scattered evidence of occupation found throughout all dune deposits with greater concentration of artifacts in paleosol; (W.B.,Jr.) pretreatment consisted of placing soil sample in 5N NaOH at room temperature, stirring, and centrifuging. Supernatant liquid was neutralized with HCl, then filtered, washed, and dried at ca. 50 to 60°C; 8.8 g subm. to lab, with no further pretreatment. Sample mixed with dead gas for counting.

Site GhPh-107 series, Alberta

Charcoal from Site GhPh-107, SE shore of Calling Lake, in NE ¼ sec. 25, Tp. 71, Rge. 22, W 4, Alberta (55° 11′ N Lat, 113° 15′ W Long). Stratified camp site on old beach ridge. Cultural affiliations undetermined. Coll. 1967 by K. Hayashi and R. Gruhn, Univ. of Alberta, Edmonton; subm. by R. Wilmeth.

1190 ± 130
GSC-1034. Site GhPh-107, Sq. A10 A.D. 760
$\delta C^{13} = -24.1‰$

Charcoal and charred wood (NMC-251) from Sq. A10, junction of gray sand and light gray sand zones. Should date late occupation of site, characterized by small corner-notched point, pottery, and microblades. Est. age between A.D. 0 and 1500.

GSC-1035. Site GhPh-107, Sq. D22 **1150 ± 160**
A.D. 800

Charcoal (NMC-250) from Sq. D22, yellow sand zone. Lerma-like projectile point assoc. Est. age ca. 5000 B.C.

General Comments (R.G.): GSC-1034 is acceptable, but GSC-1035 is not. Material dated in GSC-1035 most likely intrusive from overlying layers by root growth; (W.B.,Jr.) both samples contained rootlets, especially abundant in GSC-1035, a small sample (4.5 g vs. 19.6 g for GSC-1034). Rootlets were hand-picked, but some may have been missed (e.g., inside charcoal lumps). Presence of rootlets would account in part for age discrepancy of GSC-1035.

Head-Smashed-In Buffalo Jump series, Alberta

Burned bones from Head-Smashed-In Buffalo Jump (DkPj-1), Porcupine Hills, 10 mi W of Fort MacLeod, Alberta (49° 43′ N Lat, 113° 40′ W Long). Largest known buffalo jump in NW plains, 814 ft long, 200 ft wide; average depth, 20 ft; maximum depth, 40 ft. Upper deposits contain typical Late Prehistoric side-notched points. Lower levels contain Besant, Pelican Lake, and Hanna points. Lowest levels, containing wide assortment of stone and bone tools, but no projectile points, were dated at 5410 ± 300 yr (GSC-803; Radiocarbon, 1968, v. 10, p. 220). Coll. 1966 by B. Reeves and R. G. Forbis, Univ. of Calgary, Calgary; subm. by R. Wilmeth.

GSC-992. Head-Smashed-In Buffalo Jump, Cultural Layer 4 **700 ± 170**
A.D. 1250
$\delta C^{13} = -23.8‰$

Bone (NMC-167; ca. 300 g) from Test Pit Y, Cultural Layer 4, Soil Horizon 9 (solid bone, mostly burned), depth 3.8 to 4.3 ft. From Late Prehistoric horizons, dates appearance of Washita and related point types. Est. age A.D. 1500 ± 250.

GSC-983. Head-Smashed-In Buffalo Jump, Cultural Layer 5 **1040 ± 140**
A.D. 910
$\delta C^{13} = -22.9‰$

Burned bone (NMC-169; 908 g) from Test Pit Y, Cultural Layer 5, Soil Horizon 15 (AB), depth 8.3 to 8 ft. From horizon which contains nothing but Avonlea points. Will date maximum expansion of Avonlea tradition at site. Est. age A.D. 600.

General Comment (R.G.F. and B.R.): GSC-992 is acceptable but GSC-983 regarded as 3 centuries too late. Both samples mixed with dead gas for counting.

GSC-1085. Eagle Cave site, Alberta **130 ± 130**
A.D. 1820
$\delta C^{13} = -20.7‰$

Charred wood (NMC-254) from Eagle Cave site (DjPp-100), Crowsnest Lake, Alberta (49° 37′ N Lat, 114° 38′ W Long). From Sq. 5W, depth 124 to 127 cm below datum. Solution cavern with stratified deposits located ca. 300 ft above Crowsnest Lake near Continental Divide. Sample dates upper burned dung and twig layer containing stone and bone artifacts. Est. age ca. 1000 yr. Coll. 1967 by B. Cowan for A. L. Bryan; subm. by R. Wilmeth. *Comments* (A.L.B.): date suggests that accumulation of part of upper layer was very recent, and perhaps includes material brought in (and possibly burned) by recent cave explorers Artifacts in layer are undoubtedly older than date; (W.B., Jr.): date on 25 g sample based on one 1-day count only, as "modern" age was obviously much younger than est. age.

2130 ± 130

GSC-998. Marron Valley site, British Columbia **180 B.C.**

$\delta C^{13} = -24.5‰$

Charcoal (NMC-248) from Marron Valley site (DiQw-2), on eroded terrace spur facing creek feeding into Marron Lake, Similkameen Land Dist., British Columbia (49° 22′ 10″ N Lat, 119° 41′ 30″ W Long). Sample (7.1 g) from bottom hearth level; Excavation Unit 0 S, 6 E, depth 95 to 100 cm in Stratum 4. Hearth approx. centered in small house pit of uncertain dimensions (no more than 7 m diam.) and was basin-shaped depression excavated into sterile yellowish sand. Site apparently large chipping sta. most intensively used near single house pit. Terrace spur, ca. 0.5 acre, and terrace ca. 11 m higher were littered with chipping waste and fire-broken rocks over at least 3 to 4 acres, fronting on terrace edge and creek below. Cultural affiliation of late components probably Okanagan. Sample should provide earliest date for house pit occupation and probably terminal date for microblade manufacture. Some microblades and fragments found in edge of filled house pit probably derived from disturbance outside and pre-date house pit. Site is first well-documented occurrence of microblades and cores in Okanagan Valley. Est. age of housepit component: 1000 to 1500 yr. Coll. 1967 by G. F. Grabert, Western Washington State College, Bellingham; subm. by R. Wilmeth. *Comment* (G.F.G.): date seems reasonable and accords with date from site with similar house pits, projectile points, and very few microblades in lower Okanagan Valley, Chiliwist phase (type site at Chiliwist Creek). GSC-998 and GaK-2335 (2500 ± 100 yr) appear to bracket end of microblade techniques in N and probably S Okanagan Valley as well. In this they are comparable to Borden's Natalkuz Lake microblade component dating 2415 ± 160 B.P. (S-4; McCallum, 1955, p. 34).

120 ± 130

GSC-1154. Potlatch site, British Columbia **A.D. 1830**

$\delta C^{13} = -22.4‰$

Charcoal (NMC-307) from Potlatch site (FcSi-201), S shore of Little Anahim, Anahim Lake, British Columbia (52° 29′ 30″ N Lat, 125° 20′ 30″ W Long). From large cache pit excavated into floor in N quad of Tshandu House. Pit contained bone refuse, including 3 small dog skulls, and few bone tools. Pit extends to depth 45.7 cm below floor and 106.6 cm below surface. Site consists of 1 large rectangular house and 4 semi-subterranean circular houses. Material from Tshandu House largely aboriginal, but includes 1 copper ring and 1 copper bracelet, thus probably representing early contact period Chilcotin, as suggested by architecture. Sample dated to verify this age and to be sure house was not constructed earlier; date of 2415 ± 160 (S-4; McCallum, 1955, p. 34; Wilmeth, 1969) was obtained on similar house at Natalkuz Lake, British Columbia. Est. age A.D. 1750 to 1800. Coll. 1968 by J. Noury, Univ. of Victoria, Victoria, for R. Wilmeth. *Comment* (R.W.): date places Tshandu House in historic period. Pretreatment of 6 g-sample included *cold* NaOH-leach.

Git-aus site series, British Columbia

Charcoal from Git-aus site (GdTc-2), Kitselas Canyon, Skeena R., British Columbia (54° 36′ 15″ N Lat, 128° 25′ 20″ W Long). Stratified fishing sta. at downstream end of canyon, site, in historic times, of a village of Kitselas tribe of Tsimshian, and briefly, of a white steamboat sta. and village. Coll. 1968 by J. Heppelwhite, D. Walker, and P. Monahan for G. F. MacDonald.

3760 ± 140
GSC-1113. Git-aus site, Level 12 **1810 B.C.**
$\delta C^{13} = -23.1‰$

Charcoal (NMC-322; 15 g) from Level 12, NW quad, S 21 ft 0 in., W 7 ft 0 in., 125 in. above datum. Cross-check on Level 12 from another portion of site. Est. age ca. 2500 yr.

4100 ± 310
GSC-1141. Git-aus site, Level 12, hearth **2150 B.C.**
$\delta C^{13} = -20.1‰$

Charcoal (NMC-323; 17 g) from Level 12, S 20 ft 0 in., W 7 ft 0 in., above burnt sand lens in NW quad, at 125 in above datum. Prominent hearth feature. Will date one of lower levels of site. Est. age ca. 2500 yr.

3680 ± 130
GSC-1157. Git-aus site, Level 8 **1730 B.C.**
$\delta C^{13} = -22.5‰$

Charcoal (NMC-321; 29 g) from Level 8, from sand below large rock feature, at 118 in. above datum. Est. age ca. 2000 yr.

General Comment (G.F.M.): dates maximum for sample of projectile points with many Plano-like features of technology and form: long parallel sides; slightly concave base, occasionally with basal thinning; ground base edges; thin, lenticular cross section; and generally well controlled flaking. Similar points are known from numerous localities along N coast of British Columbia, including Prince Rupert Harbour and Queen Charlotte Is. where their context also suggests age of 3000 to 5000 yr. Recentness of dates indicates no direct connections with Plano industries. Other industries (cobble tools and ground stone forms) occur with points to confirm reliability of dates. Pretreatment of GSC-1141 and

GSC-1157 included *cold* NaOH-leach. GSC-1141 mixed with dead gas for counting; date based on one 3-day count.

C. Northern Canada, Mainland

GSC-942. Otter Falls site, Yukon Territory **4590 ± 150** **2640 B.C.** $\delta C^{13} = -23.6‰$

Spruce charcoal (NMC-213; id. by B. F. Kukachka, Forest Products Lab., Madison, Wisc.) from Otter Falls site (JgVf-2), Otter Falls, Aishihik R., Yukon (61° 05′ N Lat, 137° W Long). From trough-like depression extending 2 to 7 in. into basal lacustrine clays. Depth from surface, 4 to 9 in.; N 0-5, E 0-10. Very small site, affiliations with Campus site, central Alaska. Representative of Denali complex and/or Northwest Microblade tradition. Coll. 1966 by J. P. Cook, Univ. of Wisconsin, Madison; subm. by R. Wilmeth. *Comments* (W. B. Workman, Alaska Methodist Univ., Anchorage): surprisingly recent date for widespread and distinctive micro-core technology thought by many to be twice as old. This date is reinforced by stratigraphy at Village site, Healy Lake, Alaska, where similar material overlies cores of Tuktu type dated elsewhere in Alaska to ca. 6500 B.P. (Cook and McKennan, 1968). Three recent C^{14} dates on related Healy Lake material yielded dates within Christian Era: NMC-294, 1270 ± 80 or A.D. 680 (Gak-1884); NMC-295, 1260 ± 90 or A.D. 690 (Gak-1885); NMC-297, 1360 ± 80 or A.D. 590 (Gak-1887). On present evidence Otter Falls date is acceptable. Presumably it applies to a relatively late manifestation of microblade and core technology in SW Yukon. Otter Falls cores described and illustrated by Cook (1968); (W.B., Jr.): some modern(?) rootlets noticed in small sample (7.9 g); contamination may exist. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

Chimi site series, Yukon

Charcoal samples from Chimi site (JjVi-7), ca. 1 mi N and E of Aishihik Village, Yukon (61° 36′ 30″ N Lat, 137° 30′ W Long). Site is stratified. Upper levels, above volcanic ash layer, probably represent Athabaskan complexes. Material below ash has not yet shown relation to any regional complex, although lowest level may be affiliated with Otter Falls site (JgVf-2; this list), which resembles Campus site in central Alaska. Coll. 1966 by J. P. Cook; subm. by R. Wilmeth.

GSC-940. Chimi site, 12 in. depth **2900 ± 130** **950 B.C.** $\delta C^{13} = -25.0‰$

Spruce charcoal (NMC-210; id. by B. F. Kukachka) from small bowl-shaped depression 2 to 3 in. into basal lacustrine clays and 12 in. below surface, Sq. N 0-5, W 10-15. Probably dates 1st occupation of site. May assist in dating Campus site and its affiliates such as Denali complex and/or Northwest Microblade tradition. Est. age 8000 yr. *Comment* (W.B.W.): dates beginning of main occupation of site. If correct, it indicates ca. 4000 yr elapsed between draining of Glacial Lake Sekulmun-Aishihik and beginning of soil accumulation on slope on which Chimi is located. Enlarged sample of artifacts from 1968 excavations failed to substantiate earlier suggestions that a microblade component was present in lower portion of site. Cultural materials dated by sample are attributed to onset of Taye Lake phase occupation of site. NaOH-leach omitted from sample (15.5 g) pretreatment.

1770 ± 710
GSC-941. Chimi site, 2 in. below ash **A.D. 180**

Birch charcoal (NMC-211; id. by B. F. Kukachka) from semi-circular hearth 2 in. below ash layer, Sq. N 20-25, W 15-20, at level in which microblades are conspicuously absent, and is thus relevant for dating termination of Northwest Microblade tradition. Est. age 3000 yr. *Comments* (W.B.W.): margin of error is too large for meaningful interpretation. Generally accepted date of ash layer overlying sample suggests it is not much younger than stated midpoint of 180 A.D.; (W.B., Jr.): NaOH-leach omitted from sample pretreatment. Sample (7.6 g) produced sufficient gas for counting without mixing with dead gas. However, leakage from cylinder while sample was stored prior to counting necessitated high mixing ratio with dead gas, and resulted in large error although sample was given one 5-day count.

1190 ± 130
GSC-956. Chimi site, below ash **A.D. 760**
$\delta C^{13} = -25.1‰$

Birch charcoal (NMC-212) from thin hearth directly below volcanic ash, Sq. N 10-15, W 7-15, at level containing some bone artifacts, tentatively assigned to an Athabaskan tradition. Est. age 1750 yr. *Comments* (W.B.W.): date appears too recent, as widespread volcanic ash layer overlying sample is thought to date to ca. 1425 ± 50 B.P. in area (Stuiver *et al.*, 1964); (W.B., Jr.): GSC-956 corresponds closely with several more recent dates on E lobe of White R. ash; e.g., GSC-408 (1200 ± 140; Radiocarbon, 1968, v. 10, p. 229-230; Lerbekmo and Campbell, 1969); and GSC-748 (1160 ± 130), GSC-934 (1280 ± 130, corrected), and GSC-1000 (1300 ± 130, corrected; all in Rampton, 1969 and Radiocarbon, 1970, v. 12, p. 80). NaOH-leach omitted from sample (4.9 g) pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count.

General Comment (W.B.W.): 3 Chimi dates from 1966 excavations are in stratigraphic order, despite large margin of error for intermediate date (GSC-941). From extensive excavations at site in 1968 all 3 dates are provisionally attributed to a Taye Lake phase occupation (cf. MacNeish, 1964). Two other dates from area furnished by O. L. Hughes, Geol. Survey of Canada, are also pertinent: GSC-749 (9660 ± 150 B.P.; Radiocarbon, 1970, v. 12, p. 75) provides minimum date for retreat of glacier from a moraine belt 3.6 mi N of Aishihik Lake. GSC-755 (7170 ± 140 B.P.; *ibid.*) provides minimum date for drainage of Glacial Lake

Sekulmun-Aishihik, stony lacustrine clays of which underlie Chimi cultural deposits.

3220 ± 140
GSC-126. Little Arm site, Yukon **1270 B.C.**

Charcoal from Little Arm site (JiVs-l) Kluane Lake, Yukon (61° 25′ 30″ N Lat, 138° 58′ W Long). From S 10, W 105, Level 4. Stratified site, with occupations representing Little Arm, Gladstone, Taye Lake, and Bennett Lake phases. Sample from Gladstone component (MacNeish, 1964). Coll. 1959 by R. S. MacNeish, Natl. Mus. of Canada (now at R. S. Peabody Foundation, Andover, Mass.). *Comment* (W.D.): hardest pieces of charcoal (3.6 g) selected and visible rootlets removed. Date based on one 3-day count and one 1-day count.

2920 ± 140
GSC-127. Pelly Farm site, Yukon **970 B.C.**

Charcoal from Pelly Farm site (KfVd-2), N bank of Pelly R. ca. 3 mi above confluence with Yukon R., Yukon (62° 50′ N Lat, 137° 19′ W Long). Stratified site, with occupations representing Champagne, Little Arm, Gladstone, and Taye Lake phases. Sample from Champagne component (MacNeish, 1964). Coll. 1957 and subm. by R. S. MacNeish. *Comment* (W.D.): 6 g of best-looking charcoal pieces selected and all visible rootlets removed. Date based on one 3-day count.

420 ± 140
GSC-846. Site JcRw-3, Northwest Territories **A.D. 1530**

Burned wood, NMC-203 and 204, (*Picea* sp.), id. by E. Perem, Forest Products Lab., Ottawa, from Site JcRw-3, N end of Fisherman Lake, SW Dist. of Mackenzie, Northwest Territories (60° 21.5′ N Lat, 124° 50′ W Long). From hearth lying high in loess/silt zone in Sq. 155, coordinates 5.0 S, 4.35 W. Sample should date latest Plano horizon. Est. age 3000 to 5000 yr. Coll. 1966 by J. F. V. Millar, Univ. of Calgary, Calgary; now at Univ. of Saskatchewan, Saskatoon; subm. by R. Wilmeth. *Comments* (J.F.V.M.): archaeologic analysis of recovered artifacts showed that hearth belonged to Mackenzie complex. GSC-846 came from same hearth as Sample I-3191, 1930 ± 160; (W.B., Jr.): reason for discrepancy between dates, and re other dates at site (cf. Wilmeth, 1969; Radiocarbon, 1969, v. 11, p. 311-312) is not known. NaOH-leach omitted from pretreatment of GSC-846 due to small sample size (only 1.4 g burnt after acid pretreatment). Sample mixed with dead gas for counting.

MacLeod site series, Northwest Territories

Charcoal from MacLeod site (JcRw-8), NW corner of Fisherman Lake, SW Dist. of Mackenzie, Northwest Territories (60° 22′ N Lat, 123° 50′ W Long). Coll. 1966 (GSC-844) and 1967 by J. F. V. Millar; subm. by R. Wilmeth.

2460 ± 160
GSC-844. MacLeod site (I) **510 B.C.**

Charcoal (NMC-200) from Sq. 28, 1 S, 5 W, at contact between yellow clay and overlying yellow loess/silt. Stratified site with 2 prehistoric occupation periods. Sample should date earlier occupation, considered middle Cordilleran, with large crude flake side and end scrapers, convex choppers, and burins. Est. age 8000 yr.

GSC-1033. MacLeod site (II)

2420 ± 130
470 B.C.
$\delta C^{13} = -23.1‰$

Charcoal (NMC-259) from top of soil profile (soil developed on proglacial lake silts of late glacial age) in Sq. 73. Further work after subm. of GSC-844 (NMC-200) showed 3rd component; site is stratified with 1 low component below lake silts and 2 components mixed on top of soil profile. Sample should date easternmost of 2 upper components, which is probably later. Est. age 750 yr.

General Comments (J.F.V.M.): excavation during 2nd field season proved charcoal of GSC-844 was related to large hearth on top of mineral soil. Hearth is attributed to component JcRw-8-1 W. GSC-1033 appears to confirm GSC-844 for W sec. of site. Sample, from buried piece of charcoal in a disturbed area not id. until 1967 excavation, is from E hearth assoc. with JcRw-8-1 W component, tentatively considered a transitional complex between Fish Lake and Mackenzie complexes. Artifacts include small half-moon side blades, double-ended end scrapers, "strangulated blades," and small plano-convex end scrapers found with other artifacts similar to preceding Fish Lake or succeeding Mackenzie complex; (W.B., Jr.): NaOH-leach omitted from pretreatment of GSC-844, a small sample (1.6 g burned after acid pretreatment); sample mixed with dead gas for counting. Date for GSC-1033 (6.9 g burned after standard treatment on 10.2 g sample and after rootlets hand-picked) based on one 3-day count.

D. Northern Canada, Arctic Archipelago

GSC-1051. Closure site annex, Baffin Island

3390 ± 210
1440 B.C.
$\delta C^{13} = -26.8‰$

Charred (seal?) fat from Closure site annex (KdDq-23), Cape Tanfield, Baffin I., Northwest Territories (62° 39′ N Lat, 69° 37′ W Long). Consolidated sample from Sqs. 2 and 11, depth 0.2 to 0.4 ft below surface; thin midden in gravel matrix within active permafrost zone and active sod rootlet zone at alt 60 ft above present lichen line. Est. older than 2 previously dated components of Closure site: KdDq-11-0 at 4067 ± 73 B.P. (P-707; Radiocarbon, 1966, v. 8, p. 362); and KdDq-11-6 at 4460 ± 100 yr B.P. (Gak-1281; Radiocarbon, 1969, v. 11, p. 314) at alt ca. 34 and 45 ft a.s.l., respectively. Rootlets were possible source of contamination, and shallow depth raises problem of sample being intrusive. Coll. 1967 by A. A. Dekin, Jr., Michigan State Univ., East Lansing; now at State Univ. College at Potsdam, Potsdam, New York; subm. by W. Blake, Jr. *Comments* (A.A.D., Jr.): date is too young for artifacts assoc. with sample, as they represent early pre-Dorset culture in this area rather than late pre-Dorset, as date implies. Small sample size (2.8

g) suggests possibility of contamination; (W.B., Jr.): date is minimum for pumice found in cultural horizon; cf. older dates from Closure site, where pumice also occurs (Blake, 1970). Sample mixed with dead gas for counting.

GSC-849. Shaymarc site, Baffin Island **4140 ± 130** **2190 B.C.**

Charred fat (seal?) (NMC-138) from Shaymarc site (KkDn-2), Sylvia Grinnell R., Frobisher Bay, Baffin I., Northwest Territories (63° 45′ N Lat, 68° 34′ W Long). From Pit 8, surface depth 0.5 ft. Partially excavated site yielded 600 artifacts, belonging to a pre-Dorset assemblage. Typologic analysis places material early in pre-Dorset sequence. Est. age between 4067 ± 73 (P-707; Radiocarbon, 1966, v. 8, p. 362) for Closure site and 3814 ± 69 (P-708; *ibid.*) for Annawalk site. Coll. 1966 by M. S. Maxwell, Michigan State Univ., East Lansing; subm. by R. Wilmeth. *Comment* (M.S.M.): date fits well with est. age and archaeologic evidence. NaOH-leach omitted from sample pretreatment (19.0 g burned after acid pretreatment).

E. Alaska

GSC-883. Desperation Lake Site 4 **1830 ± 170** **A.D. 120**

Wood charcoal (NMC-103) from Desperation Lake Site 4, S shore of Desperation Lake, Brooks Range, Alaska, ca. 0.25 mi E of prominent village site (68° 35′ N Lat, 158° 45′ W Long) (Irving, 1962). From hearth covered by slopewash from low cutbank overlooking beach. Sample accompanied by few stone implements resembling Ipiutak culture. Est. age 2000 ± 500 yr. No occupation of Brooks Range is yet known for this time range. Coll. 1962 and subm. by W. N. Irving, Natl. Museum of Canada (now at Univ. of Toronto, Toronto). *Comments* (W.N.I.): date is plausible but is earliest of all dates for Ipiutak at Point Hope and Cape Krusenstern (Rainey and Ralph, 1959). But, date at Point Hope, on antler arrowheads, may be erroneously young. Attribution of site to Ipiutak culture is tentative and needs confirmation by further excavation; (W.B., Jr.): despite possibility of rootlets in sample, NaOH-leach omitted from pretreatment because of small sample size (1.0 g burnt after acid treatment). Sample mixed with dead gas for counting. Date based on one 3-day count.

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GLASGOW UNIVERSITY RADIOCARBON MEASUREMENTS II

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A third radiocarbon counting system has been established in the Chemistry Department, University of Glasgow, since April, 1968. Operating conditions for the previous systems have remained essentially as described by Baxter *et al.* (1969).

The counting assembly was supplied by Johnston Laboratories, Inc., Baltimore and consists of 2.6L internal gas counter and a concentric multiple anode anticoincidence meson detector. The counters are encased in a 4-in.-thick shield manufactured from aged lead by J. Girdler and Co., London.

CO_2 is employed as the counting gas at a constant filling pressure of 760 mm. Hg at 15°C. Operational parameters are as follows: (1) anticoincidence plateau: greater than 800 v long with slope less than 0.5% per 100 v; (2) detector operating voltage: 3.48 ± 0.05 Kv. Adjustment is made within this range to ensure identical gas gain for all gases counted; (3) detector background count rate: 5.53 ± 0.12 ($\pm 2\sigma$) counts/min. at 1013 mbar. A linear variation of background count rate with barometric pressure, amounts to −0.01 count/min./mbar; (4) net activity of NBS oxalic acid modern standard: 14.37 ± 0.08 ($\pm 2\sigma$) counts/min., after correction for fractionation and decay.

CO_2 samples are normally stored for 14 days prior to counting to allow for radon decay. The presence of radon, however, is monitored via energy discrimination during each counting sequence. When necessary, a correction is applied to the total count rate to allow for the contribution of radon and its beta active daughter products.

Samples are counted at least twice and several days apart to give a minimum total of 60,000 counts. Modern standard and background activities are monitored weekly to check counter performance.

Mass spectrometric analysis for fractionation correction have been performed at The National Physical Laboratory, Teddington.

Calculations are based on the Lamont VIII formulae (Radiocarbon 1961, v. 3, p. 176-204) and errors arising from uncertainties in C^{14} measurement are quoted to one standard deviation (1σ).

ACKNOWLEDGMENTS

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SAMPLE DESCRIPTIONS

I. INTERCALIBRATION SAMPLES

Prior to routine measurement of C^{14} activities with the new system intercalibration was performed in conjunction with the established radiocarbon counting facilities at Glasgow (Baxter *et al.*, 1969).

1922 ± 60

GU-67. Kilphedir hut circles, Sutherland, Scotland A.D. 28

Charcoal. *Comment*: sample previously described and reported under GU-10, 1908 ± 60, GU-11, 2064 ± 55 and L-1061, 2100 ± 80.

Snowdon, Wales 1968

Atmospheric CO_2 samples, counted as CO_2 and then converted to CH_4 for measurement on alternative counting systems. Coll. by Central Electricity Generating Board at Cwm Dyli, Mt. Snowdon, Wales, alt 300 ft (53° 03′ N Lat, 04° 00′ W Long).

	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-83.	60.0 ± 0.9	−21.3	58.9 ± 0.9
CO_2 coll. April 1968. Counted as CO_2 on new system.			
GU-68.	59.8 ± 0.7	−21.3	58.7 ± 0.8
CO_2 coll. April 1968. Counted as CH_4 on system 1.			
GU-69.	60.5 ± 1.1	−21.3	59.4 ± 1.2
CO_2 coll. April 1968. Counted as CH_4 on system 2.			
GU-70.	61.6 ± 0.9	−20.5	60.2 ± 0.9
CO_2 coll. June 1968. Counted as CO_2 on new system.			
GU-71.	60.0 ± 0.7	−20.5	58.7 ± 0.8
CO_2 coll. June 1968. Counted as CH_4 on system 1.			

Agreement between systems is satisfactory; no further designation of counting system is deemed necessary.

II. ATMOSPHERIC CO_2 SAMPLES

A. Ground level

Data reported here are derived from atmospheric CO_2 samples coll. at various sites in the U.K. and throughout the world. Measurements were made as part of 2 continuing research programs, viz., (a) C^{14} concentrations in humans in relationship to those of their immediate environment (Harkness and Walton, 1969) and (b) transport of C^{14} within the "dynamic" carbon reservoir (Walton *et al.*, 1969).

CO_2 coll. by exposure of carbonate free 8N KOH solution to atmosphere for each calendar month.

Snowdon series

CO_2 coll. by the Central Electricity Generating Board in a ventilated cabinet at Cwm Dyli Power Sta. on E slope of Mt. Snowdon (53° 03′ N Lat, 04° 00′ W Long).

Snowdon series, 1967

Sample no.	Coll. date	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-72	May	64.4 ± 0.8	−19.9	62.7 ± 0.8
GU-73	June	54.0 ± 0.9	−18.1	51.8 ± 1.0
GU-74	July	64.8 ± 1.5	−17.4	62.2 ± 1.6
GU-75	Aug.	60.0 ± 0.6	−22.8	59.3 ± 0.7
GU-76	Sept.	62.1 ± 0.8	−17.8	59.8 ± 0.8
GU-77	Oct.	59.8 ± 0.6	−18.0	57.6 ± 0.7
GU-78	Nov.	59.1 ± 0.8	−20.2	57.6 ± 0.8
GU-79	Dec.	54.3 ± 1.4	−18.3	52.2 ± 1.5

Snowdon series, 1968

GU-80	Jan.	58.5 ± 1.4	−21.4	57.3 ± 1.5
GU-81	Feb.	52.9 ± 1.3	−21.6	51.9 ± 1.4
GU-82	March	57.1 ± 1.4	−20.7	55.8 ± 1.5
GU-83	April	60.0 ± 0.9	−21.3	58.9 ± 0.9
GU-84	May	60.3 ± 0.8	−20.5	58.8 ± 0.9
GU-85	June	61.6 ± 0.8	−20.5	60.2 ± 1.0
GU-86	July	61.9 ± 0.9	−20.6	60.5 ± 1.0
GU-87	Aug.	56.0 ± 1.0	−20.0	54.4 ± 1.1
GU-88	Sept.	59.3 ± 1.0	−20.4	57.8 ± 1.1
GU-89	Oct.	55.8 ± 1.4	−19.9	54.9 ± 1.4
GU-90	Nov.	54.9 ± 1.2	−21.5	54.0 ± 1.3
GU-91	Dec.	50.7 ± 0.9	−22.9	50.0 ± 1.0

Snowdon series, 1969

GU-92	Jan.	57.5 ± 1.3	−21.6	56.5 ± 1.4
GU-93	Feb.	55.1 ± 0.8	−24.5	55.0 ± 0.9
GU-95	April	57.4 ± 0.7	−21.2	56.2 ± 0.8
GU-96	May	57.9 ± 0.8	−20.3	56.4 ± 0.9
GU-97	June	52.4 ± 0.8	−19.2	50.7 ± 0.9
GU-98	July	56.8 ± 0.8	−21.4	55.7 ± 0.8
GU-99	Aug.	54.9 ± 0.8	−19.5	53.2 ± 0.9

Comment: sampling station is remote from any source of fossil fuel CO_2 or possible contamination by $C^{14}O_2$ from nuclear establishments. A seasonal variation in the tropospheric C^{14} concentration is evident, and is in agreement with present theories of stratospheric/tropospheric mixing patterns.

Chilton, England series

CO_2 coll. by the United Kingdom Atomic Energy Comm. at a site adjacent to A.E.R.E. Harwell (51° 31′ N Lat, 01° 20′ W Long).

Chilton series, 1967

Sample no.	Coll. date	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-100	May	78.2 ± 0.9	−24.0	77.2 ± 1.0
GU-101	June	70.8 ± 0.8	−22.1	69.8 ± 0.9
GU-102	July	67.3 ± 0.4	−20.3	65.8 ± 0.6
GU-103	Aug.	60.3 ± 1.6	−24.7	59.3 ± 1.7
GU-104	Sept.	68.0 ± 0.8	−21.1	66.8 ± 0.8
GU-105	Oct.	61.0 ± 0.8	−25.3	61.1 ± 1.0
GU-106	Nov.	58.2 ± 1.0	−22.9	57.5 ± 1.2
GU-107	Dec.	62.8 ± 1.2	−22.5	61.8 ± 1.2

Chilton series, 1968

GU-108	Jan.	54.8 ± 1.4	−25.1	54.9 ± 1.4
GU-109	Feb.	49.6 ± 0.5	−24.9	48.7 ± 0.6
GU-110	March	57.3 ± 1.0	−22.0	56.3 ± 1.0
GU-111	April	62.5 ± 0.9	−25.5	62.6 ± 1.0
GU-112	May	63.0 ± 0.9	−21.3	61.8 ± 1.0
GU-113	June	63.5 ± 0.9	−21.0	62.2 ± 1.0
GU-114	July	61.0 ± 1.3	−24.6	60.9 ± 1.4
GU-115	Aug.	60.3 ± 1.3	−23.4	59.7 ± 1.4
GU-116	Sept.	63.4 ± 1.1	−24.1	63.1 ± 1.2
GU-117	Oct.	79.9 ± 1.4	−25.6	80.1 ± 1.5
GU-118	Nov.	52.3 ± 1.2	−26.4	52.8 ± 1.3
GU-119	Dec.	49.2 ± 1.1	−22.4	48.5 ± 1.2

Chilton series, 1969

GU-120	Jan.	65.7 ± 0.8	−25.6	65.9 ± 0.9
GU-121	Feb.	55.1 ± 0.8	−29.4	56.5 ± 0.9
GU-122	March	55.1 ± 0.9	−25.5	55.3 ± 1.0
GU-123	April	64.8 ± 0.8	−24.7	64.7 ± 0.8
GU-124	May	56.9 ± 0.7	−24.5	56.8 ± 0.7
GU-125	June	73.6 ± 0.8	−22.8	72.6 ± 0.9
GU-126	July	59.2 ± 0.8	−22.9	58.5 ± 0.9
GU-127	Aug.	71.0 ± 0.8	−23.6	70.6 ± 0.9

Comment: occasional high C^{14} concentrations would appear to indicate localized atmospheric contamination from adjacent nuclear establishment (ca. 2 km away). A study of the above data relative to prevailing wind direction at sampling site is being made to clarify this possibility.

Lerwick, Scotland series

Samples coll. by Meteorologic Office in their ventilated East hut, Lerwick (60° 08′ N Lat, 01° 11′ W Long).

Lerwick series, 1967

Sample no.	Coll. date	δC¹⁴%	δC¹³‰	Δ%
GU-128	Nov.	65.0 ± 1.1	−22.6	64.2 ± 1.2
Lerwick series, 1968				
GU-129	Jan.	62.4 ± 1.2	−21.2	61.1 ± 1.2
GU-130	April	68.1 ± 1.2	−22.7	67.3 ± 1.3
GU-131	July	64.0 ± 0.9	−18.4	61.8 ± 1.0
GU-132	Oct.	58.8 ± 1.0	−19.9	57.2 ± 1.0

Victoria, B.C. series

Samples coll. by Defence Research Establishment Pacific, Canada, in covered box with gauze sides to allow free circulation of air (48° 25′ N Lat, 123° 19′ W Long).

Victoria series, 1967

Sample no.	Coll. date	δC¹⁴%	δC¹³‰	Δ%
GU-133	Jan.	60.4 ± 0.8	−18.4	58.3 ± 0.9
GU-134	April	63.9 ± 0.9	−17.6	61.5 ± 0.9
GU-135	July	65.1 ± 0.9	−18.3	62.9 ± 1.0
GU-136	Oct.	59.4 ± 0.8	−18.0	57.1 ± 0.9
Victoria series, 1968				
GU-137	Jan.	58.4 ± 0.9	−20.7	57.0 ± 1.0
GU-138	April	68.4 ± 1.0	−21.9	67.4 ± 1.1
GU-139	May	66.0 ± 1.0	−20.2	64.4 ± 1.1
GU-140	Sept.	53.5 ± 0.9	−21.8	52.6 ± 1.0
GU-141	Dec.	53.0 ± 1.0	−21.5	51.9 ± 1.0

Gibraltar series

Samples coll. by Meteorologic Office, R.A.F. Gilbraltar, in well-ventilated room, adjacent to open window (36° 09′ N Lat, 05° 21′ W Long).

Gibraltar series, 1967

Sample no.	Coll. date	δC¹⁴%	δC¹³‰	Δ%
GU-142	Sept.	64.9 ± 1.1	−19.0	62.9 ± 1.2
GU-143	Nov.	69.1 ± 1.6	−21.6	68.0 ± 1.7
Gibraltar series, 1968				
GU-144	Jan.	67.8 ± 0.8	−20.1	66.2 ± 0.9
GU-145	April	57.4 ± 1.1	−20.4	56.0 ± 1.2
GU-146	July	52.6 ± 0.9	−23.2	52.0 ± 1.0
GU-147	Oct.	67.0 ± 1.1	−22.3	66.1 ± 1.2
GU-148	Nov.	54.0 ± 1.2	−21.2	52.9 ± 1.3

Hong Kong series

Samples coll. by Meteorologic Office at Tates Cairn radar sta. in Stevenson screen which shelters samples from both rain and dry deposition (22° 18′ N Lat, 14° 10′ E Long).

Hong Kong series, 1967

Sample no.	Coll. date	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-149	Jan.	60.4 ± 0.9	−26.3	60.8 ± 1.0
GU-150	April	61.2 ± 0.9	−25.5	61.3 ± 0.9
GU-151	July	55.2 ± 0.8	−26.2	55.6 ± 0.9
GU-152	Nov.	51.1 ± 1.0	−27.0	51.7 ± 1.1

Hong Kong series, 1968

GU-153	Jan.	54.0 ± 1.1	−28.1	55.0 ± 1.2
GU-154	April	56.6 ± 1.0	−26.2	56.9 ± 1.1
GU-155	July	52.6 ± 1.1	−21.4	51.5 ± 1.2
GU-156	Nov.	54.7 ± 1.0	−24.4	54.5 ± 1.0

Singapore series

Samples coll. by Meteorologic Office, R.A.F. Changi, Singapore, at airport (01° 22′ N Lat, 103° 59′ E Long).

Singapore series, 1968

Sample no.	Coll. date	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-157	Jan.	59.0 ± 0.8	−22.0	58.1 ± 0.9
GU-158	April	57.4 ± 0.8	−23.8	57.0 ± 1.0
GU-159	July	53.2 ± 1.1	−25.5	53.4 ± 1.2
GU-160	Oct.	51.1 ± 1.1	−23.6	50.7 ± 1.2

Suva, Fiji Island series

Samples coll. by Meteorologic Office in instrument hut (18° 09′ S Lat, 178° 27′ E Long).

Fiji Island series, 1967

Sample no.	Coll. date	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-161	Jan.	61.8 ± 0.8	−18.5	59.7 ± 0.9
GU-162	April	58.1 ± 0.8	−18.9	56.2 ± 0.9
GU-163	July	58.5 ± 0.9	−18.1	56.3 ± 1.0
GU-164	Oct.	64.5 ± 1.2	−18.0	62.2 ± 1.3

Fiji Island series, 1968

GU-165	Jan.	54.9 ± 1.1	−20.8	53.6 ± 1.2
GU-166	April	55.4 ± 0.9	−21.2	54.3 ± 1.0
GU-167	July	56.1 ± 0.9	−21.9	55.2 ± 1.0
GU-168	Oct.	54.6 ± 1.0	−21.7	53.5 ± 1.0

Pretoria series

Samples coll. by Atomic Energy Board, Pelindaba, Pretoria, in Stephenson screen housing a variety of meteorologic instruments (25° 45′ S Lat, 28° 16′ E Long).

Pretoria series, 1968

Sample no.	Coll. date	$\delta C^{14}\%$	$\delta C^{13}‰$	Δ%
GU-169	Jan.	59.0 ± 1.1	−23.3	58.4 ± 1.1
GU-170	April	54.2 ± 0.9	−24.8	54.2 ± 1.0
GU-171	July	51.9 ± 1.2	−21.6	50.9 ± 1.3
GU-172	Oct.	63.2 ± 1.0	−24.3	63.0 ± 1.1
GU-173	Dec.	52.5 ± 0.8	−23.6	52.1 ± 0.9

Melbourne series

Samples coll. by Meteorologic Office, in thermometer screen fitted with perspex hood for protection against dry deposition (37° 49′ S Lat, 144° 58′ E Long).

Melbourne series, 1967

Sample no.	Coll. date	$\delta C^{14}\%$	$\delta C^{13}‰$	Δ%
GU-174	Jan.	55.6 ± 0.9	−25.0	55.6 ± 1.0
GU-175	April	56.3 ± 0.8	−26.7	56.9 ± 0.9
GU-176	July	51.2 ± 1.0	−20.1	49.8 ± 1.0
GU-177	Oct.	52.3 ± 0.9	−21.4	51.2 ± 0.9

Melbourne series, 1968

GU-178	Jan.	52.9 ± 0.8	−19.1	51.1 ± 0.9
GU-179	April/May	50.4 ± 1.1	−20.6	49.0 ± 1.2
GU-180	July	47.2 ± 1.1	−21.7	46.3 ± 1.2
GU-181	Oct.	49.6 ± 1.1	−22.1	48.7 ± 1.2

Comment: C^{14} activities in Melbourne samples are generally low. The reason for this may be a "local" Suess effect, because there are some smoke-producing stacks within 1 mi of sampling site and the harbour is ca. 3 mi away.

Stanley, Falkland Islands series

Samples coll. outdoors by Meteorologic Office, Stanley, Falkland Is., in meteorologic thermometer screen (51° 42′ S Lat, 57° 52′ W Long).

Stanley series, 1968

Sample no.	Coll. date	δC^{14}%	δC^{13}‰	Δ%
GU-182	Jan.	55.1 ± 1.0	–21.9	54.2 ± 1.0
GU-183	April	56.3 ± 0.8	–24.2	56.1 ± 0.8
GU-184	July	52.4 ± 0.8	–24.8	52.3 ± 0.9
GU-185	Oct.	49.0 ± 1.0	–24.7	49.0 ± 1.0

Argentine Islands series

Samples coll. by British Antarctic Survey in magnetic observatory (65° 15′ S Lat, 64° 16′ W Long).

Argentine Islands series, 1967

Sample no.	Coll. date	δC^{14}%	δC^{13}‰	Δ%
GU-186	April	55.4 ± 0.9	–20.4	54.0 ± 1.0
GU-187	July	53.9 ± 0.8	–20.9	52.6 ± 0.9
GU-188	Oct.	54.7 ± 0.9	–21.4	53.6 ± 0.9

Argentine Islands series, 1968

GU-189	April	53.2 ± 0.9	(–20.9)	52.0 ± 1.0*
GU-190	Oct.	52.8 ± 0.9	(–20.9)	51.5 ± 0.9*

Comment: * indicates that no mass spectrometric measurement was available for sample; a value of –20.9 ± 1‰ was assumed.

Halley Bay series

Samples coll. by British Antarctic Survey in magnetic hut during summer and in ozone hut during winter (75° 31′ S Lat, 26° 45′ W Long).

Halley Bay series, 1967

Sample no.	Coll. date	δC^{14}%	δC^{13}‰	Δ%
GU-191	Dec.	55.8 ± 0.9	–20.0	54.2 ± 0.9

Halley Bay series, 1968

GU-192	May	55.3 ± 0.9	–28.3	56.4 ± 1.0
GU-193	July	55.1 ± 1.0	–22.0	54.2 ± 1.1
GU-194	Oct.	52.2 ± 1.0	–22.9	51.6 ± 1.1

B. Upper atmospheric samples

The following C^{14} activities were measured for CO_2 coll. from the upper troposphere and lower stratosphere during the period June 1967 to December 1968.

Sampling was confined to flight paths within the region 50° to 60° N Lat, and 1° E to 8° W Long.

Atmospheric CO_2 was adsorbed on 1/8 in. pellets of molecular sieve, Linde Type 4A, using the techniques described by Godwin and Willis (Radiocarbon, 1964, v. 6, p. 134). Sampling time was 20 min. and this proved sufficient for the collection of ca. 4.0L – atm. CO_2, using 2 kg sieve per sample. Adsorbed CO_2 was recovered from the sieve material with steam displacement and coll. as $BaCO_3$ by absorption in $Ba(OH)_2$/KOH solution (Harkness, 1970).

Upper atmospheric CO_2

Sample no.	Coll. date	Alt. (ft)	Tropo-pause ht. (ft)	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-195	30 June 1967	41,000	39,000	87.7 ± 1.4	−20.2	85.9 ± 1.6
GU-196	20 Dec. 1967	41,000	39,000	87.0 ± 1.9	−19.6	85.0 ± 2.1
GU-197	15 Jan. 1968	43,000	41,000	79.9 ± 0.9	−18.3	77.5 ± 1.0
GU-198	15 Feb. 1968	39,000	35,000	74.5 ± 0.8	−17.8	72.0 ± 0.8
GU-199	15 Feb. 1968	31,000	35,000	58.3 ± 0.7	−17.1	55.8 ± 0.7
GU-200	15 Mar. 1968	43,000	41,000	62.8 ± 2.1	−20.5	61.4 ± 2.1
GU-201	19 Mar. 1968	31,000	28,000	62.8 ± 0.9	−19.8	61.1 ± 0.9
GU-202	19 Mar. 1968	25,000	28,000	64.6 ± 0.9	−20.3	63.0 ± 1.0
GU-203	26 Mar. 1968	41,000	38,000	72.3 ± 0.8	−20.2	70.6 ± 0.8
GU-204	26 Apr. 1968	41,000	39,000	73.6 ± 0.9	−16.9	70.7 ± 0.7
GU-205	30 Apr. 1968	39,000	29,000	63.7 ± 2.2	−22.4	62.8 ± 2.2
GU-206	30 Apr. 1968	27,000	29,000	62.1 ± 0.8	−19.7	60.4 ± 0.9
GU-207	21 May 1968	39,000	34,000	79.5 ± 1.6	−21.8	78.3 ± 1.6
GU-208	4 Nov. 1968	45,000	41,000	74.8 ± 0.8	−18.9	72.7 ± 0.9
GU-209	6 Dec. 1968	41,000	39,000	72.5 ± 0.6	−20.3	70.8 ± 0.7

III. BLOOD PROTEIN SAMPLES

Data reported here are derived from the protein fraction separated from human blood plasma collected in S Scotland. Each sample represents a composite prepared from the whole blood of 10 donors. Collection date quoted is accurate to within ± 5 days.

Blood protein, S Scotland

Sample no.	Sample date	δC^{14}%	δC^{13}‰	Δ%
GU-210	26 Oct. 1952	—3.6 ± 0.5	—28.4	—2.9 ± 0.6
GU-211	20 Sept. 1953	—8.1 ± 0.6	—26.4	—7.9 ± 0.6
GU-212	1 Apr. 1954	—5.4 ± 0.7	—26.2	—5.1 ± 0.8
GU-213	23 Mar. 1955	—1.6 ± 0.5	—26.2	—1.3 ± 0.5
GU-214	5 May 1956	—7.8 ± 0.6	—29.5	—7.0 ± 0.7
GU-215	26 Sept. 1957	—5.0 ± 0.7	—30.8	—3.9 ± 0.8
GU-216	11 Feb. 1960	9.1 ± 0.6	—26.5	9.4 ± 0.7
GU-217	23 May 1961	16.4 ± 0.9	—27.2	16.9 ± 1.0
GU-218	7 Apr. 1962	9.9 ± 0.9	—29.4	10.8 ± 0.9
GU-219	15 July 1963	32.0 ± 1.0	—32.3	33.9 ± 1.1
GU-220	9 Feb. 1964	44.4 ± 1.0	—29.4	45.6 ± 1.0
GU-221	5 Mar. 1965	60.1 ± 0.8	—29.5	61.5 ± 0.8
GU-222	17 Oct. 1966	65.4 ± 0.8	—27.2	66.2 ± 0.8
GU-223	15 Nov. 1966	64.0 ± 0.7	—30.0	65.6 ± 0.8
GU-224	30 Dec. 1966	64.5 ± 0.7	—27.9	65.4 ± 0.7
GU-225	8 Apr. 1967	64.2 ± 0.6	—28.4	65.3 ± 0.7
GU-226	27 Oct. 1967	62.7 ± 0.7	—33.2	65.3 ± 0.8
GU-227	10 July 1968	63.2 ± 1.0	—26.3	63.4 ± 1.0

Comment: C^{14} concentrations in blood protein indicate significant correlation with modifying influences on atmospheric C^{14} levels, viz. Suess effect and bomb effect. Blood protein C^{14} levels, however, did not reach peak concentrations attained in atmosphere, reflecting variations in source of carbon in diet and possibly tissue "turnover" time (Harkness and Walton, 1969).

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GLASGOW UNIVERSITY RADIOCARBON MEASUREMENTS III

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INTRODUCTION

The following list presents results obtained during 1968-69 on a series of samples chosen to investigate temporal variations of C^{14} concentrations in the atmosphere during the past century. Together with data presented previously (Radiocarbon, 1969, v. 11, p. 45-52) they constitute a study of annual variations of C^{14} activities at N temperate latitudes.

Procedures for the analysis of a variety of organic and inorganic materials were previously reported and these have remained virtually unchanged. In some instances C^{14} concentrations were revised slightly in view of mass spectrometric analyses for C^{13}/C^{12} ratios. All δC^{14} and Δ values of recent samples are decay-corrected, although this correction is very small.

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I. SPIRIT SAMPLES

The study of atmospheric C^{14} concentrations in past years through analyses of malt whiskies of known age has continued. Results pub. in Radiocarbon, 1969, v. 11, p. 43-52 established the reliability of malt whiskies as indicators of atmospheric C^{14} concentrations during barley growth periods.

Malt whisky, Scotland series

Sample no.	Barley coll. date	Distill. date	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-228	1919	1920	-1.6 ± 0.6	-27.1	-1.2 ± 0.6
GU-229	1920	1921	-2.0 ± 0.6	-25.7	-1.8 ± 0.6
GU-230	1925	1926	-3.4 ± 0.6	-27.7	-2.8 ± 0.6
GU-231	1935	1936	-1.7 ± 0.5	-27.6	-1.2 ± 0.5
GU-232	1939	1940	-3.5 ± 0.6	-28.1	-2.9 ± 0.6
GU-233	1947	1948	-5.7 ± 0.5	-27.9	-5.2 ± 0.5
GU-234	1947	1948	-5.9 ± 0.7	-29.1	-5.1 ± 0.8

II. VINTAGE WINE SAMPLES

L'Orange and Zimen (1968) have shown that a good correlation exists between atmospheric C^{14} concentrations and those in vintage wine

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samples. To extend our knowledge of past atmospheric C^{14} concentrations a number of French and Portuguese wines were analyzed.

Sample no.	Sample site	Yr	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-238	Portugal	1897	-1.7 ± 0.5	-30.2	-0.7 ± 0.5
GU-239	France	1906	-2.8 ± 0.6	-29.2	-2.0 ± 0.6
GU-240	France	1907	-4.7 ± 0.5	-38.3	-2.2 ± 0.5
GU-241	France	1907	-2.7 ± 0.5	-27.8	-2.2 ± 0.5
GU-242	France	1908	-3.3 ± 0.5	-29.9	-2.4 ± 0.5
GU-243	France	1914	-2.4 ± 0.5	-30.5	-1.3 ± 0.5
GU-244	France	1914	-1.0 ± 1.1	-29.4	-0.1 ± 1.1
GU-245	Portugal	1917	-4.0 ± 0.6	-31.6	-2.8 ± 0.6
GU-246	France	1918	$+97.6 \pm 1.7$	-29.6	$+99.4 \pm 1.8$

Comments: high Δ value indicative of 1963 sample. Since lab contamination of sample to such an extent would seem impossible, discrepancy appears due to mistaken identity of sample. The analysis, however, reveals the possibility of applying C^{14} analysis to dating of recent wines even though accuracy of age-assessment may be limited within certain time periods.

Sample no.	Sample site	Yr	$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-247	France	1920	-1.6 ± 0.5	-30.5	-0.5 ± 0.5
GU-248	France	1926	-3.3 ± 0.6	-28.7	-2.5 ± 0.6
GU-249	Portugal	1927	-4.6 ± 0.5	-31.6	-3.3 ± 0.5
GU-250	France	1928	-3.2 ± 0.6	-32.0	-1.8 ± 0.6
GU-251	France	1928	-2.2 ± 0.5	-28.4	-1.5 ± 0.5
GU-252	France	1929	-2.2 ± 0.5	-31.7	-1.0 ± 0.6
GU-253	France	1929	-2.8 ± 0.5	-31.4	-1.6 ± 0.5
GU-254	Portugal	1929	-2.1 ± 0.6	-29.8	-1.2 ± 0.6

III. TREE SEED SAMPLES

In a study of atmospheric C^{14} concentrations during the period 1959-1968 a number of tree seeds (subm. and id. by U. K. Forestry Comm.) have been analyzed. The seeds, stored in vacuum since collection, represent a variety of species and were coll. from Scotland and Oregon, U.S.A.

		$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-255.	Scotland	18.7 ± 0.6	-24.9	18.7 ± 0.7

Seeds (*Tsuga mertensiana*) coll. 1960 from SW Scotland (56° 30′ N Lat, 3° 30′ W Long).

		$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-256.	Scotland	21.6 ± 0.6	−28.9	22.5 ± 0.6

Seeds (*Pinus mugo*) coll. 1961 from NW Scotland (57° 30′ N Lat, 4° 30′ W Long).

GU-257.	Scotland	29.4 ± 0.7	−26.2	29.8 ± 0.7

Seeds (*Pinus mugo*) coll. 1962 from NW Scotland (57° 30′ N Lat, 4° 30′ W Long).

GU-258.	Scotland	85.4 ± 1.2	−26.8	86.1 ± 1.2

Seeds (*Pinus sylvestris*) coll. 1963 from Moray (57° 30′ N Lat, 3° 30′ W Long).

GU-259.	Scotland	93.8 ± 1.2	−26.7	94.4 ± 1.3

Seeds (*Pinus sylvestris*) coll. 1964 from Moray (57° 30′ N Lat, 3° 30′ W Long).

GU-53.	Scotland	72.9 ± 1.0	−26.9	73.5 ± 1.0

Seeds (*Pinus sylvestris*) coll. 1965 from Moray (57° 30′ N Lat, 3° 30′ W Long).

GU-260.	Scotland	69.9 ± 0.8	−29.4	71.4 ± 0.8

Seeds (*Pinus sylvestris*) coll. 1966 from S Scotland (55° 30′ N Lat, 3° 30′ W Long).

GU-261.	Scotland	62.7 ± 0.7	−25.7	62.9 ± 0.7

Seeds (*Larix decidua*) coll. 1967 from Moray (57° 30′ N Lat, 3° 30′ W Long).

GU-262.	England	55.7 ± 0.7	−33.0	58.2 ± 0.8

Seeds (*Fagus sylvatica*) coll. 1967 from Cirencester (51° 40′ N Lat, 1° 57′ W Long).

GU-263.	Scotland	59.4 ± 0.7	−29.8	60.9 ± 0.7

Seeds (*Picea sitchensis*) coll. 1968 from N Scotland (58° N Lat, 4° 30′ W Long).

GU-264.	Oregon	33.4 ± 1.0	−28.0*	34.2 ± 1.0

Seeds (*Pseudotsuga taxifolia*) coll. 1959 (45° N Lat, 120° W Long).

GU-265.	Oregon	18.5 ± 0.5	−30.6	19.8 ± 0.6

Seeds (*Abies grandis*) coll. 1960 (45° N Lat, 120° W Long).

GU-266.	Oregon	19.9 ± 0.6	−26.5	20.3 ± 0.6

Seeds (*Picea sitchensis*) coll. 1961 (45° N Lat, 120° W Long).

GU-267.	Oregon	28.7 ± 0.8	−25.6	28.8 ± 0.8

Seeds (*Abies nobilis*) coll. 1962 (45° N Lat, 120° W Long).

* Estimated, as mass-spectrometric measurements were not available.

		$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-268.	Oregon	78.7 ± 1.1	−26.3	79.2 ± 1.1

Seeds (*Pinus contorta*) coll 1963 (45° N Lat, 120° W Long).

GU-269.	Oregon	89.2 ± 1.2	−29.6	90.9 ± 1.2

Seeds (*Pinus contorta*) coll. 1964 (45° N Lat, 120° W Long).

GU-270.	Oregon	67.6 ± 1.0	−23.9	67.2 ± 1.1

Seeds (*Abies amabilis*) coll. 1966 (45° N Lat, 120° W Long).

GU-271.	Oregon	70.3 ± 1.0	−26.1	70.7 ± 1.1

Seeds (*Abies nobilis*) coll. 1967 (45° N Lat, 120° W Long).

GU-272.	Oregon	58.7 ± 0.7	−28.4	59.8 ± 0.8

Seeds (*Abies nobilis*) coll. 1968 (45° N Lat, 120° W Long).

Comment: C^{14} activities of N hemispheric tree seeds accurately reflect atmospheric levels during seed growth periods. Rate of equilibration of atmospheric C^{14} concentrations since 1963 is approximated by the expression $\Delta_t = 97e^{-0.10t}$ where Δ_t is the tropospheric C^{14} concentration (%) at time and yr after 1963. Discrepancies between the 2 seed series (Scotland and Oregon) although in part statistical, may also be due to slightly different growth periods and to minor disequilibrium in atmospheric C^{14} distribution in N Lats.

IV. FLAX SEEDS, CEREAL, AND WOOL SAMPLES

A variety of biospheric materials including flax seeds, and cereals coll. near Belfast, N Ireland (54° 35′ N Lat, 5° 50′ W Long) and English wool samples of known age were analyzed to permit estimation of past atmospheric C^{14} activities. Samples were provided by the N Ireland Ministry of Agriculture.

		$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-273.	Flax seeds	−3.5 ± 0.6	−33.2	−1.9 ± 0.6

Seeds (*Linum usitatissimum*) coll. 1934.

GU-274.	Oats	−2.4 ± 0.5	−30.3	−1.3 ± 0.5

Seeds (*Avena sterilis*) coll. 1935.

GU-275.	Barley	−4.0 ± 0.6	−30.0	−3.0 ± 0.6

Seeds (*Hordeum distichum*) coll. 1936.

GU-276.	Flax seeds	−4.3 ± 0.5	−29.9	−3.4 ± 0.5

Seeds (*Linum usitatissimum*) coll. 1936.

GU-277.	Flax seeds	−4.7 ± 0.7	−32.6	−3.2 ± 0.7

Seeds (*Linum usitatissimum*) coll. 1938.

		$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-278.	Flax seeds	−4.5 ± 0.5	−30.7	−3.4 ± 0.5

Seeds (*Linum usitatissimum*) coll. 1938.

GU-279.	Flax seeds	−3.8 ± 0.5	−30.1	−2.8 ± 0.5

Seeds (*Linum usitatissimum*) coll. 1940.

GU-280.	Flax seeds	−3.8 ± 0.6	−32.1	−2.5 ± 0.6

Seeds (*Linum usitatissimum*) coll. 1942.

GU-281.	Flax	−4.4 ± 0.5	−30.7	−3.4 ± 0.6

Straw (*Linum usitatissimum*) coll. 1943.

GU-282.	Flax seeds	−5.3 ± 0.6	−32.6	−3.8 ± 0.6

Seeds (*Linum usitatissimum*) coll. 1944.

GU-283.	Flax seeds	−5.8 ± 0.5	−30.7	−4.7 ± 0.5

Seeds (*Linum usitatissimum*) coll. 1945.

GU-284.	Flax seeds	−6.1 ± 0.5	−32.0	−4.8 ± 0.6

Seeds (*Linum usitatissimum*) coll. 1946.

GU-285.	Flax	−6.0 ± 0.4	−30.7	−4.9 ± 0.4

Straw (*Linum usitatissimum*) coll. 1947.

GU-286.	Flax seeds	−6.1 ± 0.6	−31.0	−5.0 ± 0.6

Seeds (*Linum usitatissimum*) coll. 1948.

GU-287.	Flax seeds	−5.1 ± 0.6	−29.1	−4.3 ± 0.6

Seeds (*Linum usitatissimum*) coll. 1950.

GU-288.	Wool, 1962	20.4 ± 0.6	−30.7	21.7 ± 0.6

Comment: wool sample has C^{14} content representative of 1961 atmospheric C^{14} levels.

GU-289.	Wool	−3.0 ± 0.8	−31.8	−1.7 ± 0.8

Wool coll. 1851 from NE England (54° N Lat, 1° W Long).

GU-290.	Wool	−2.3 ± 0.7	−27.5	−1.8 ± 0.8

Wool coll. 1851 from NE England (54° N Lat, 1° W Long).

GU-291.	Wool	−4.1 ± 0.5	−30.5	−3.0 ± 0.6

Wool coll. 1944 from NE England (54° N Lat, 1° W Long).

Comment: results of analyses of malt whiskies, vintage wines, flax seeds, and other biospheric materials indicate that N hemisphere C^{14} activities have fluctuated significantly on an annual basis during the time period 1890-1950. The causes of these variations are to be discussed elsewhere.

V. ARCHAEOLOGIC SAMPLES

Mortar series

1158 ± 57
GU-292. Carlisle Castle mortar **A.D. 792**

Mortar from "De Ireby's Tower" Carlisle Castle (54° 47′ N Lat, 2° 55′ W Long), from ground floor W room, Garderobe entrance, 9.5 ft from ground level, 2 ft from interior wall face, and 1.5 ft above lower side of stone lintel. Coll. and subm. 1967 by Ministry of Public Bldgs. and Works, Ancient Monuments Branch. *Comment*: true age is 580. Sample prepared from 1st CO_2 fraction during acid hydrolysis and contains less contaminant old carbon than GU-66 (2002 ± 58) prepared from the total CO_2 yield (Radiocarbon, 1969, v. 11, p. 51).

2936 ± 72
GU-293. Carlisle Castle mortar **986 B.C.**

Same mortar sample as GU-292 (above) and GU-66 but prepared from the 2nd CO_2 fraction during hydrolysis. *Comment*: discrepancies between 1st, 2nd, and over-all fractions not due to fractionation since mass spectrometric measurements performed. Presumably non-crystalline carbonate (from atmospheric CO_2) is hydrolyzed preferentially to the carbonate of calcareous sands and/or limestone residues.

738 ± 52
GU-294. **A.D. 1212**

Mortar from Projecting Garderobe Bay Hampton Court Palace (51° 25′ N Lat, 0° 24′ W Long), from top of wall immediately below courtyard paving cobbles. Coll. and subm. 1967 by Ministry of Public Bldgs. and Works, Ancient Monuments Branch. *Comment*: true age is 440. Contamination by old carbon evident.

GU-295. London Tower mortar

δC^{14}‰	δC^{13}‰	Δ‰
7.09 ± 0.59	−17.09	5.39 ± 0.61

Mortar from Cold Harbour Tower, Tower of London (51° 32′ N Lat, 0° 05′ W Long), from NW drum of tower immediately above footing offset and present ground level. Repair mortar from 1953. Coll. and subm. 1967 by Ministry of Public Bldgs. and Works, Ancient Monuments Branch. *Comment*: Δ value representative of post-1953 nuclear era with same C^{14} content as 1956 atmosphere. Thus mortar "hardening" appears to have reached an advanced stage during the 1st 5 to 10 yr (since significant incorporation of 1963 atmospheric C^{14} would have been readily detectable).

7370 ± 87
GU-296. Orford Castle mortar **5420 B.C.**

Mortar from W Tower Orford Castle (52° 05′ N Lat, 1° 35′ W Long), from W wall of tower 35 ft above ground level. Coll. and subm. 1968 by Ministry of Public Bldgs. and Works, Ancient Monuments

Branch. *Comment*: true age is 800. Sample appears contaminated to >50% by inactive carbon.

2012 ± 53
GU-297. Conway Town Wall mortar **62 B.C.**

Mortar from Conway Town Walls (53° 17′ N Lat, 3° 50′ W Long), from steps outside E tower 65 ft from end of tower and from 0.5 ft to 1.5 ft into wall. Coll. and subm. 1968 by Ministry of Public Bldgs. and Works, Ancient Monuments Branch. *Comment*: true age is 680 and thus contamination by old carbon is evident.

370 ± 31
GU-298. Hampton Court mortar **A.D. 1580**

Mortar from Apt 35, Wolsey Rooms Hampton Court Palace (51° 25′ N Lat, 0° 24′ W Long), from brickwork on internal wall ground floor. Coll. and subm. by Ministry of Public Bldgs. and Works, Ancient Monuments Branch. *Comment*: true age is ca. 420 and thus contamination by old carbon is not present.

General Comment: this series of data from mortar samples confirms inherent unreliability of this material for dating purposes in the U.K. (Baxter and Walton, 1970). Studies by Stuiver and Smith (1965) and Delibrias and Labeyrie (1965) suggest that conflicting opinions exist on the value of mortar for dating.

2370 ± 40
GU-299. Kilphedir hut circles, Sutherland, Scotland **420 B.C.**

Charcoal (birch and hazel) from Hut Circle III, 1 of 5 in locality just below turf at Kilphedir site, Sutherland, Scotland, 3.5 mi from sea at Helmsdale (58° 09′ N Lat, 3° 43′ W Long), 400 ft. Coll. and subm. 1968 by H. Fairhurst, Archaeol. Dept., Univ. of Glasgow. *Comment*: age (based on assumption of $\delta C^{13} = -28.10‰$, is in reasonable agreement with archaeologic assessment of ca. 300 B.C.

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ILLINOIS STATE GEOLOGICAL SURVEY RADIOCARBON DATES II

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The following date list includes samples processed by the Illinois State Geological Survey Radiocarbon Dating Laboratory from September 1968 through November 1969. Detailed descriptions of sample methods are published elsewhere (Kim and Ruch, 1969; Kim, Ruch, and Kempton, 1969).

Ages are based on a C^{14} half-life of 5568 years, and errors (1σ) quoted are based on counting errors of NBS oxalic acid standard, sample, and background. In general, 200 years is chosen as a minimum error, if the calculated error is less than 200 years.

For geochemical samples, δC^{14} is calculated as follows:

$$\delta C^{14} = \frac{^{A}\text{sample} - {}^{A}\text{standard}}{^{A}\text{standard}} \times 1000$$

where ^{A}sample is specific activity of a sample and ^{A}standard is 95% of NBS oxalic acid standard specific activity.

The laboratory counting system used is capable of dating samples up to 48,000 years old with a 10cc counting vial and as much as 52,000 years old with a 20cc counting vial. Maximum ages are based on a counting period of 3 days and a counting error of 3σ.

Members of the Isotopic Analysis Committee, J. P. Kempton (Chairman), Charles Collinson, and R. E. Bergstrom, with John C. Frye, Chief, assisted in selecting and screening samples for radiocarbon dating. H. B. Willman helped to prepare the manuscript. R. R. Ruch and J. G. Goessling assisted with laboratory operations.

SAMPLE DESCRIPTIONS

GEOLOGIC SAMPLES

A. Illinois

ISGS-12. Danvers Section, Z-1 **23,900 ± 200**
21,950 B.C.

Wood chips from organic silt; McLean Co., SE¼ SE¼ NW¼ Sec. 34, T25N, R1W, 3 mi SW of Congerville, Illinois, 5 mi NW of Danvers, Illinois (40° 35′ N Lat, 89° 14′ 40″ W Long). From Farmdale Silt 4½ ft below the surface. Coll. 1967 by J. P. Kempton, P. B. DuMontelle, S. M. Kim, and R. R. Ruch, Illinois State Geol. Survey; subm. by S. M. Kim. *Comment* (S.M.K.): this sample was used principally as a check and was dated as 23,880±490 B.P. (TX-693, E. M. Davis, pers. commun.) and 24,000±870 B.P. (AERIK-2, K. R. Yang, pers. commun.). A sample was previously dated as 25,150±700 B.P. (W-406) from the same stratigraphic unit (Frye, Glass, and Willman, 1962, p. 50).

ISGS-16. Lake Bloomington Spillway Section **>40,000**

Wood chips from organic silt; McLean Co., NW¼ SW¼ NE¼ Sec. 1, T25N, R2E, 4.5 mi NE of Hudson, Illinois, 4 mi ESE of Kappa, Illinois (40° 39′ 45″ N Lat, 88° 56′ 15″ W Long). From an organic zone below 3 tills and above 2 lower exposed tills that are separated by boulder pavement (Leonard and Frye, 1960, p. 29). Coll. 1967 by J. P. Kempton, P. B. DuMontelle, and S. M. Kim, Illinois State Geol. Survey; subm. by J. P. Kempton. *Comment* (J.P.K.): date eliminates the possibility that the organic silt is Farmdalian in age.

ISGS-19. Mulberry Grove Section, P-3142 **>40,000**

Wood fragments in gravel; Fayette Co., SW corner, Sec. 31, T6N, R1W, ½ mi SE of Mulberry Grove, Illinois. From a gravel between Vandalia and Smithboro tills (Jacobs and Lineback, 1969). The gravel is part of a channel fill truncating the lower part of the Vandalia till and the upper part of the Smithboro till. The channel contains an abundance of twigs and branches. Coll. 1967 by A. M. Jacobs, Illinois State Geol. Survey; subm. by A. M. Jacobs and J. A. Lineback.

ISGS-21. Macon County, P-3866 **25,500 ± 600**
23,500 B.C.

Peat; Macon Co., NE¼ SW¼ NW¼ Sec. 13, T16N, R1W, 1 mi SSE of Niantic, 9 mi W of Decatur, Illinois (39° 50′ 20″ N Lat, 89° 09′ 10″ W Long). From silty peat unit overlying gray silt (Altonian-Sangamonian) below Peoria Loess. Coll. 1968 by J. A. Lineback and N. C. Hester, Illinois State Geol. Survey; subm. by J. A. Lineback. *Comment* (J.A.L.): pollen samples taken from this peat and gray silt below indicate that spruce-pine forest existed in this area before 25,500 B.P. during deposition of the peat (Farmdalian Substage).

ISGS-25. Macon County, Ni 323-335 **>33,000**

Organic silt from Macon Co., NE¼ SW¼ NW¼ Sec. 13, T16N, R1W, 1 mi SSE of Niantic, 9 mi W of Decatur, Illinois (39° 50′ 20″ N Lat, 89° 09′ 10″ W Long). From a core sample 323 to 335 cm below surface. Coll. 1968 by J. A. Lineback and N. C. Hester; subm. by J. A. Lineback. *Comment* (J.A.L.): sample is ca. 30 cm below a Farmdalian peat dated 25,500±600 B.P. (ISGS-21) and is probably from the Roxana Silt of Altonian age. Pollen samples from this core show that spruce-pine forest became dominant in the area at the horizon dated >33,000 B.P. Pollen studies indicate that this spruce-pine forest persisted until the end of Woodfordian time.

ISGS-31. Wedron Section, P-1915 **25,900 ± 500**
23,950 B.C.

Wood within pink till; LaSalle Co., NW¼ SE¼ NW¼ Sec. 9, T34N, R4E, W edge of Wedron, Illinois (41° 26′ 5″ N Lat, 88° 48′ 45″ W Long). The wood was found in pink "Bloomington" till 4 ft above base in Wedron sec. (Frye and Willman, 1965). Coll. 1964 by H. B. Willman and

J. C. Frye, Illinois State Geol. Survey; subm. by J. C. Frye. *Comment* (J.C.F.): wood almost certainly had been incorporated into till from underlying Farmdale Silt.

Vandalia Core series

ISGS-5.	VAND-B, 251 to 257 cm	>22,000
ISGS-9.	VAND-A, 237 to 243 cm	>22,300
ISGS-10.	VAND-A, 247 to 251 cm	>27,900
ISGS-11.	VAND-A, 273 to 280 cm	38,100 ± 1000 36,150 B.C.
ISGS-13.	VAND-A, 327 to 346 cm	>40,000
ISGS-14.	VAND-Q, 145 to 170 cm	8300 ± 1900 6350 B.C.
ISGS-22.	VAND-C, 257 to 267 cm	>40,000

Core samples of organic-rich sediments are from an ice-block lake basin formed in Illinoian drift. Site is located SW¼ NE¼ SW¼ Sec. 3, T5N, R1W of Fayette Co., 0.8 mi SSW of Hagarstown, 6.0 mi SW of Vandalia, Illinois (38° 54′ 00″ N Lat, 89° 11′ 30″ W Long). Series dated for current research project, "Pollen Analysis of Pleistocene Deposits from Illinois," conducted jointly by the Limnological Research Center, Univ. of Minnesota and the Illinois State Geol. Survey. Coll. 1968 by H. E. Wright and E. J. Grüger, Univ. of Minnesota, and A. M. Jacobs; subm. by A. M. Jacobs. *Comment* (A.M.J.): samples indicate more or less continuous sedimentation from Recent to ca. 40,000 B.P. Preliminary results on pollen analysis and clay mineralogy of the sediments and geomorphology of the lake basin were presented at the 7th INQUA Congress, Paris, France (Jacobs, 1969; Grüger, 1969).

Danville area samples

ISGS-15. Vermilion County, Danville 1-Wood >38,000

Wood in till; Vermilion Co., NE¼ SW¼ SW¼ Sec. 33, T20N, R12W, 1.25 mi N, and 1.75 mi W of Hillery, Illinois (40° 8′ 45″ N Lat, 87° 44′ 0″ W Long). From basal Wisconsinan till, 3rd till in the sec. 25 ft below surface (Johnson, Gross, and Moran, 1969, ms. in preparation). This till includes the interval from 15 ft 8 in. to 38 ft 8 in. from top of sec. Coll. 1968 by W. H. Johnson, D. L. Gross, and S. R. Moran, Univ. of Illinois; subm. by D. L. Gross. *Comment* (D.L.G.): no samples from Danville, Illinois, region have yielded a finite date.

ISGS-23. Vermilion County, 5-14 >40,000

Wood in silt; Vermilion Co., SE¼ NE¼ NE¼ Sec. 2, T19N, R12W, 3 mi W of Danville, Illinois (40° 8′ 35″ N Lat, 87° 40′ 43″ W Long). From 2½ ft bed of carbonaceous silt between 2 till units; top of bed is 17 ft below surface, and bottom of silt bed is 20 ft above base of exposure.

Coll. by W. H. Johnson, D. L. Gross, and S. R. Moran; subm. by D. L. Gross. *Comment* (D.L.G.): from regional correlations, this silt is now believed to be Illinoian.

ISGS-29. Vermilion County, Danville K-19 **>47,000**

Wood from Vermilion Co., SW¼ NW¼ NW¼ Sec. 4, T19N, R12W, 4.5 mi W of Danville, Illinois (40° 8′ 30″ N Lat, 87° 43′ 50″ W Long). From peat and silt 2.5 ft thick, below 2 tills. Coll. and subm. 1969 by W. H. Johnson. *Comment* (D.L.G.): from regional correlations, this peat is now believed to be Illinoian.

Urbana Mastodon site

ISGS-17A. Urb Mast No. 1 **7490 ± 200** **5540 B.C.**

Bone dissolved in 2N HCl; insoluble fraction combusted and dated.

ISGS-17B. Urb Mast No. 1 **8330 ± 200** **6380 B.C.**

Bone washed with 0.1N NaOH; then dissolved in 2N HCl. Insoluble fraction combusted and dated.

ISGS-17C. Urb Mast No. 1, Ivory **9190 ± 200** **7240 B.C.**

Ivory first dissolved in dilute CH_3COOH; insoluble fraction acidified with H_3PO_4; resulting CO_2 was dated.

Bones of *Mammut americanum* from Urbana, Illinois, near center SW¼ SW¼ Sec. 15, T19N, R9E, 20° N from WCCR Radio Tower (40° 06′ 03″ N Lat, 88° 10′ 45″ W Long). The fragmented but well-preserved sample is from homogeneous, gray, slightly sandy clay that apparently represents deposition in a pond on the Urbana Moraine. Clay apparently overlies the uppermost of 3 tills above the Farmdale horizon, and is overlain by 31 in. of dark, humic soil. Coll. 1969 by C. Collinson, Illinois State Geol. Survey; subm. by C. Collinson and J. P. Kempton. *Comment* (S.M.K.): sample is contaminated with modern humic acids. The bone "collagen fraction" and the ivory ages do not agree, perhaps due to carbon-isotopic fractionation or old carbonate contamination of the ivory.

Stockton Northeast Core 2

ISGS-24. Jo Daviess, B-2JD-5, depth 13½ to 5 ft **27,200 ± 400** **25,250 B.C.**

ISGS-30. Jo Daviess, B-2JD-6, depth 16 to 17½ ft **26,300 ± 400** **24,350 B.C.**

Organic silt from Jo Daviess Co., NE¼ NW¼ NE¼ Sec. 32, T28N, R5E, ca. 3½ mi NE of Stockton, Illinois (89° 56′ 10″ N Lat, 89° 56′ 35″ W Long). From Farmdale Silt. Sequence from top: Peoria Loess 13 ft, Farmdale Silt 5 ft, accretion-gley (Sangamonian Stage?) and Illinoian drift including Winslow till 40 ft (Frye *et al.*, 1969). Coll. and subm. 1969 by J. P. Kempton. *Comment* (J.P.K. and S.M.K.): dates indicate that silt is entirely Farmdalian in age. Sample B-2JD-6 was from base of the organic silt. Time inversion shown by dates should be ignored and dates considered equivalent because humic acids were not removed from the samples prior to processing, and the dates are within 3σ error.

Shelby County Moraine section

ISGS-26. 16-12 **20,000 ± 200**
18,050 B.C.

ISGS-32. 16-17 **21,300 ± 500**
19,350 B.C.

Silty peat samples from Shelby Co., NE¼ SW¼ SW¼ Sec. 8, T11N, R3E, 1 mi E of Shelbyville, Illinois (39° 24′ 36″ N Lat, 88° 46′ 54″ W Long). Upper sample from upper 2 in. of 18 in. peat bed; lower sample is from base of peat, which underlies Shelbyville till. Section includes 30 ft of Shelbyville till, 2 to 4 ft of silt, 18 in. of peat, 5 to 10 ft of accretion-gley, and 18 ft of Vandalia till over bedrock. Coll. 1969 by D. L. Gross and W. H. Johnson, Univ. of Illinois; subm. by D. L. Gross. *Comment* (D.L.G.): samples collected below base of Woodfordian deposits in the Wisconsinan terminal moraine. Upper sample dates maximum advance of ice of the Wisconsinan Stage in this region, the lower dates beginning of peat deposition. Together, samples indicate time span represented by the peat at this locality.

Quarry, Coles County

ISGS-27. 68F4-8A **19,500 ± 200**
17,500 B.C.

Wood from bedded sand and silt samples; Coles Co., NW¼ NE¼ SW¼ Sec. 5, T12N, R10E, 3 mi ENE of Charleston and 5 mi WSW of Ashmore, Illinois (39° 30′ 50″ N Lat, 88° 6′ 56″ W Long). Sample collected from a thick-bedded sand and silt 1 ft above the top of an organic silt and peat of probable Farmdalian age and below Woodfordian till. Coll. 1969 by W. H. Johnson, J. P. Kempton, and J. P. Ford, Illinois State Geol. Survey; subm. by J. P. Kempton. *Comment* (J.P.K.): sample indicates that the Woodfordian glacier reached this area, which is near the southernmost limit of Wisconsinan glaciation in Illinois, <19,500 ± 200 B.P. yr ago.

ISGS-28. 68F3-8 **21,300 ± 200**
19,350 B.C.

Wood chips and organic silt sample from Coles Co., SW¼ NE¼ NW¼ Sec. 5, T12N, R10E, 3 mi ENE of Charleston and 5 mi WSW of Ashmore, Illinois (39° 31′ N Lat, 88° 6′ 56″ W Long) ca. 1/3 mi N of ISGS-27 but in the same quarry. Sample came from organic silt 1 ft thick 46.5 ft below land surface. Silt lies below 2 tills that are similar but separated by thin sand and gravel, and overlies another till that is correlated with Vandalia till. Coll. 1969 by W. H. Johnson, J. P. Kempton, and J. P. Ford: subm. by J. P. Kempton. *Comment* (J.P.K.): date indicates that both tills above silt are Woodfordian.

B. Canada

ISGS-18. Yukon, PA-12 **$\delta C^{14} = +19.6‰$**

Decomposed peat from area 140 mi W of Whitehorse, Yukon Territory, Canada (61° 23′ N Lat, 138° 13′ W Long). Sample was 5 in. below surface at bottom of modern organic layer. Coll. 1968 by C. S. Alexander and L. W. Price, Univ. of Illinois; subm. by C. S. Alexander.

ISGS-20. Yukon, 18 **$\delta C^{14} = -35.8‰$**

Decomposed peat from area 140 mi W of Whitehorse, Yukon Territory, Canada (61° 23′ N Lat, 138° 13′ W Long). Sample was 55 in. below surface. Coll. 1968 by C. S. Alexander and L. W. Price; subm. by C. S. Alexander.

CORRECTION

ISGS-3. Shark Bay, Australia **38,600 ± 500**
36,650 B.C.

Date previously pub. as 38,600 ± 200 (Radiocarbon, 1969, v. 11, p. 394).

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[RADIOCARBON, VOL. 12, No. 2, 1970, P. 509-525]

INSTITUTO VENEZOLANO DE INVESTIGACIONES CIENTIFICAS NATURAL RADIOCARBON MEASUREMENTS V

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The laboratory has been operating more than five years, supported entirely from Venezuelan government funds. Approximately 530 samples have been dated to the end of 1969. Of these, 40% are archaeologic specimens, the majority (141 samples) from Venezuela. Materials from most other countries of Latin America have been processed. The rest of the samples are from research programs of the Radiocarbon Laboratory itself. Thirty per cent of the total are measurements on carbonate species extracted from Venezuelan ground water aquifers.

In years previous to the inauguration of the Caracas laboratory (November, 1963), only 56 samples from Venezuela had been accepted by foreign universities (Rouse and Cruxent, 1963). Establishment of a radiocarbon dating facility permits scientists in this country to eliminate dependence on distant laboratories in the United States or Europe. Furthermore, possibilities for studies have expanded considerably and important cultural, scientific, and practical advances have been made. The pre-history of the entire Caribbean area is now being investigated (Cruxent and Rouse, 1969), as well as details in the Venezuelan chronology (Wagner, 1967; Zucchi, 1965). Ground waters of the arid zones of this country have been thoroughly sampled and critical facts have emerged (Tamers, 1967b). For example, it was found that the unique fresh water supply for the second largest city in Venezuela comes from a fossil ground water deposit that could be exhausted in the near future. A variety of other projects are yielding significant results, published periodically in international scientific journals.

The dates presented here, as in the previous lists, were calculated using 5568 years as the half-life of carbon-14. A.D. 1950 is the reference year in the B.P. (before present) notation of ages. The modern standard is taken as 95% of the activity of the NBS oxalic acid. Errors are the standard deviations arising from the random nature of the radioactive disintegration process. The modern reference activity is 21.7 cpm and the background 6.9 cpm for the 3 cc benzene counter vessel used for the routine measurements. The laboratory employs liquid scintillation techniques with synthesized benzene. A chromium activated silica-alumina catalyst (Pietig and Scharpenseel, 1966) converts acetylene to benzene. Acetylene production is described in a previous date list (Tamers, 1969a).

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G. Chuchani, head, are important to the operation of the laboratory. Routine chemical analyses and the benzene syntheses are done by the technicians, V. García and F. Machado. A. Russo maintains the electronics.

Special acknowledgment must be made to the past director of I.V.I.C., Marcel Roche, who was responsible for the decision to establish the radiocarbon laboratory in 1963 and who has continued to be exceptionally interested in all ways with its functioning.

SAMPLE DESCRIPTIONS

I. GROUND WATER SAMPLES

Measurements presented here, except for IVIC-565, represent the continuation of the sequential sampling program for various ground water aquifers in Venezuela. The waters on the N and S sides of Lake Valencia and those of the Bosque Macuto in Barquisimeto are modern. When corrected for limestone dilution, they show nuclear weapon testing contamination (Tamers, 1967b). Annual samplings permit comparisons with previously measured excess activity levels of plants in this country, which, in favorable cases, can result in exact age determinations of these contemporary materials (Tamers, 1969b).

The Maracaibo aquifer is a non-recharged deposit and annual measurements verify this. Nevertheless, the well at La Cañada shows periodically decreasing ages, either due to infiltration of younger water from the inland Campo 4 deposit or from the Lake of Maracaibo, which is ca. 100 m distant.

The well at the Finca del Portugués was tested because it was believed that this ground water could not be more than a few years old. The radiocarbon contamination level in Venezuela being approx. constant at 160% modern during the past 5 yr (cf. Sec. IV), if the limestone corrected concentration gave approx. this value, this would be evidence for the validity of radiocarbon dates on ground water. The following formula was used (Tamers, 1969b):

$$\delta C^{14}_{corrected} = \frac{\delta C^{14}_{final}}{\delta C^{14}_{initial}} \div \frac{[C_{total}] - \frac{1}{2}[HCO_3^-]}{[C_{total}]}$$

where $[HCO_3^-]$ is the bicarbonate concentration (= 2.1 meq/l here) measured at the well by a sulfuric acid titration controlled with a pH meter. $[C_{total}]$ is the total amount of dissolved carbonate species (= 2.4 meq/l here). δC^{14}_{final} is the measured activity and $\delta C^{14}_{initial}$ is the activity of the modern standard. The value for $\delta C^{14}_{corrected}$ is calculated to be 156.4 ± 7.9% modern, the error term taking into account uncertainties in carbonate species analyses. This agrees with the expected value.

Radiocarbon contents are reported as % of modern without correction for limestone dilution. Earlier measurements in these series are given in previous date lists.

	Collection (day/month/yr)	C^{14} (% of modern)
Wells of Valencia Lake Basin		
IVIC-567. Mariara 1 (10° 15′ N Lat, 67° 43′ W Long)	4/2/69	88.9 ± 0.7
IVIC-568. Mariara 2 (10° 13′ N Lat, 67° 43′ W Long)	4/2/69	99.0 ± 0.8
IVIC-569. El Trompillo (10° 4′ N Lat, 67° 46′ W Long)	4/2/69	100.2 ± 0.7
IVIC-570. Güigüe 1 (10° 5′ N Lat, 67° 47′ W Long)	4/2/69	97.8 ± 0.8
IVIC-571. Güigüe 2 (10° 5′ N Lat, 67° 47′ W Long)	4/2/69	93.9 ± 0.8
IVIC-572. Güigüe 3 (10° 5′ N Lat, 67° 47′ W Long)	4/2/69	96.5 ± 0.8
Barquisimeto Wells		
IVIC-610. Macuto 1 (10° 3′ N Lat, 69° 19′ W Long)	6/5/69	93.0 ± 0.8
IVIC-611. Macuto 2 (10° 3′ N Lat, 69° 19′ W Long)	6/5/69	89.1 ± 0.8
IVIC-612. Macuto 3 (10° 3′ N Lat, 69° 19′ W Long)	6/5/69	82.4 ± 0.8
IVIC-613. Macuto 4 (10° 3′ N Lat, 69° 19′ W Long)	6/5/69	98.8 ± 0.9
IVIC-614. Macuto 5 (10° 3′ N Lat, 69° 19′ W Long)	6/5/69	86.5 ± 0.8
IVIC-615. Macuto 6 (10° 3′ N Lat, 69° 19′ W Long)	6/5/69	85.6 ± 0.7
IVIC-616. Macuto 7 (10° 3′ N Lat, 69° 19′ W Long)	6/5/69	87.9 ± 0.8
IVIC-617. Macuto 8 (10° 3′ N Lat, 69° 19′ W Long)	6/5/69	83.9 ± 0.8
Maracaibo Aquifer Wells		
IVIC-628. Campo 1, Pozo 28 (10° 33′ N Lat, 71° 42.5′ W Long)	2/9/69	19.0 ± 0.4
IVIC-629. Campo 1, Pozo 23 (10° 32′ N Lat, 71° 43′ W Long)	2/9/69	17.8 ± 0.4

	Collection (day/month/yr)	(% of modern) C^{14}
IVIC-630. Campo 2, Pozo 6 (10° 30′ N Lat, 71° 48′ W Long)	2/9/69	26.1 ± 0.4
IVIC-631. Campo 2, Pozo 2 (10° 30′ N Lat, 71° 48′ W Long)	2/9/69	25.8 ± 0.4
IVIC-632. Campo 3A, Pozo 1 (10° 30′ N Lat, 71° 43′ W Long)	2/9/69	17.0 ± 0.4
IVIC-633. La Cañada (10° 25′ N Lat, 71° 41′ W Long)	2/9/69	5.49 ± 0.34
Altos de Pipe		
IVIC-565. Finca del Portugués (10° 23′ N Lat, 66° 58′ W Long)	2/1/69	87.9 ± 0.7

II. ARCHAEOLOGIC SAMPLES

A. Venezuela

Indo-Hispanic Epoch

IVIC-625. La Maternidad Norte **200 ± 60** **A.D. 1750**

Small charcoal sample from surface exposed by moving sand dunes, N of Monumento de la Maternidad, Parque de Exposiciones, Coro, state of Falcón (11° 26′ N Lat, 69° 40′ W Long). Assoc. pottery might be Dabajuroid from Caquetio Indians. Coll. 1969 and subm. by J. Cruxent, I.V.I.C. *Comment*: see IVIC-626.

IVIC-626. La Maternidad Sur **500 ± 60** **A.D. 1450**

Charcoal from surface of same site as IVIC-625, but a little more S. Coll. at same time. *Comment* (J.C.): both IVIC-625 and IVIC-626 dates are reasonable; however, even after returning to site again, we were unable to find any trace of European artifacts.

Neo-Indian Epoch

IVIC-673. El Muro de Yaima **860 ± 70** **A.D. 1090**

Charcoal taken 0.00 to 0.25 m below surface of shell mound NE of village of Santa Rita, Paraguaná peninsula, state of Falcón (12° 9′ N Lat, 69° 57′ W Long). Assoc. with pottery of Dabajuroid style from Paraguaná which have not been dated. Coll. 1969 and subm. by J. Cruxent. *Comment* (J.C.): date is reasonable. Sample was expected to be Period IV.

IVIC-574. Monou-teri **500 ± 170** **A.D. 1450**

Charcoal, 0.25 to 0.50 m below surface, near Mavaco R., a tributary of the Orinoco, Amazonas Terr. (3° 25′ N Lat, 65° 30′ W Long). Assoc.

with crude simple pottery. First date for region and indicates origins of Yanamamo (Waika) Indians now in area. Coll. 1969 and subm. by E. Wagner, I.V.I.C., who estimated age at 400 to 1000 yr. *Comment* (E.W.): date is reasonable.

1010 ± 70
IVIC-573. Monou-teri soil, 0.00 to 0.25 m **A.D. 940**

Black earth from same pit as IVIC-574, taken 0.00 to 0.25 m below surface. Abundant rootlets removed by hand and carbonates removed by acid pretreatment. Organic carbon content was 1.8%, relatively high. Coll. at same time as IVIC-574. Sample used as part of program to study the validity of radiocarbon dates on soil. *Comment*: see IVIC-575.

910 ± 70
IVIC-575. Monou-teri soil, 0.25 to 0.50 m **A.D. 1040**

Black earth in contact with charcoal of IVIC-574, 0.25 to 0.50 m below surface. Rootlets removed by hand and absence of carbonates insured by acid pretreatment. Organic carbon content was 1.6%, a high value similar to that of the adjacent level of IVIC-573. Coll. at same time as previous samples. Control for investigation of validity of radiocarbon dates on soil. *Comment*: IVIC-573 and IVIC-575, with statistically indistinguishable ages, produce radiocarbon dates older than that of assoc. charcoal. This is surprising in view of conclusions of the Bonn lab. (Scharpenseel and Pietig, 1969) that soil-date errors make these materials appear too young. We also found, in the Taima-taima site, a wood sample (IVIC-655, this date list) that was younger than organic carbon fraction of its assoc. soil (IVIC-627, this date list). An explanation of the Monou-teri soil samples is that the soil was mixed deeper than 0.50 m before IVIC-574 was deposited. However, this could not have been the case for Taima-taima samples.

650 ± 80
IVIC-645. El Mocao Alto bones A-1 **A.D. 1300**

Organic carbon of human bone, not charred, taken 0.75 to 1.10 m below surface, Trench A, Pit 1, 4 km SE Mucuchíes, state of Merida, in Venezuelan Andes (9° 19′ N Lat, 71° 8′ W Long). Assoc. with ceramic fragments, stone slabs, grinding stones, and lithic bat wing pendants. El Mocao Alto charcoal previously dated from 450 to 1120 B.P. (Tamers, 1969a). Coll. 1968 and subm. by E. Wagner. Hydrochloric acid pretreatment completely removed carbonates. Organic carbon content was 3.0%. *Comment* (E.W.): date falls within range of charcoal dates, but is older than IVIC-481 which dated human bones at 230 ± 40 (Radiocarbon, 1969, v. 11, p. 404). Human skeleton material is atypical if it is Indian.

970 ± 70
IVIC-650. La Era Nueva E-8, 0.25 to 0.50 m **A.D. 980**

Charcoal from Pit 8, Sec. E. excavated 0.25 to 0.50 m below surface of site ca. 8 km SE Mucuchíes, state of Mérida, in Venezuelan Andes (9° 19′ N Lat, 71° 10′ W Long). Previous dates for site were 820 to

1060 B.P. (Tamers, 1969a). Assoc. with crude pottery, bones, terrestrial snail shells, and corn cobs. Coll. 1968 and subm. by E. Wagner. *Comment* (E.W.): agrees with previous dates from same site.

IVIC-651. La Era Nueva E-9, 0.50 to 0.75 m **Modern**

Small charcoal sample from Pit 9, Sec. E, taken 0.50 to 0.75 m below surface of same site as IVIC-650. Pit and section, at level 0.25 to 0.50 m below surface, previously dated at 820 ± 70 B.P. (IVIC-447, Radiocarbon, 1969, v. 11, p. 404). Coll. 1968 and subm. by E. Wagner. *Comment* (E.W.): probably contaminated with modern charcoal.

430 ± 80
IVIC-648. Frailejón leaves **A.D. 1520**

Dried frailejón (*Espeletia* sp.) leaves apparently used as packing material for artifacts including ceramic fragments, bat wing pendants, and fruit seeds found in cave near Mucuchíes, state of Mérida, Venezuelan Andes by P. Villarreal. Coll. 1967 and subm. by E. Wagner. *Comment* (E.W.): date reasonable for this area.

La Calzada series

Continuation of samples dated from artificial mound, No. 1, near La Calzada ranch in state of Barinas (8° 2′ N Lat, 70° 8′ W Long). Series of dates ranging from modern to 1990 B.P. were reported in previous date list (Tamers, 1969a). Mound contains Caño del Oso and La Betania complex ceramic from Neo-Indian Periods II to IV (Zucchi, 1965). Coll. 1968 to 1969 by A. Zucchi and E. Duran, I.V.I.C., and subm. by A. Zucchi. The samples reported here are all charcoal.

2870 ± 150
IVIC-549. La Calzada B-2, 9.25 to 9.50 m **920 B.C.**

Sample from Trench B, Pit 2. Subm. to obtain date on lower level of mound. Caño del Oso complex pottery found in all levels of this trench and pit. Level 8.50 to 8.75 m previously dated at 1510 ± 70 B.P. (IVIC-471, Radiocarbon, 1969, v. 11, p. 405).

1490 ± 80
IVIC-550. La Calzada B-1, 9.25 to 9.50 m **A.D. 460**

1530 ± 80
IVIC-551. La Calzada B-1, 9.50 to 9.75 m **A.D. 420**

Samples from Trench B, Pit 1. Level 7.75 to 8.00 m previously dated at 1800 ± 100 B.P. (IVIC-472, Radiocarbon, 1969, v. 11, p. 405).

1690 ± 90
IVIC-580. La Calzada B-3, 11.75 to 12.00 m **A.D. 260**

1740 ± 70
IVIC-581. La Calzada B-3, 12.00 to 12.25 m **A.D. 210**

1400 ± 60
IVIC-582. La Calzada B-3, 12.25 to 12.50 m **A.D. 550**

IVIC-583. La Calzada B-3, 12.50 to 12.75 m **1820 ± 70**
A.D. 130

IVIC-584. La Calzada B-3, 12.75 to 13.00 m **1800 ± 70**
A.D. 150

Samples from Trench B, Pit 3. Assoc. with material corresponding to Caño del Oso complex.

IVIC-586. La Calzada A-8, 10.50 to 10.75 m **1510 ± 80**
A.D. 440

IVIC-587. La Calzada A-8, 11.50 to 11.75 m **1570 ± 70**
A.D. 380

IVIC-588. La Calzada A-8, 12.00 to 12.25 m **1480 ± 70**
A.D. 470

Samples from Trench A, Pit 8. Assoc. with Caño del Oso complex ceramics.

IVIC-593. La Calzada A-6, 9.75 to 10.00 m **1350 ± 70**
A.D. 600

IVIC-592. La Calzada A-6, 11.75 to 12.00 m **1810 ± 80**
A.D. 140

IVIC-591. La Calzada A-6, 12.50 to 12.75 m **1640 ± 80**
A.D. 310

Samples from Trench A, Pit 6. All with Caño del Oso complex ceramics.

IVIC-590. La Calzada A-14, 12.00 to 12.25 m **1730 ± 80**
A.D. 220

Sample from Trench A, Pit 14. In contact with Caño del Oso and La Betania complex ceramics.

General Comment (A.Z.): series of dates obtained for Mound 1 presents irregularity that can be explained by the fact that the constructors employed earth corresponding to old habitation surfaces. Dates from 1500 to 2870 B.P. are from these old occupations, whereas those from 1400 to 1500 B.P. are possibly from initiation of mound construction.

IVIC-557. Puerto Carayaca 1 **1050 ± 70**
A.D. 900

Charcoal sample, PC 1-pp 1-6, from Pit 1, 0.75 to 0.90 m below surface in excavation on W side of Puerto Carayaca village, near La Guaira, Venezuela (10° 30′ N Lat, 67° 15′ W Long). Assoc. with direct secondary human burial, abundant ceramic fragments, fish bones, sea shells, and a polished stone. Coll. 1968 and subm. by J. Armand, Univ. de Oriente, Ciudad Bolivar, Venezuela.

IVIC-589. Quíbor 2nd **1650 ± 70**
A.D. 300

Charcoal from Indian burial site in Bolivar Plaza of Quíbor, state of Lara, Venezuela (9° 55′ N Lat, 69° 38′ W Long). Taken ca. 1.20 m below surface and assoc. with unclassified type of pottery, but believed to be at least 1000 yr old. Previous charcoal date on this site of 290 ± 60 B.P. (IVIC-332, Radiocarbon, 1967, v. 9, p. 241) was unacceptable and considered an intrusive sample. Coll. 1969 by A. Lucena, Univ. Central de Venezuela, Caracas; subm. by J. Cruxent. *Comment* (J.C.): radiocarbon date agrees with estimated antiquity.

Paleo-Indian Epoch

IVIC-627. Taima-taima soil **12,580 ± 150**
10,630 B.C.

Friable, blocky structure, sandy soil, dark gray, with abundant sulphur, taken 1.50 to 2.25 m below surface of Pleistocene animal kill site near Coro, state of Falcón, Venezuela (11° 30′ N Lat, 69° 30′ W Long). Date on organic carbon, 0.2% concentration, carbonate removed by acid pretreatment. Sample from soil Horizon C and in contact with animal bones. Organic carbon in other bones from this site previously dated at 13,010 ± 280 and 14,440 ± 435 B.P. (IVIC-191-1 and IVIC-191-2, Radiocarbon, 1966, v. 8, p. 206-207). Coll. 1969 and subm. by J. Cruxent. *Comment*: Bonn lab. showed (Scharpenseel and Pietig, 1969) that soil dates can be too young by as much as 5000 yr in regions with abundant plant cover. However, the situation here is confused because the present vegetation is scarce, but A horizon has very high carbon content. Soil dating in this site is being continued.

IVIC-655. Taima-taima wood **11,860 ± 130**
9910 B.C.

Wood, black with abnormally high density, apparently well-preserved, from same site and ca. same depth as sample of IVIC-627. Carbonates removed by acid pretreatment. Sample taken in apparent direct assoc. with Pleistocene animal bones. Coll. 1969 and subm. by J. Cruxent. Taima-taima archaeologic site has been described in a previous article (Cruxent, 1967). *Comment*: wood was preserved by sulfides in soil. Concordance of this date with that of soil sample, IVIC-627, was unexpected. Even more difficult to explain is fact that bone dates are older, since bone invariably has errors that make dates too recent or else has no error. One possible explanation is that wood sample is intrusive, buried by animals that came after those offering bones for previous dating.

B. Colombia

IVIC-559. Necropolos Alto **630 ± 70**
A.D. 1320

Small charcoal sample, S-Gua-2, T-1, MC-1, from filling of Tomb 1, 1.5 m below surface. Municipality of Guapotá, Dept. of Santander, Colombia (6° 18′ N Lat, 73° 19′ W Long). Assoc. with ceramic vessels similar to those found in nearby Oiba, Santander. Tomb is a well with lateral chamber. Coll. 1966 and subm. by D. R. Sutherland, Dept. Anthropol. and Sociol., Univ. S. Carolina, U.S.A. *Comment* (D.R.S.): this sample and IVIC-560 are 1st radiocarbon dates for area N of Bogota in Santander. Age is reasonable.

790 ± 60
IVIC-560. San Lorenzo **A.D. 1160**

Charcoal sample, S-Oib-1, T-3, MC-1, found inside ceramic vessel on floor of Tomb 3, 1.9 m below surface. On San Lorenzo farm, Municipality of Oiba, Dept. Santander, Colombia (6° 13′ N Lat, 73° 15′ W Long). Assoc. with 6 ceramic vessels, a ceramic whistle, and human bones, on floor of tomb with lateral chamber. Artifacts similar to those of IVIC-559. Coll. 1967 and subm. by D. R. Sutherland. *Comment* (D.R.S.): date is reasonable.

710 ± 60
IVIC-596. Finca Moralba 18 **A.D. 1240**

Charcoal sample, Moralba Tube 18, from Trench 2, lower part of Level 6, base of stratum with Sonso style sherds. From Moralba farm, W bank of Cauca R., 5 km S Mediacanoa, Dept. Valle, Colombia (3° 55′ N Lat, 76° 20′ W Long). This material should approx. date beginning of Sonso occupation at site. Upper interface of stratum, *i.e.*, end of Sonso occupation, was dated previously at A.D. 1550 ± 70 (GrN-4697, Radiocarbon, 1967, v. 9, p. 152). Coll. 1964 and subm. by Warwick Bray, London Univ., England. *Comment* (W.B.): quite acceptable. Sample stratigraphically and chronologically older than GrN-4697 and these 2 dates bracket Sonso occupation at Moralba site. Allowing for standard deviations on both dates, duration of this occupation is rather longer than anticipated, but is, nevertheless, satisfactory. IVIC-596 fulfills another expectation. Previous dates for Sonso material in Cauca Valley were ca. mid-16th century A.D., whereas dates on similar material in Calima Valley were mid-13th century (IVIC-160, Radiocarbon, 1966, v. 8, p. 209 and NPL-60, Radiocarbon, 1964, v. 6, p. 29). IVIC-596 agrees well with Calima dates.

2840 ± 270
IVIC-597. Finca Moralba 166 **890 B.C.**

Very small charcoal sample (large date error term), Cauca Label 166, from Moralba farm, W bank of Cauca R., 5 km S Mediacanos, Dept. Valle, Colombia (3° 55′ N Lat, 76° 20′ W Long). Obtained from Trench 2, lower part of Level 8, near base of Yotoco style stratum. Estimated date A.D. 1000 to A.D. 1400, and early stage of Yotoco occupation of site. Coll. 1964 and subm. by Warwick Bray. *Comment* (W.B.): surprisingly early date which conflicts with IVIC-598 and previous A.D. 1175 ± 65 (GrN-4694, Radiocarbon, 1967, v. 9, p. 151) for similar pottery from Yotoco Ferry excavation. Dates seem more reasonable and nothing suggests long duration for Yotoco phase. I would be inclined to discount IVIC-597, but have no explanation for discrepancy.

IVIC-598. Yotoco Ferry 13 **850 ± 140**
A.D. 1100

Small charcoal sample from Trench 1, 1.4 to 1.5 m below surface on E bank of Cauca R., opposite its confluence with Yotoco R. near town of Yotoco, Dept. Valle, Colombia (3° 50′ N Lat, 76° 40′ W Long). Assoc. with sherds of Yotoco style and should date a middle stage of Yotoco occupation of site. Sample is stratigraphically between others previously dated at A.D. 1175 ± 65 (GrN-4694, Radiocarbon, 1967, v. 9, p. 151) and A.D. 1780 ± 40 (GrN-4940, Radiocarbon, 1967, v. 9, p. 152). Coll. 1964 by E. Moseley, Harvard Univ., Massachusetts, U.S.A., and subm. by W. Bray. *Comment* (W.B.): as expected. IVIC-598 agrees closely with GrN-4694, which is stratigraphically a little earlier within same stratum.

C. Trinidad

Palo Seco series

IVIC-638. Palo Seco D-4, 0.25 to 0.50 m **2130 ± 80**
180 B.C.

IVIC-639. Palo Seco D-4, 0.50 to 0.75 m **1480 ± 70**
A.D. 470

IVIC-640. Palo Seco D-4, 0.75 to 1.00 m **1990 ± 70**
40 B.C.

IVIC-641. Palo Seco D-4, 1.00 to 1.25 m **2060 ± 80**
110 B.C.

Charcoal samples from a shell midden, No. 1, Trench D, Pit 4, on S coast of Trinidad, in front of delta of the Venezuelan Orinoco R. Site in Trinidad Tesoro Beach Camp, Palo Seco municipality (10° 4′ N Lat, 61° 35′ W Long). Sample important for study of the entrance of Indians from continent to West Indies. Site described previously (Bullbrook, 1953). Expected to date in Period III of Rouse and Cruxent chronology (Rouse and Cruxent, 1963). Coll. 1969 and subm. by F. Olsen and I. Rouse, Yale Univ. and J. Cruxent, I.V.I.C. *Comment* (J.C.): IVIC-638 must be contaminated with asphalt, which was present on surface in this zone. Date should be disregarded. Other dates are reasonable.

Cedros series

IVIC-642. Cedros A-1, 0.00 to 0.50 m **2140 ± 70**
190 B.C.

IVIC-643. Cedros A-1, 0.50 to 0.75 m **1850 ± 80**
A.D. 100

Charcoal samples from a shell midden, Trench A, Pit 1, near end of Cedros peninsula, N of Envieuse Bay, Trinidad (10° 2′ N Lat, 61° 57′ W Long). Site could signal arrival of Saladoid people in Trinidad. Expected to date in Period II and be older than Palo Seco. Coll. 1969 and subm. by F. Olsen, I. Rouse, J. A. Correia, and J. Cruxent. *Comment* (J.C.):

dates are reasonable; they are not statistically distinguishable and can be averaged to 1995 ± 50 B.P.

III. ETHNOLOGIC SAMPLES

The application of nuclear weapon contamination of the biosphere to the estimation of the possible ages of recent materials was described in a previous publication (Tamers, 1969b). At that time it appeared that there was a definite decrease in Venezuela for the years 1960 and 1961. However, two recent known-age samples (IVIC-539 and IVIC-541, this date list), have devaluated this conclusion and the dating is now most useful in the region 1963 to 1965, when the large increase occurred.

The previous work with the Warao Indians of E Venezuela showed that they were calculating in the past with clearly less accuracy than peoples of more developed civilizations. But the samples were not collected by professional ethnologists and there remained the question whether the inexperience of the collectors could account for the errors in the Indians' age estimations. In this date list are presented samples taken under optimum conditions, by a professional who had been living with this group of primitive peoples for more than a year and who is familiar with their language and many of their customs. Samples described here come from the Piaroa Indians of the S Amazonas Terr. of Venezuela. The houses of this tribe are large conical structures with roofs made of various types of palm leaves. Samples coll. and subm. by J. Monod, Lab. d'Anthropol. Sociale, Collège de France, Paris.

IVIC-533. Caño Naranjillo 1A **152.5 ± 1.0% modern**

Mavaco palm leaves, with old appearance, taken from midway up roof, exterior, of communal house, Caño Naranjillo, Cuao R., a tributary of the Sipapo (5° 5′ N Lat, 67° 35′ W Long). This is the oldest house occupied by this group of Piaroa from the Lower Cuao. Indians estimated construction date as summer, 1964. Coll. Aug., 1968. *Comment*: see IVIC-534.

IVIC-534. Caño Naranjillo 1B **148.7 ± 1.0% modern**

Clarera palm leaves from lower part of roof, exterior, of same structure as IVIC-533 and coll. at same time. *Comment*: radiocarbon dates agree well with Indians' calculations.

IVIC-535. Caño Naranjillo 2A **143.0 ± 1.0% modern**

Mavaco palm leaves from abandoned communal house of same camp as IVIC-533 and IVIC-534. Coll. Aug., 1968 from midway up roof, exterior. Oldest structure still standing in region. Not occupied since 1964 when replaced by present communal house. Indians stated that it was only a provisional building and was constructed in winter, 1962. However, sample submitter doubted that Indians would have lived in this small house 2 yr before constructing present shelter. *Comment*: see IVIC-536.

IVIC-536. Caño Naranjillo 2B **161.3 ± 1.0% modern**

Llanera palm leaves from midway up roof of same structure as IVIC-535, also exterior, opposite side. Coll. same time as IVIC-535. *Comment*: radiocarbon dates of this and previous sample would suggest late 1963 or early 1964 and do not agree with Indians' calculation of 1962. The 1963-64 date is more reasonable since it indicates that Indians did not stay long in this provisional structure.

IVIC-537. Caño Cucurito 3A **126.2 ± 0.9% modern**

Llanera palm leaves from lower, exterior part of roof of abandoned house of "Carlo" and his group on Caño Cucurito, tributary of Cuoto R. (5° 20′ N Lat, 67° 35′ W Long). Coll. Aug., 1968. Indians calculated construction in 1963. *Comment*: radiocarbon content does not disagree with Indians' estimation of age.

IVIC-601. Caño Raya 1 **141.3 ± 0.9% modern**

Temiche palm leaves with old appearance from lower part of roof of abandoned chiruatto type house on Caño Paria Chiquito, tributary of Orinoco R. (5° 30′ N Lat, 67° 40′ W Long). Indians stated that this house was constructed 1 yr after that of IVIC-537 and that it was begun at end of 1963 and terminated June, 1964. Sample coll. Dec., 1968. *Comment*: radiocarbon content agrees exactly with Indians' late 1963, early 1964 calculation.

IVIC-602. Caño Raya 2A **152.5 ± 1.0% modern**

Ura (?) palm leaves, old appearance, from wall of abandoned house of rectangular type with double roof. Same site as IVIC-601. This structure built in 2 steps, actually 2 houses connected. Sample from oldest part coll. Dec., 1968. This is oldest house constructed by Tsitino, but he calculated it as only 1 yr old, *i.e.,* 1967. *Comment*: radiocarbon content is a little low, but does not disagree completely with date estimation.

IVIC-603. Caño Raya 2B **146.7 ± 1.0% modern**

Palm leaves from roof of structure of IVIC-602. Coll. at same time. *Comment*: this radiocarbon content is lower than any measured in Venezuela during 1965 to 1968. It might suggest that the house was built in 1964. More samples should be taken here.

IVIC-604. Caño Raya 4 **159.9 ± 1.0% modern**

Temiche palm leaves from lower part of roof of oval-shaped house inhabited by Riu. In same site as IVIC-601. Coll. Dec., 1968. Leaves of relatively young appearance. Indians stated construction date as beginning of 1968. *Comment*: radiocarbon content agrees with Indians' statement.

IVIC-605. Caño Raya 3A **159.1 ± 1.1% modern**

Palm leaves from lower part of roof of house of Antonio Luis. Coll. Jan., 1969 in camp on tributary of Caño Paria Chiquito (50° 25′ N Lat, 67° 35′ W Long). In principle constructed at end of 1967. *Comment*: see IVIC-606.

IVIC-606. Caño Raya 3B **156.5 ± 1.0% modern**

Palm leaves from opposite side of lower part of roof of structure of IVIC-605. Coll. same time. *Comment*: radiocarbon contents do not disagree with age estimation.

IVIC-607. Caño Santan **155.2 ± 1.0% modern**

Temiche palm leaves, old appearance, from lower part of roof of communal house on Caño santan, tributary of Cataniapo R. (5° 45′ N Lat, 67° 30′ W Long). Oldest inhabited structure in Camp. Coll. Jan., 1969. Indians stated construction date as 1965. *Comment*: radiocarbon content does not disagree with Indians' estimation of age.

IVIC-608. Rabipelado **159.1 ± 1.0% modern**

Mavaco palm leaves, old appearance, from lower part of roof of small abandoned churuata house on Catariapo R., near Rabipelado R., a tributary of the Orinoco (5° 45′ N Lat, 67° 30′ W Long). Indians stated that structure was only ca. 1 yr old, *i.e.*, built in 1967. However, sample collector doubts this because of very old appearance of house. Coll. Jan., 1969. *Comment*: radiocarbon content requires only that house was built after 1963 and does not contradict Indians' statement.

General Comment: this group of ethnologic samples represents 9 houses, but, unfortunately, majority date within the last years of almost constant radiocarbon contamination, *i.e.*, 1965 to 1968. Radiocarbon contents of these materials do not disagree with Indians' calculations, but possible ages are too numerous to determine Indians' ability to count in the past. However, 4 houses, IVIC-533, 534, IVIC-535, 536, IVIC-537, and IVIC-601, were estimated as pre-1965 and provide a more significant group. Here, one calculation by the Indians is clearly wrong (IVIC-535, 536), 2 are certainly right (IVIC-533, 534 and IVIC-601), and 1 is possible (IVIC-537). Also, age of house, IVIC-602, 603 probably is incorrect, but this is not as certain as that of IVIC-535, 536. Although these results by the ethnologist collector are better than those from the previous date list, Indians made at least one clear mistake which supports the previous suggestion that these primitive populations are not calculating past events with the accuracy of peoples in more developed civilizations.

IV. KNOWN AGE SAMPLES

Periodic measurements of radiocarbon contamination of atmospheric CO_2 in Venezuela continues. As before, plant materials are employed. Excess levels, after reaching a rounded peak in 1965 (Tamers, 1969b), are slowly decreasing. Contributions from the recent tests on the Asian continent and in the Pacific Ocean have not been noticed, nor is there any seasonal tendency.

Sample no.	Sample	Date	δC^{14}
IVIC-555	Hojas de Guama	29 Nov. 1968	158.9 ± 1.3% modern
IVIC-558	Hojas de Guama	29 Dec. 1968	158.3 ± 0.9% modern
IVIC-566	Hojas de Guama	29 Jan. 1969	154.0 ± 0.9% modern
IVIC-594	Hojas de Guama	28 Feb. 1969	156.2 ± 0.9% modern
IVIC-599	Hojas de Guama	28 Mar. 1969	154.7 ± 1.0% modern
IVIC-609	Hojas de Guama	30 Apr. 1969	150.9 ± 1.1% modern
IVIC-618	Hojas de Guama	16 May 1969	145.0 ± 0.9% modern
IVIC-619	Hojas de Guama	30 May 1969	134.2 ± 1.1% modern
IVIC-620	Hojas de Guama	30 June 1969	145.0 ± 0.8% modern
IVIC-622	Hojas de Guama	31 July 1969	154.3 ± 1.0% modern
IVIC-624	Hojas de Guama	29 Aug. 1969	154.8 ± 1.1% modern
IVIC-646	Hojas de Guama	1 Oct. 1969	157.6 ± 1.1% modern
IVIC-647	Hojas de Guama	15 Oct. 1969	152.8 ± 1.0% modern
IVIC-656	Hojas de Guama	30 Oct. 1969	153.8 ± 1.0% modern
IVIC-676	Hojas de Guama	28 Nov. 1969	155.9 ± 1.0% modern

Green leaves from 2 Guama trees (*Inga Fastuosa*) in Altos de Pipe, 14 km from Caracas (10° 23′ N Lat, 66° 58′ W Long). IVIC-555 came from same tree used previously for this purpose and rest of samples from a tree 10 m distant. Coll. and subm. by memberss of Radiocarbon Lab. of I.V.I.C. *Comment*: exceptionally low values noted for May and June, 1969 (IVIC-618, 619, 620).

IVIC-539. Hojas de Maiz **120.8 ± 1.4% modern**

Green leaves from corn plant in Maracay, state of Aragua, Venezuela (10° 15′ N Lat, 67° 35′ W Long). Coll. Jan. 1960 by F. Herold, I.V.I.C., and subm. by members of the Radiocarbon Lab., I.V.I.C. This is a known age sample. *Comment*: see IVIC-541.

IVIC-541. El Cenizo Alfalfa **117.7 ± 1.3% modern**

Green alfalfa plants growing in the region of El Cenizo, state of Trujillo, Venezuela (9° 30′ N Lat, 70° 49′ W Long). Coll. 1961 by F. Herold and subm. by members of the Radiocarbon Lab., I.V.I.C. This is a known age sample. *Comment*: both IVIC-539 and IVIC-541 have higher activities than previously seen in Venezuela for 1960 and 1961 (Tamers, 1969a). Decrease previously assumed for these years is not clear and cannot be used for age estimations of recent events here.

IVIC-562. Venezuelan plants **167.6 ± 1.7% modern**

Leaves and stems of small live plants growing in various localities in region of the llanos and coast of Venezuela. Coll. 1964 by K. Heinze, I.V.I.C. visitor in Lab. of F. Herold; subm. by members of the Radiocarbon Lab., I.V.I.C. This is a known age sample. *Comment*: agrees with previous measurement for this year in Venezuela.

V. GEOLOGIC SAMPLES

Bahía El Tablazo series

This project dating underwater sediments continues that reported in date list IV; preliminary findings have been pub. (Tamers, 1969c). Samples are from top 20 cm of El Tablazo Bay or adjacent Gulf of Venezuela. Unless noted otherwise, carbonates were removed by hydrochloric acid wash. Coll. 1968 and subm. by members of Radiocarbon Lab., I.V.I.C.

400 ± 70
IVIC-542. Golfo de Venezuela C-20 **A.D. 1550**

Fine sand with few shells in Gulf of Venezuela near San Carlos I. (11° 2′ N Lat, 71° 38′ W Long).

2740 ± 170
IVIC-543(c). Golfo de Venezuela C-21 carbonates **790 B.C.**

Carbonate portion of sand with very little organic carbon (11° 3′ N Lat, 71° 40′ W Long).

840 ± 60
IVIC-544. Golfo de Venezuela C-22 **A.D. 1110**

Clayey mud with few shells in Gulf of Venezuela near San Carlos I. (11° 3′ N Lat, 71° 37′ W Long).

2150 ± 110
IVIC-544(c). Golfo de Venezuela C-22 carbonates **200 B.C.**

Carbonate portion of clayey-mud sample in Gulf of Venezuela (11° 3′ N Lat, 71° 37′ W Long). Organic portion also dated.

1860 ± 70
IVIC-503(c). Lado del Canal C-7 carbonates **A.D. 90**

Carbonate portion of coarse sand with many shells and stones sample from E side of canal (10° 48′ N Lat, 71° 36′ W Long). Previous date on organic fraction was 4560 ± 80 B.P. (IVIC-503, Radiocarbon, 1969, v. 11, p. 420).

870 ± 50
IVIC-545. Golfo de Venezuela C-23 **A.D. 1080**

Clayey mud with few shells in Gulf of Venezuela near San Carlos I. (11° 1′ N Lat, 71° 37′ W Long).

1170 ± 60
IVIC-547. Bahía El Tablazo C-25 **A.D. 780**

Clayey mud from Bay, E of canal and close to entrance into Gulf of Venezuela (10° 56′ N Lat, 71° 33′ W Long).

IVIC-547(c). Bahía El Tablazo C-25 carbonates **1570 ± 120 A.D. 380**

Carbonate portion of clayey-mud sample from Bay (10° 56′ N Lat, 71° 33′ W Long). Organic portion also dated.

General Comment: organic-fraction samples from Gulf of Venezuela average 700 B.P.; this agrees with average of samples from the Bay (beyond canal influence) which is 530 B.P. Sedimentation in Canal of Maracaibo is probably due to redeposition of material from sides. Carbonate dates do not agree with organic fractions which should be more reliable of the two (Tamers, 1969b).

Tierra Pipe series

Soil organic matter accumulation on top of developing layer of clayey earth evolving mainly from mica. Rootlets and other plant debris are abundant. Brown earth of A-C horizon type in Altos de Pipe, State of Miranda, Venezuela (10° 23′ N Lat, 66° 58′ W Long), alt ca. 1400 m. Soil mixed thoroughly with water and passed through sieve to remove rootlets. Acid treatment eliminated carbonates; dates came from remaining organic material. Coll. 1969 and subm. by members of Radiocarbon Lab., I.V.I.C.

IVIC-652. Tierra Pipe, 0.15 to 0.30 m **2230 ± 60 280 B.C.**

Light brown soil with abundant rootlets. 0.9% non-carbonate, non-rootlet carbon content.

IVIC-653. Tierra Pipe, 0.30 to 0.45 m **4220 ± 90 2270 B.C.**

Soil, lighter brown than that of IVIC-652. ⩾0.7% non-carbonate, non-rootlet carbon content.

IVIC-654. Tierra Pipe, 0.45 to 0.60 m **5720 ± 80 3770 B.C.**

Reddish soil with few rootlets. 0.5% non-carbonate, non-rootlet carbon content.

General Comment: date sequence agrees with stratigraphy; however, ages are greater than expected since samples were taken from a pit on the side of a steep hill. We had thought erosion here must be considerable, with new surfaces constantly appearing.

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[RADIOCARBON, VOL. 12, NO. 2, 1970, P. 526-533]

UNIVERSITY OF KIEL RADIOCARBON MEASUREMENTS V

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Measurements reported in this paper were obtained with the 4.5 L and 3 L CO_2 counters, details of which were given earlier (Radiocarbon, v. 11, p. 423). The automatic data recording system built in 1968 (Hänsel, 1968) is now operating for both counting apparatus. For each one the counts of the guard counters ring (A counts), the total counts of the C^{14} counter (B counts), the coincidences of central and guard ring counter (AB counts), and the anticoincidences ($\overline{A}$B counts) are tape punched every 100th minute. By an ALGOL program, all counts are checked first for large disturbances. Secondly, equation $B = AB + \overline{A}B$ must hold (as an integral check for proper operation of logical circuitry and the data recording system) and finally statistical compatibility is examined before age and other data for the actual counting apparatus are computed. This detailed check of counting rates by computer has proved to be very efficient to yield reliable long-term measurements.

In 1969, a new technique for CO_2 gas purification was developed. In the former (Radiocarbon, v. 8, 1966, p. 235; Münnich, 1957a) CO_2 was absorbed in a $NH_4OH–CaCL_2$ solution and precipitated as $CaCO_3$. CO_2 was liberated again by sulfuric acid and dried. Gas quality, though generally good, in some cases showed great variations and purification had to be repeated. At the end of 1968, after 3 years of steady operation, ammonium carbamate contamination of glass tubes and bulbs prevented efficient gas purification. The use of active charcoal seems to be a reliable, straightforward purification technique.

CO_2 is prepared by combustion, using two quartz tubes as described by de Vries (1953). Oxidation is performed by hot Pt-Asbestos and CuO (600°C). A first purification step is accomplished by bubbling the gas through solutions of potassium permanganate, potassium bichromate, and a mixture of conc. sulfuric acid and diphenylamine (for binding nitrogen oxides). The gas is dried in a two-stage cold trap at −78°C and then frozen in two liquid air traps under vacuum pumping.

For secondary purification CO_2 slowly enters a stainless steel cold trap at liquid air temperature filled with 50 g of active charcoal. The trap outlet is vacuum pumped. When all the gas (ca. 5 L atm) is adsorbed, the inlet valve is shut and the trapped CO_2 is allowed to evaporate slowly, being trapped again in two succeeding vacuum pumped liquid air traps. Evaporation is completed by heating the charcoal to 100°C for about half an hour. CO_2, obtained in this way, does not require further purification or drying. Gas yield is better than 99.5%. Charcoal is regenerated by degassing at 750°C under vacuum. Up to January 1970, this process was applied to more than 90 gas samples; excellent counter gases have been obtained. Charcoal filling has not been replaced at this time. The second purification step is completed within two hours. Outgassing requires about the same length of time and often runs overnight.

Age calculations are based on 95% of NBS oxalic acid standard activity with modern value A.D. 1950. Results are calculated using Libby half-life and are given in the B.P. scale. Errors correspond to 1 σ variation of sample net counting rate including statistics of modern standard and background. Uncertainty in C^{14} half-life and in secular variations have not been taken into account. Unless otherwise stated dates are not corrected for isotopic fractionation.

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I. GEOLOGIC SAMPLES

Segeberger See series

Lake sediments of the Grosser Segeberger See (53° 56.6′ N Lat, 10° 19.4′ E Long), NW Germany. Coll. and subm. 1967 by F. R. Averdieck, Inst. f. Ur- und Frühgeschichte, Univ. Kiel, who also made pollen analysis. Basin of lake was formed by glaciers during last glaciation (Würm). In subsequent late glacial and post-glacial, detritus gyttja sediments up to 15 m thick were deposited. Samples were taken by a Livingstone corer (4 cms diam.). Except the basal meters of sediment, which consisted of pure clay, all layers contained enough organic material for C^{14} measurement within 6 to 12 cms. Carbonate was removed by chloric acid. Samples were taken ca. every 30 cm, and pollen were analyzed every 2.5 cm. Thus we have a complete pollen diagram of the whole post-glacial with a fairly close set of C^{14} dates. In this region, analogous measurements on bogs do not reach beyond 5000 or 6000 yr B.P.

General Comment: by linear extrapolation of Libby values of the upper layers, we get an apparent age of 940 yr B.P. for contemporary sediment. Also some pollen analytic boundaries show about the same age difference when compared with corresponding layers in bogs. C^{13} values show no severe isotopic fractionation between atmospheric CO_2 and sediments; the discrepancy may be explained by the assumption (cf. Münnich, 1957b), that in the lake part of dead carbon is recycled according to

$$CO_3^{--} + CO_2 + H_2O \rightarrow HCO_3^{-}.$$

We assumed a constant fraction of dead carbon in the organic part of lake sediments and tested different values for this fraction to get the correct age of 0 yr B.P. for contemporary sediments. With 10% dead carbon, the measured Libby age (Table 1, col. 4) is 800 yr older than the real Libby age (col. 5). These values were corrected dendrochronologically until 6000 B.P. according to pub. tree-ring data (Willkomm, 1968). The straight line representing the least squares fit to these "astro-

TABLE 1

C^{14} dates of Segeberger See sediments

Age calculations were made without δC^{13} corrections.

C^{14} – Labor Kiel		Grosser Segeberger See			KI – 235	
1	2	3	4		5	6	
Lab. no.	Depth within sediment m	C^{13} ‰	Libby age measured, ± 1σ B.P.		Libby age "real" B.P.	Range of dendrochronol. corr. age (from 5) A.D./B.P.	
235.01	13.90		12690 ±	130	11890		
02	13.67	–25	11890	95	11090		
03	13.34		12290	340	11490		
04	12.94		11320	120	10520		
05	12.63		10750	280	9950		
06	12.27		10770	280	9970		
08	11.64		10180	390	9380		
09	11.36		10670	170	9870		
10	11.14		9950	130	9150		
11	10.85		9560	75	8760		
12	10.56		9250	100	8450		
13	10.22		8760	55	7960		
14	9.94		8020	50	7220		
16	9.33		6880	85	6080		
17	9.10	–24	7270	85	6470		
19	8.35		6730	90	5930		
20	8.06		6240	60	5440		
21	7.81		6030	85	5230		
43	7.41	–25	6060	95	5260		
23	7.27		5820	45	5020	–3910 to	–3730
44	6.77		5250	95	4450	–3390	–3000
25	6.54		5610	90	4810	–3720	–3420
26	6.30		4960	40	4160	–2900	–2600
27	6.07		5040	80	4240	–3150	–2630
28	5.80		4930	45	4130	–2850	–2570
29	5.44		4660	95	3860	–2500	–2140
30	5.10		4550	75	3750	–2450	–2080
31	4.65	–31	4110	45	3310	–1750	–1530
33	4.09		4150	55	3350	–1930	–1570
34	3.64		3630	70	2830	–1200	– 980
35	3.32	–27	3650	110	2850	–1210	– 960
36	3.11		3120	55	2320	– 570	– 300
37	2.68		2730	75	1930	– 130	+ 210
38	2.42		2580	65	1780	110	300
39	2.18		2390	50	1590	280	470
40	1.66		2070	60	1270	630	820
41	1.36		1930	60	1130	730	950
42	1.11	–31	1890	60	1090	780	980

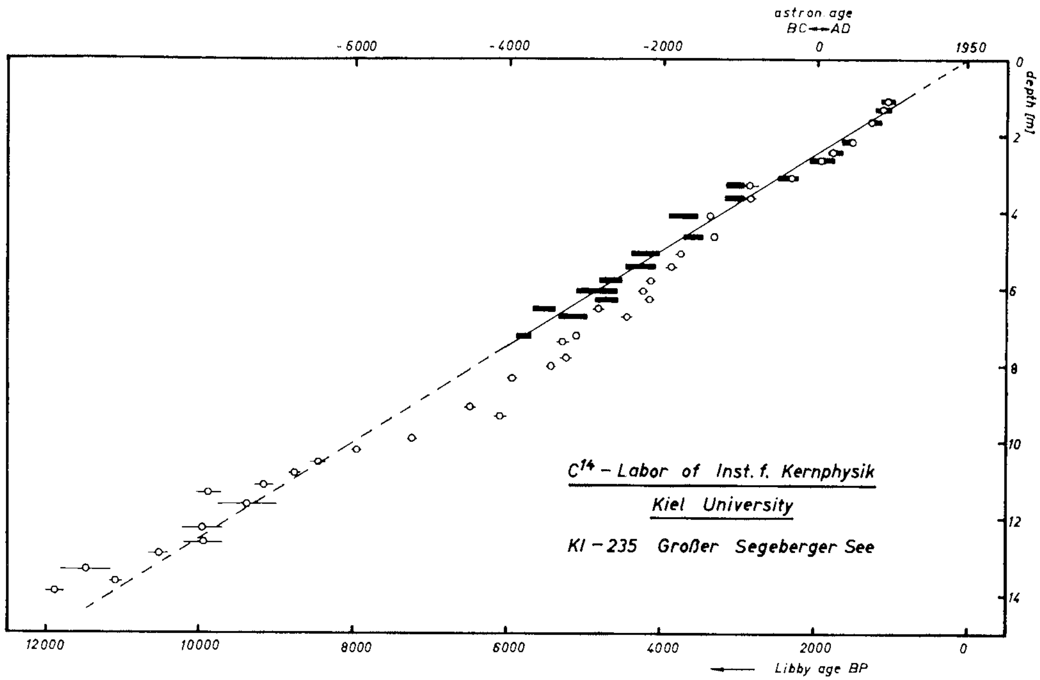

Fig. 1. C^{14} dates of Segeberger See sediments. Circles: "real" Libby age = Libby age −800 yr (Table 1, col. 5) in B.P. scale; bars: range of dendrochronol. corr. age (Table 1, col. 6) in A.D./B.C. scale.

nomical" dates yields the required value of 0 B.P. for surface sediments (Fig. 1).

According to these values, mean sedimentation rate was fairly constant during the last 6 millennia except for short variations. Fig. 1 assumes similar rates of sedimentation and chemical behavior of the lake during period investigated. If these assumptions are valid, then differences between the "real" Libby age and the extended straight line may be interpreted as variations in the recent value of the C^{14} content. It follows from Fig. 1 that deviation of recent activity has a maximum of $\Delta C^{14} = 110‰$ corresponding to 900 yr between 6000 B.P. and 7500 B.P. (astronomic age) and decreases to 0‰ at 8500 B.P. Beyond 8500 B.P., Libby age and astronomic age do not show statistically significant difference. These determinations support the results of Stuiver concerning sedimentation in 3 lakes (Stuiver, 1967; 1969, p. 550) and calibration by varve chronology (Tauber, 1970).

KI-315. Soholm, Profile 4 **104.5 ± 1.2%**

Rootlets, 165 cm below surface, taken from soil sec. near Soholm (54° 41.9′ N Lat, 9° 4.6′ E Long), Schleswig-Holstein, Germany. Coll. and subm. 1969 by G. Jatho, Geog. Inst., Univ. Kiel. Surface vegetation: *Calluna, Pinus, Picea.* Below several differently strong leached sandy layers a meadow ore layer extended ca. 60 cm to 160 cm depth, overlying sample. *Comment*: sandy meadow ore layer was formed in Middle age when large areas were deforested for production of charcoal needed for smelting of numerous local bog-iron ore deposits. Rootlets should date beginning of meadow ore layer formation, because younger vegetation was not expected to penetrate stone-like layer. Result disproves assumption.

KI-317. Soholm, Profile 1 **12,250 ± 170**
10,300 B.C.

Well-preserved wooden branches, 280 cm below surface, from soil sec. (54° 43.5 N Lat, 9° 1.9′ E Long) near Soholm, Schleswig-Holstein, Germany. Coll. and subm. 1969 by G. Jatho. Overlying sample were several layers of alternating humus and bleached sands. Deepest layer that was to be dated by branches was formed by air blown sands.

II. ARCHAEOLOGIC SAMPLES

Möllenknob series

Excavations near Archsum (54° 52.7′ N Lat, 8° 22.5′ E Long) on Sylt I., Germany (Radiocarbon 1968, v. 10, p. 331; 1969, v. 11, p. 428). Coll. 1967 by R. Kenk; subm. 1967 by G. Kossack and F. R. Averdieck, Inst. f. Ur- und Frühgeschichte, Univ. Kiel.

Möllenknob 245(2)

Cereals, weeds, and small pieces of charcoal from small ditches. Younger Bronze age or older pre-Roman Iron age.

2970 ± 60
KI-243. Fraction A **1020 B.C.**

Coarse fraction consisting of cereals only.

3060 ± 65
KI-244. Fraction B **1110 B.C.**

Second fraction of sample. *Comment*: no significant difference between the two fractions.

2070 ± 45
KI-237. Möllenknob 288(11) **120 B.C.**

Carbonized cereals and Gramineae, 100 to 120 cm below surface. Some rootlets of recent origin had to be removed. Expected age: ca. A.D. ± 0.

KI-249. Münchsteinach PfA-Reg 11/1 (1966-1970) **295 ± 50**
A.D. 1655

Human skull, from Münchsteinach (49° 34.4′ N Lat, 10° 37.1′ E Long), Germany. Coll. 1966 by H. Metzeler, Evang. Luth. Pfarramt, Münchsteinach/Neustadt a.d. Aisch; subm. 1968 by H. Helmuth, Anthropol. Inst., Univ. Kiel. Skull was found when renovating the former Benediktinerabtei Münchsteinach, 30 cm below floor flaps. Considering C^{14} variations (Willkomm, 1968) skull may date from A.D. 1450 until 1640.

2190 ± 50
KI-316. Eggstedt **240 B.C.**

Peat, enclosing a human skull, found near Eggstedt and Schafstedt (54° 4′ N Lat, 9° 15′ E Long), Schleswig-Holstein, Germany. Coll. 1969 by J. Peters, Eggstedt; subm. 1969 by H. Helmuth and F. R. Averdieck. Probably originating from pre-Christian Iron age, 500 B.C. to ± 0 B.C. *Comment* (F.R.A.): belongs to Pollen Zone X (Overbeck, 1950, p. 106). Low but significant values of *Fagus* and *Carpinus*. Cereals below 1%, but *Secale* and *Linum usitatissimum* are found.

Belau series

Samples of Belau (54° 6.7′ N Lat, 10° 29.5′ E Long), NW Germany. KI-90 and KI-230 coll. and subm. 1966 by F. Tidelski, who also made pollen analysis (unpub.). KI-283 coll. 1967 by E. Erich and subm. 1968 by F. R. Averdieck. *Comment* (E.E. and F.T.): samples coll. near to Schmalensee lake for proving the name *stagnum colse* (= lake of charcoal) appropriate. Other authors attribute name to the Stocksee (6 kms E) and thus obtain unnecessary extension of *limes Saxoniae,* wall of frontier built by Charlemagne (Ostertun, 1967).

4270 ± 60
KI-90. **2320 B.C.**

Wood (*Quercus*) 170 cm below surface. Forest was necessary for charcoal production of greater extent.

KI-230. **4800 ± 75**
2850 B.C.

Peat of about same stratigraphic layer as KI-90.

KI-283. **2530 ± 40**
580 B.C.

Charcoal.

III. DENDROCHRONOLOGIC SAMPLES

Wienhausen series

Dendrochronologically dated wood from monastery of Wienhausen/Celle (52° 34.5′ N Lat, 10° 12′ E Long). Coll. and subm. by D. Eckstein and J. Bauch, Lehrstuhl f. Holzwirtschaft, Univ. Hamburg, Reinbek. Dated by D. Eckstein and J. Bauch.

KI-238. Wienhausen 1 $\Delta = (-4.6 \pm 4.1)‰$ **690 ± 35**
A.D. 1260

A.D. 1275 to 1285

KI-239. Wienhausen 2 $\Delta = (-8.3 \pm 3.5)‰$ **730 ± 30**
A.D. 1220

A.D. 1265 to 1275

KI-240. Wienhausen 3 $\Delta = (-17.5 \pm 4.0)‰$ **970 ± 35**
A.D. 980

A.D. 1095 to 1105

General Comment: A.D. values under sample are determined by tree-ring counting. Δ values are calculated according to:

$$\Delta = 1000 \frac{A_m \cdot e^{\lambda T} - A_o}{A_o}$$

where A_m = measured activity (not corrected for δC^{13}, because trees never have a serious deviation to $\delta C^{13} = -25‰$); T = dendrochron. age B.P.; $\lambda = \frac{1}{8270}$ = best value available for decay constant; $A_m \cdot e^{\lambda T}$ is activity reduced for A.D. 1950; and A_o = standard recent activity (= 95% of oxalic acid).

Correction

In Kiel IV, v. 11, p. 425, 3rd line of Keitum series should be omitted.

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UNIVERSITY OF LUND RADIOCARBON DATES III

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INTRODUCTION

The C^{14} measurements reported here were made in this laboratory between October 1968 and October 1969.

The measuring technique and equipment, and the treatment of samples are the same as reported previously (Radiocarbon, 1968, v. 10, p. 36-37). Shell samples are treated in the following way: after removal of foreign matter by mechanical cleaning, outermost parts of shells, 10% or more depending on sample size, are removed by washing in dilute HCl. CO_2 is normally liberated from remaining shells in 2 stages with predetermined amounts of HCl. CO_2 from the first stage is called outer fraction (o) and the rest inner fraction (i). Subsequent treatment is same as for other samples. Amount of CO_2 in each fraction is given in sample descriptions as per cent of CO_2 from total shell sample. Bone samples are treated as follows: mechanical cleaning of bone surface, washing, crushing, sizing (0.3 to 2 mm), removal of all bone carbonate with cold 0.7N HCl under reduced pressure, washing, leaching of insoluble residue with cold NaOH (0.1 to 0.5N), repeated washing, acidification, and drying.

The remark, "undersized; diluted", in *Comments* means the sample did not produce enough CO_2 to fill the counter to normal pressure and "dead" CO_2 from anthracite was introduced to make up the pressure.

Age calculations are based on a contemporary value equal to 0.950 of the activity of the NBS oxalic acid standard and on a half-life for C^{14} of 5568 yr. Results are reported in years before 1950 (years B.P.), and in the A.D./B.C. scale. Errors quoted ($\pm 1\sigma$) include the standard deviations of the count rates for the unknown sample, the contemporary standard, and the background. In view of the increased possibilities to correct for variations in initial C^{14}-content in the atmosphere during the last 7000 yr (Suess, 1970; Michael and Ralph, 1970; Willkomm, 1968) we now report $\sigma = 1$ standard deviation also for dates with $\sigma < 100$ yr, starting with this date list. Corrections for deviations from the normal C^{13}/C^{12} ratio for terrestrial plants ($\delta C^{13} = -25.0‰$ in the P.D.B. scale) are applied for all samples. δC^{13} values quoted are relative to the P.D.B. standard.

The description of each sample is based on information provided by the person submitting the sample to the laboratory.

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Inst., Stockholm, for making the C^{13} analyses. Special thanks are due Christian Cavallin for assistance with the electronic equipment.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Sweden

Trummen series

Sediment samples continued from Lund II (Radiocarbon, 1969, v. 11, p. 434) from Lake Trummen, near city of Växjö, central S Sweden (56° 52′ N Lat, 14° 50′ E Long). Coll. 1967 and subm. by G. Digerfeldt, Dept. Quaternary Geol., Univ. of Lund. Pollen zones according to Nilsson (1935, 1961) and Berglund (1966). Water depth 1.5 m at main profile and 1.0 m at complementary profile. Depths given in sample titles are below lake water level. HCl pretreatment of all samples.

Trummen, main profile, Late-Glacial part:

11,730 ± 150
Lu-210. Trummen, 721 to 726 cm **9780 B.C.**
$\delta C^{13} = -21.6‰$

Clay gyttja. Increase of *Empetrum* during AL. *Comment*: sample undersized; diluted.

11,060 ± 100
Lu-209. Trummen, 711 to 716 cm **9110 B.C.**
$\delta C^{13} = -22.8‰$

Clay gyttja. Decrease of *Empetrum* around AL/DR3.

10,360 ± 105
Lu-208. Trummen, 696 to 701 cm **8410 B.C.**
$\delta C^{13} = -22.5‰$

Clay gyttja. Increase of *Empetrum* around DR3/DR3-PB.

10,230 ± 105
Lu-207. Trummen, 684 to 689 cm **8280 B.C.**
$\delta C^{13} = -21.3‰$

Clayey gyttja. Culmination of *Empetrum* in DR3-PB.

Trummen, complementary profile:

Complementary profile taken in shallower and more sheltered part of lake than main profile. Comprises only uppermost ca. 1.6 m of layer sequence. The limnology and postglacial development of Lake Trummen has been investigated by Björk and Digerfeldt (1965) and Digerfeldt (1969).

2480 ± 55
Lu-227. Trummen, 232.5 to 237.5 cm **530 B.C.**
$\delta C^{13} = -29.8‰$

Brown detritus gyttja. Beginning decrease of *Juniperus* in SA2.

1340 ± 50
Lu-226. Trummen, 207.5 to 212.5 cm **A.D. 610**
$\delta C^{13} = -29.1‰$

Brown detritus gyttja. Strong increase of *Juniperus* in SA2.

1010 ± 50
Lu-225. Trummen, 167.5 to 172.5 cm **A.D. 940**
$\delta C^{13} = -28.8‰$

Brown detritus gyttja. *Picea* limit in SA1.

1000 ± 50
Lu-224. Trummen, 127.5 to 132.5 cm **A.D. 950**
$\delta C^{13} = -28.2‰$

Brown detritus gyttja. Increase of *Fagus* just below SB2/SB1.

Ranviken Bay series

Sediment samples continued from Lund II (Radiocarbon, 1969, v. 11, p. 431-434) from Ranviken Bay of Lake Immeln, ca. 30 km N of town of Kristianstad, NE Scania (56° 17′ N Lat, 14° 18′ E Long). Coll. 1967 and subm. by G. Digerfeldt. Samples come from main profile taken in central and deepest part of bay, and represent lateglacial part of sediment sequence. Water depth 1.1 m. Depths given in sample titles are below lake water level. HCl pretreatment.

12,670 ± 130
Lu-223. Ranviken, 809 to 814 cm **10,720 B.C.**
$\delta C^{13} = -18.2‰$

Clay gyttja. Preliminary in late part of DR2.

11,430 ± 115
Lu-222. Ranviken, 796 to 799 cm **9480 B.C.**
$\delta C^{13} = -22.4‰$

Clay gyttja. Preliminary in late part of AL.

10,370 ± 120
Lu-221. Ranviken, 780 to 785 cm **8420 B.C.**
$\delta C^{13} = -22.1‰$

Clay gyttja. Culmination of *Empetrum* in DR3-PB. *Comment*: sample undersized; diluted.

Torreberga series

Wood and peat samples from ancient lake occupying part of Torreberga valley, 10 km S of Lund, S Sweden (55° 37′ N Lat, 13° 15′ E Long). Dated as part of investigation of postglacial lake development. Owing to influence from local forest vegetation pollen zoning is very complicated. A paleoecologic study of the lateglacial lake has been published (Berglund and Digerfeldt, 1970). Coll. 1965 (Lu-134) and 1967, and subm. by G. Digerfeldt. MBP2 is a profile from deepest part of ancient lake, MBP4 from shallower part, and MBP3 from intermediate position. HCl and NaOH pretreatment.

Lu-238. Torreberga MBP2 — **2600 ± 55**
650 B.C.
$\delta C^{13} = -27.7‰$

Wood of *Alnus*, 35 to 40 cm below surface in *Alnus* carr peat.

Lu-134. Torreberga MBP3 — **6070 ± 70**
4120 B.C.
$\delta C^{13} = -29.5‰$

Wood of *Alnus*, 120 to 125 cm below ground surface in *Alnus* carr peat.

Lu-239. Torreberga MBP4, 57.5 to 62.5 cm, peat — **8560 ± 90**
6610 B.C.
$\delta C^{13} = -28.0‰$

Magnocaricetum peat.

Lu-239A. Torreberga MBP4, 57.5 to 62.5 cm, humic acid — **8440 ± 90**
6490 B.C.
$\delta C^{13} = -27.4‰$

NaOH-soluble fraction from material used for Lu-239.

Lu-240. Torreberga MBP4, 35 to 40 cm, peat — **4130 ± 65**
2180 B.C.
$\delta C^{13} = -26.9‰$

Alnus carr peat.

Lu-240A. Torreberga MBP4, 35 to 40 cm, humic acid — **3880 ± 65**
1930 B.C.
$\delta C^{13} = -26.6‰$

NaOH-soluble fraction from material used for Lu-240.

Väby series

Samples from forest soil profile in Väby, Bräkne-Hoby parish, Blekinge (56° 10′ N Lat, 15° 08′ E Long), from which local-influenced pollen diagram has been derived. Forest succession includes 3 phases: *Quercetum Mixtum, Fagus,* and *Picea.* Coll. and subm. by B. E. Berglund and C. E. Nylander, Dept. Quaternary Geol., Univ. of Lund.

Lu-213. Väby 2 — **3360 ± 60**
1410 B.C.
$\delta C^{13} = -29.1‰$

Bark of birch, 45 to 50 cm below surface. *Comment*: HCl pretreatment.

Lu-214. Väby 1a — **2520 ± 55**
570 B.C.
$\delta C^{13} = -27.0‰$

Lu-264. Väby 1b — **2330 ± 55**
380 B.C.
$\delta C^{13} = -26.1‰$

Charcoal of birch, 40 to 45 cm below surface, dating regression of *Quercetum Mixtum* forest. *Comment*: HCl and NaOH pretreatment.

Lu-265. Väby 3 **150 ± 80**
A.D. 1800
$\delta C^{13} = -28.3‰$

Wood of willow, 30 to 35 cm below surface. *Comments*: HCl and NaOH pretreatment. Sample undersized; diluted. (B.E.B.): unexpected low value indicates material has been derived from down-growing roots. *General Comment* (B.E.B.): dates for Väby 1 and Väby 2 confirm pollen-analytical dating.

Torps Mosse series

Wood samples from peat bog on island of Senoren, Ramdala parish, Blekinge (56° 07′ N Lat, 15° 45′ E Long). Bog dried out in Atlantic time and became wooded with pine and oak, later oak, and birch. During preliminary investigation wood from stump layer ca. 60 cm below surface was coll. for dating. A study of forest succession will be published later. Coll. and subm. 1968 by B. E. Berglund. HCl and NaOH pretreatment.

Lu-267. Torps Mosse 2, *Pinus* **6570 ± 75**
4620 B.C.
$\delta C^{13} = -25.0‰$

Lu-266. Torps Mosse 1, *Quercus* **4800 ± 65**
2850 B.C.
$\delta C^{13} = -24.1‰$

Lu-268. Torps Mosse 3, *Quercus* **3650 ± 60**
1700 B.C.
$\delta C^{13} = -24.3‰$

General Comment (B.E.B.): dates show spread of ca. 3000 yr for ages of stumps and indicate very low peat accumulation rate. Oak stumps are of Early Sub-Boreal age and indicate low ground water level.

Spjutsten series

Peat samples from heath soil profile on island of Spjutsten, outer archipelago of Stockholm (59° 44′ N Lat, 19° 15′ E Long), belonging to the maritime birch forest area. Peat layer is 43 cm thick, lying directly on rock surface in open dwarf-shrub heath. Lower peat, 36 to 43 cm below surface, seems to derive from birch forest and upper peat from dwarf-shrub heath. Depts given are below surface. Coll. 1963 by M. Fries, Royal Inst. of Forestry, Stockholm, and B. E. Berglund; subm. by B. E. Berglund. HCl and NaOH pretreatment.

Lu-273. Spjutsten 2, 40 to 43 cm, peat **1200 ± 50**
A.D. 750
$\delta C^{13} = -23.4‰$

Lu-273A. Spjutsten 2, humic acid **1090 ± 55**
A.D. 860
$\delta C^{13} = -26.4‰$

NaOH-soluble fraction from material used for Lu-273.

Lu-272. Spjutsten 1, 30 to 35 cm, peat **330 ± 50**
A.D. 1620
δC^{13} = −26.2‰

Lu-272A. Spjutsten 1, humic acid **360 ± 50**
A.D. 1590
δC^{13} = −25.0‰

NaOH-soluble fraction from material used for Lu-272.

General Comment (B.E.B.): dates indicate that on this site the maritime birch forest is native and climatically conditioned and that the coast heath is a rather modern vegetation type.

Siretorp series

Samples from profile on distal side of complex Littorina beach ridge with brackish lagoon sediments at Siretorp, Sölvesborg, Blekinge (56° 01′ N Lat, 14° 37′ E Long). Site is described by Bagge and Kjellman (1939) and discussed by Berglund (1964) and Mörner (1969). Bottom beach sand is covered by brackish gyttja, upper part of which may be subdivided into 3 gyttja lenses separated by sand lenses. Organic layers have been supposed to correspond to transgression phases of the Littorina Sea. Pollen diagram of the profile covers the Late Atlantic and the Early Sub-Boreal zones. Depths given are below surface. Coll. 1968 and subm. by B. E. Berglund. HCl and NaOH pretreatment.

Lu-269. Siretorp 1 **6820 ± 75**
4870 B.C.
δC^{13} = −24.6‰

Charcoal of oak from bottom beach sand.

Lu-302. Siretorp 2 **6640 ± 70**
4690 B.C.
δC^{13} = −26.5‰

Slightly brackish muddy sand, 133 to 136 cm.

Lu-302A. Siretorp 2, humic acid **6450 ± 75**
4500 B.C.
δC^{13} = −24.9‰

NaOH-soluble fraction from material used for Lu-302.

Lu-303. Siretorp 3 **6220 ± 70**
4270 B.C.
δC^{13} = −26.5‰

Slightly brackish gyttja, 126 to 128 cm.

Lu-304. Siretorp 4 **6090 ± 70**
4140 B.C.
δC^{13} = −21.9‰

Slightly brackish gyttja, 113 to 115 cm.

Lu-305. Siretorp 5 **5930 ± 70**
3980 B.C.
δC^{13} = −30.1‰

Slightly brackish gyttja, 108 to 110 cm.

Lu-306. Siretorp 6 **6000 ± 70**
4050 B.C.
$\delta C^{13} = -23.1‰$

Slightly brackish coarse detritus gyttja, 96 to 100 cm.

Lu-306A. Siretorp 6, humic acid **5770 ± 85**
3820 B.C.
$\delta C^{13} = -26.7‰$

NaOH-soluble fraction from material used for Lu-306. *Comment*: sample undersized; diluted.

Lu-307. Siretorp 7 **5700 ± 70**
3750 B.C.
$\delta C^{13} = -27.6‰$

Brackish gyttja, 94 to 96 cm.

Lu-307A. Siretorp 7, humic acid **5520 ± 90**
3570 B.C.
$\delta C^{13} = -22.4‰$

NaOH-soluble fraction from material used for Lu-307. *Comment*: sample undersized; diluted.

Lu-308. Siretorp 8 **5030 ± 80**
3080 B.C.
$\delta C^{13} = -21.8‰$

Brackish gyttja, 83 to 85 cm. Slightly below the *Ulmus*-decrease. *Comment*: sample slightly undersized; diluted.

Lu-309. Siretorp 9 **5040 ± 65**
3090 B.C.
$\delta C^{13} = -21.0‰$

Brackish gyttja, 74 to 76 cm. At the *Ulmus*-decrease. *Comment*: sample slightly undersized; diluted. Date based on 3 1-day counts.

Lu-309A. Siretorp 9, humic acid **4640 ± 85**
2690 B.C.
$\delta C^{13} = -27.0‰$

NaOH-soluble fraction from material used for Lu-309. *Comment*: sample undersized; diluted.

Lu-310. Siretorp 10 **4470 ± 80**
2520 B.C.
$\delta C^{13} = -21.0‰$

Limnic to slightly brackish gyttja in lower lens, 68 to 70 cm. *Comment*: sample undersized; diluted.

Lu-310A. Siretorp 10, humic acid **4340 ± 70**
2390 B.C.
$\delta C^{13} = -28.2‰$

NaOH-soluble fraction from material used for Lu-310.

Lu-311. Siretorp 11 **4270 ± 60**
2320 B.C.
$\delta C^{13} = -21.8‰$

Limnic to slightly brackish gyttja in middle lens, 56 to 60 cm.

Lu-311A. Siretorp 11, humic acid **3930 ± 65**
1980 B.C.
$\delta C^{13} = -21.8‰$

NaOH-soluble fraction from material used for Lu-311.

Lu-312. Siretorp 12 **3950 ± 60**
2000 B.C.
$\delta C^{13} = -23.4‰$

Limnic to slightly brackish gyttja in upper lens, 50 to 52 cm.

Lu-312A. Siretorp 12, humic acid **3870 ± 65**
1920 B.C.
$\delta C^{13} = -22.8‰$

NaOH-soluble fraction from material used for Lu-312.

Lu-313. Siretorp 13 **3820 ± 65**
1870 B.C.
$\delta C^{13} = -27.3‰$

Limnic to slightly brackish sandy gyttja in upper lens, 45 to 47 cm.

Lu-313A. Siretorp 13, humic acid **3610 ± 65**
1660 B.C.
$\delta C^{13} = -31.0‰$

NaOH-soluble fraction from material used for Lu-313.

General Comments (B.E.B.): samples seem to date 2 Atlantic and 3 Sub-Boreal transgressions in accordance with shoreline displacement curve of Berglund (1964). (S.H.): NaOH-soluble fraction was dated for some samples to obtain information about magnitude of contamination with younger material in sediment of this kind.

Lake Striern series

Sediment samples from Lake Striern, 900 m NE of Hägerstad new church, Östergötland (58° 05′ N Lat, 15° 47′ E Long). Alt of sediment surface at sampling point ca. 86 m. Coll. 1966 by H. Göransson; subm. by T. Nilsson, Dept. Quaternary Geol., Univ. of Lund. Pollen analyses by H. Göransson. Samples represent characteristic levels in pollen diagram. Depths given in sample titles are below sediment surface. HCl pretreatment of all samples.

Lu-243. Striern, 490 to 500 cm **12,090 ± 280**
10,140 B.C.
$\delta C^{13} = -24.4‰$

Samples 198+199. Clayey gyttja. Culmination of *Juniperus*. *Comment*: sample undersized; diluted. Date based on 3 1-day counts.

Lu-296. Striern, 480 to 490 cm

11,750 ± 220
9800 B.C.
$\delta C^{13} = -25.9‰$

Samples 196+197. Slightly calcareous clayey gyttja. Lower part of *Betula* maximum. *Comment*: sample undersized; diluted. Date based on 3 1-day counts. Dated to check reliability of Lu-243.

Lu-244. Striern, 465 to 475 cm

10,220 ± 105
8270 B.C.
$\delta C^{13} = -25.1‰$

Samples 193+194. Gyttja. Somewhat below rational *Corylus* limit. Upper part of Pre-Boreal.

Lu-245. Striern, 415 to 425 cm

8900 ± 95
6950 B.C.
$\delta C^{13} = -26.3‰$

Samples 183+184. Gyttja. Rational *Alnus* limit.

Lu-246. Striern, 345 to 355 cm

7390 ± 80
5440 B.C.
$\delta C^{13} = -27.2‰$

Samples 169+170. Gyttja. Rational *Quercus* limit.

Lu-247. Striern, 335 to 345 cm

6930 ± 65
4980 B.C.
$\delta C^{13} = -28.8‰$

Samples 167+168. Gyttja. Rational *Tilia* limit.

Lu-248. Striern, 310 to 320 cm

5390 ± 55
3440 B.C.
$\delta C^{13} = -22.6‰$

Samples 162+163. Gyttja. Beginning of classical *Ulmus* fall at Atlantic/Sub-Boreal boundary.

Lu-249. Striern, 240 to 250 cm

3740 ± 55
1790 B.C.
$\delta C^{13} = -24.7‰$

Samples 148+149. Gyttja. Final fall of *Ulmus* curve, *Quercus* maximum, *Pinus* minimum, *Betula* maximum.

Lu-250. Striern, 185 to 195 cm

2310 ± 60
360 B.C.
$\delta C^{13} = -23.5‰$

Samples 137+138. Gyttja. Empirical *Picea* limit, distinct increase of *Juniperus*, rather low *Pinus* values. *Comment*: sample undersized; diluted.

Lu-251. Striern, 140 to 150 cm

2040 ± 60
90 B.C.
$\delta C^{13} = -26.0‰$

Samples 128+129. Gyttja. Rational *Picea* limit, *Fraxinus* maximum, increase of *Pinus*. *Comment*: sample undersized; diluted.

Lu-252. Striern, 80 to 90 cm **1220 ± 70**
A.D. 730
$\delta C^{13} = -27.2‰$

Samples 116+117. Gyttja. Increase of *Picea, Fagus* maximum. *Comment*: sample undersized; diluted.

Lu-242. Striern, 35 to 45 cm **740 ± 75**
A.D. 1210
$\delta C^{13} = -26.3‰$

Samples 107+108. Gyttja. Distinct increase of *Juniperus*, NAP, and *Gramineae cultae*. *Comment*: sample undersized; diluted.

General Comments (T.N.): compared with varve chronology and radiocarbon dates from other parts of S Scandinavia Lu-243 and Lu-296 seem 1000 to 2000 yr too old. Lu-244 is probably too old also. (S.H.): Lu-243 was older than expected and possible contamination with calcareous matter was suspected since only cold HCl had been used for pretreatment (small sample). Material overlying Lu-243 was given normal treatment with hot HCl (2%) and dated as Lu-296. Result agrees well with Lu-243. Unexpected high age for Lu-243 and Lu-296 (and probably also Lu-244) may be due to "hard-water" error.

Lu-280. Ellesbo, Sample 6 **$30,300^{+950}_{-850}$**
28,350 B.C.
$\delta C^{13} = -26.6‰$

Sand from gravel pit at Ellesbo, 3 km S of Kungälv, Bohuslän (57° 50′ N Lat, 12° 00′ E Long). Alt 35 m. Coll. 1968 and subm. by Å. Hillefors, Dept. Geog., Univ. of Lund. Area described by submitter (Hillefors, 1969). *Comment*: no pretreatment due to small organic content. Processing of 4.4 kg sample yielded ca. 62% of full requirement. Diluted with CO_2 from anthracite; date based on 2 3-day counts. Test on part of sample indicated < 1% of carbon came from carbonates. NaOH-soluble fraction was extracted from 2.2 kg of HCl-treated material and processed. Yield indicated ca. 19% of carbon in Lu-280 came from NaOH-soluble material. Two 3-day counts on CO_2 from NaOH-soluble fraction, much diluted, gave age > 20,000 yr.

Lu-237. Kristineberg, marine shells **Apparent Age 420 ± 50**
$\delta C^{13} = +1.1‰$

Marine mollusc shells from shallow water near Kristineberg on island of Skaftölandet, Bohuslän (58° 15′ N Lat, 11° 26′ E Long). Coll. between 1889 and 1904; subm. by Å. Hillefors. *Comment*: outermost 10% of shells removed by acid washing. Date agrees with previous dates on contemporary marine shells (Lu-234, 370 ± 46; Lu-235, 410 ± 46; Lu-236, 430 ± 46, Radiocarbon, 1969, v. 11, p. 441). Correction for deviation from normal C^{13}/C^{12} ratio for terrestrial plants ($\delta C^{13} = -25.0‰$ in P.D.B. scale) is applied.

Fossil marine shells series

Lu-260. Högenorum, *Mya truncata*, i

11,760 ± 115
9810 B.C.
$\delta C^{13} = +1.3‰$

Thick shells (*Mya truncata*) from Högenorum, Norum, Stenungssund, Bohuslän (58° 04′ N Lat, 11° 53′ E Long). Stratigraphic sequence from bottom to top: glaciofluvial sediments, clay, sand, clay, sand, varved glacial clay, sand, symmict glacial clay with shells, 20 cm washed material. Symmict clay also contained shells of *Saxicava arctica* and fragments of *Pecten islandicus*. Alt ca. 50 m. Coll. 1968 and subm. by Å. Hillefors. *Comments*: inner fraction (30% of shells) was used. (Å.H.): shells probably redeposited to some extent. Sample approx. dates deposition of symmict glacial clay. Deglaciation may have taken place some hundred yr earlier (cf. Björsjö, 1949, p. 133 f., 138).

Lu-261. Högenorum, *Mya truncata*, o

11,670 ± 115
9720 B.C.
$\delta C^{13} = +0.9‰$

Outer fraction of shells used for Lu-260. *Comment*: outer fraction corresponds to 32% of shells; outermost 38% removed by acid washing.

Lu-262. Glimsås, Sample 1

11,280 ± 130
9330 B.C.
$\delta C^{13} = +1.1‰$

Thick shells (*Saxicava arctica, Mya truncata*) from 100 m SW of road at Glimsås, 1.5 km SE of Ellös on Orust island (58° 10′ N Lat, 11° 29′ E Long). Ref. Björsjö (1949, p. 85). Stratigraphic sequence from bottom to top: basal till, sand, varved clay, clay with shells just above varved clay. Alt ca. 55 m. Coll. 1968 and subm. by Å. Hillefors. *Comments*: outermost 45% of shells removed by acid washing. (Å.H.): shells probably redeposited to some extent. Sample approx. dates deposition of clay with shells.

Lu-263. Glimsås, Sample 2

11,090 ± 125
9140 B.C.
$\delta C^{13} = -0.8‰$

Shells (*Saxicava arctica, Mya truncata*) from same stratigraphic position as Lu-262. Coll. 1968 and subm. by Å. Hillefors. *Comment*: outermost 40% of shells removed by acid washing.

Lu-270. Grimbo, *Balanus hameri*, i

12,880 ± 125
10,930 B.C.
$\delta C^{13} = -0.1‰$

Shells (*Balanus hameri*) from W of Lillhagen R.R. Sta., Grimbo, Hisingen (57° 45′ N Lat, 11° 57′ E Long). In natural position with plates together in varved clay, 25 to 35 varves above glaciofluvial sand, overlain by coarse glaciofluvial gravel. Alt 23 m. Ref. Hillefors (1966, p. 54; 1969, p. 271, 302-303). Coll. 1969 and subm. by Å. Hillefors. *Comments*: inner fraction (40% of shells) was used. Date based on 3 1-day counts.

(Å.H.): sample probably dates deposition of varved clay and time of deglaciation (after subtraction of ca. 400 yr for apparent age of living marine shells; cf. Lu-237, this date list).

12,960 ± 135
Lu-271. Grimbo, *Balanus hameri*, o **11,010 B.C.**
δC^{13} = −0.4‰

Outer fraction of shells used for Lu-270. *Comment*: outer fraction corresponds to 44% of shells; outermost 16% removed by acid washing.

12,880 ± 145
Lu-281. Bläsebo, *Balanus* **10,930 B.C.**
δC^{13} = −1.9‰

Shells (*Balanus balanus, Balanus crenatus*) (id. by G. Digerfeldt) from Bläsebo, Lärjedalen, 7 km NNE of Göteborg center (57° 46′ N Lat, 12° 02′ E Long). From varved clay with fragments of *Mytilus edulis* and *Saxicava arctica* underlain by glaciofluvial gravel. Alt ca. 24 m. Coll. 1955 and subm. by Å. Hillefors. *Comments*: outermost 20% of shells removed by acid washing. Sample undersized; diluted. (Å.H.): date earlier than expected (cf. Lu-270, this date list).

General Comment: corrections for deviations from normal C^{13}/C^{12} ratio for terrestrial plants (*δC^{13} = −25.0‰* in P.D.B. scale) are applied also for shell samples. No corrections are made for apparent age of shells of living marine molluscs (cf Lu-237, this date list and Lu-234 through Lu-236, Radiocarbon, 1969, v. 11, p. 441).

Skillinge series

Wood from Skillinge, E Scania (55° 29′ N Lat, 14° 17′ E Long). Coll. 1969 by W. Vortisch; subm. by T. Nilsson, Dept. Quaternary Geol., Univ. of Lund. Samples are connected with transgression deposits. HCl and NaOH pretreatment. All samples undersized; diluted.

6840 ± 140
Lu-299. Skillinge 1 **4890 B.C.**
δC^{13} = −26.5‰

Driftwood from boulder stratum 1.2 m below surface, on building site No. 326, ca. 100 m NNE of Skillinge harbour. Alt ca. 3 m. Boulder stratum overlies clayey Baltic basal till; overlain by sand and gravel. *Comment*: date based on 3 1-day counts.

7080 ± 105
Lu-300. Skillinge 2 **5130 B.C.**
δC^{13} = −28.0‰

Wood from tree roots *in situ* in Baltic basal till ca. 0.3 m below Lu-299.

3680 ± 80
Lu-301. Skillinge 3 **1730 B.C.**
δC^{13} = −30.3‰

Wood from obliquely stratified sand, 0.6 m below surface on building site No. 258, ca. 400 m NNE of Skillinge harbour. Alt ca. 4.5 m.

B. Spitsbergen

Lu-241. Adventdalen **2650 ± 55**
700 B.C.
$\delta C^{13} = -23.4‰$

Wood from tree trunk (probably driftwood) partly hidden in minerogenic topsoil in summit area of 22 m pingo at Adventdalen, Spitsbergen (78° 13′ N Lat, 15° 52′ E Long). Foot of pingo is at alt ca. 5 m. Coll. 1968 and subm. by H. Svensson, Sci. Res. Council, Stockholm. HCl and NaOH pretreatment.

C. Norway

Porsangerfjord series

Peat from fossil tundra polygon furrows on raised glaciomarine delta adjacent to Lake Björvatn, 2 km S of Indre Brenna and 2 km from present coast at Porsangerfjord (70° 29′ N Lat, 25° 43′ E Long). Coll. 1968 by R. Langlo; subm. by H. Svensson. Dated as part of study of fossil polygonal ground in N Norway. HCl and NaOH pretreatment.

Lu-258. Porsangerfjord I, peat **3100 ± 60**
1150 B.C.
$\delta C^{13} = -27.1‰$

Peat from one of deepest furrows delineating polygons; taken just above stratification boundary between inorganic and organic material. Organic layer 29 cm thick in middle of furrow. Alt ca. 54 m.

Lu-258A. Porsangerfjord I, humic acid **2980 ± 60**
1030 B.C.
$\delta C^{13} = -27.1‰$

NaOH-soluble fraction from material used for Lu-258.

Lu-259. Porsangerfjord IV, peat **1590 ± 50**
A.D. 360
$\delta C^{13} = -26.9‰$

Peat from middle of polygon furrow, taken just above inorganic material. Peatlike organic layer 16 cm thick. Alt ca. 51 m. Porsangerfjord IV coll. ca. ½ km from Porsangerfjord I.

Lu-259A. Porsangerfjord IV, humic acid **1720 ± 55**
A.D. 230
$\delta C^{13} = -27.7‰$

NaOH-soluble fraction from material used for Lu-259.

Altevatn series

Peat from pals (*i.e.*, permafrost mound) situated 3 km SE of Politiodden, E Altevatn, N Norway (68° 29′ N Lat, 19° 48′ E Long). Alt 496 m. Coll. 1968 and subm. by R. Åhman, Dept. Phys. Geog., Univ. of Lund. Dated as part of study of permafrost forms in N Norway (cf. Radiocarbon, 1968, v. 10, p. 45-46). Depths given in sample descriptions are below upper surface of pals. HCl and NaOH pretreatment.

Lu-283. Altevatn, Sample 1 **1140 ± 70**
A.D. 810
$\delta C^{13} = -25.5‰$

Moderately humified peat, depth 10 cm. *Comment*: sample undersized; diluted.

Lu-284. Altevatn, Sample 3 **2500 ± 60**
550 B.C.
$\delta C^{13} = -25.9‰$

Highly humified peat, 70 to 75 cm.

Lu-285. Altevatn, Sample 5 **5110 ± 65**
3160 B.C.
$\delta C^{13} = -26.2‰$

Highly humified peat, 130 to 135 cm.

Lu-286. Altevatn, Sample 7 **6100 ± 110**
4150 B.C.
$\delta C^{13} = -25.9‰$

Highly humified peat, 190 to 195 cm. *Comment*: sample undersized; diluted.

Lu-287. Altevatn, Sample 9, peat **7600 ± 155**
5650 B.C.
$\delta C^{13} = -26.7‰$

Highly humified peat, 250 to 255 cm; same level as bog surface. *Comment*: sample undersized; diluted.

Lu-287A. Altevatn, Sample 9, humic acid **7090 ± 80**
5240 B.C.
$\delta C^{13} = -25.9‰$

NaOH-soluble fraction from material used for Lu-287.

Lakselv series

Peat from pals on bog Brennelvmyren, 3.5 km E of Lakselv airport, N Norway (70° 04′ N Lat, 25° 03′ E Long). Alt 24 m. Coll. 1968 and subm. by R. Åhman. HCl and NaOH pretreatment.

Lu-288. Lakselv, Sample 2, peat **2930 ± 60**
980 B.C.
$\delta C^{13} = -28.0‰$

Highly humified peat, 0 to 3 cm above mineral substratum.

Lu-288A. Lakselv, Sample 2, humic acid **3300 ± 60**
1350 B.C.
$\delta C^{13} = -27.3‰$

NaOH-soluble fraction from material used for Lu-288.

Lu-289. Lakselv, Sample 4, peat **3380 ± 70**
1430 B.C.
$\delta C^{13} = -27.3‰$

Highly humified peat, 60 cm above mineral substratum. *Comment*: sample undersized; diluted.

Lu-289A. Lakselv, Sample 4, humic acid **3270 ± 60**
1320 B.C.
δC^{13} = –27.6‰

NaOH-soluble fraction from material used for Lu-289.

Lu-290. Lakselv, Sample 6 **2430 ± 60**
480 B.C.
δC^{13} = –26.2‰

Moderately humified peat, 120 cm above mineral substratum.

Lu-291. Lakselv, Sample 8, peat **220 ± 50**
A.D. 1730
δC^{13} = –24.6‰

Slightly humified peat, 170 cm above mineral substratum and 15 cm below upper surface of pals.

Lu-291A. Lakselv, Sample 8, humic acid **170 ± 50**
A.D. 1780
δC^{13} = –29.3‰

NaOH-soluble fraction from material used for Lu-291.

Varangerbotn series

Peat samples from pals situated 1 km NW of road parting at Varangerbotn, N Norway (70° 11′ N Lat, 28° 32′ E Long). Ref. Åhman (1967). Coll. 1968 and subm. by R. Åhman. HCl and NaOH pretreatment.

Lu-292. Varangerbotn, Sample 1, peat **4900 ± 95**
2950 B.C.
δC^{13} = –27.9‰

Moderately humified peat from same level as water surface outside pals. No mineral substratum found at bottom of pals. *Comment*: sample undersized; diluted.

Lu-292A. Varangerbotn, Sample 1, humic acid **5010 ± 70**
3060 B.C.
δC^{13} = –26.7‰

NaOH-soluble fraction from material used for Lu-292.

Lu-293. Varangerbotn, Sample 2, peat **5110 ± 70**
3160 B.C.
δC^{13} = –28.3‰

Slightly humified peat taken 50 cm above Sample 1.

Lu-293A. Varangerbotn, Sample 2, humic acid **4880 ± 65**
2930 B.C.
δC^{13} = –31.2‰

NaOH-soluble fraction from material used for Lu-293.

Lu-294. Varangerbotn, Sample 4 **4370 ± 65**
2420 B.C.
δC^{13} = –26.5‰

Slightly humified peat taken 110 cm above Sample 1.

Lu-295. Varangerbotn, Sample 6 **3130 ± 60**
1180 B.C.
$\delta C^{13} = -26.2‰$

Slightly humified peat taken 170 cm above Sample 1 and 10 cm below upper surface of pals.

D. England

Lu-297. Honeygore Track, Somerset Levels **4760 ± 65**
2810 B.C.
$\delta C^{13} = -27.6‰$

Wood (*Betula* sp.) from prehistoric trackway in Somerset, England (51° 09′ N Lat, 2° 49′ W Long), built on Fen wood peat and later overwhelmed by development of ombrogenous peat (*Sphagnum* and *Eriophorum* peat). See Coles and Hibbert (1968). Coll. 1969 and subm. by F. A. Hibbert, Sub-Dept. Quaternary Research, Univ. of Cambridge. *Comment* (S.H.): dated to check operating condition of rebuilt dating equipment in Cambridge. Same wood dated in Cambridge as Q-909 (see index, this volume) gave 4773 ± 75 B.P. in good agreement with Lu-297. HCl and NaOH pretreatment.

Lu-298. Abbot's Track, Somerset Levels **3940 ± 65**
1990 B.C.
$\delta C^{13} = -25.3‰$

Wood from prehistoric trackway in Somerset, England (51° 09′ N Lat, 2° 49′ W Long), built on a surface of *Sphagnum-Calluna-Eriophorum* peat and embedded in peat of similar kind. See Dewar and Godwin (1963), Coles and Hibbert (1968). Coll. 1969 and subm. by F. A. Hibbert. *Comment* (S.H.): same wood dated in Cambridge as Q-926 (see index, this volume) gave 4018 ± 80 B.P. in good agreement with Lu-298.

II. ARCHAEOLOGIC SAMPLES

Sweden

Bare Mosse series

Charcoal from Maglemose settlement at Bare Mosse, Halmstad parish, Scania (55° 57′ N Lat, 13° 05′ E Long). Stratigraphic sequence from bottom to top: washed till, 15 cm gyttja, 20 cm *Cladium* peat, ca. 2 cm thick culture stratum, 215 cm carr peat. Coll. 1968 and subm. by S. Welinder, Dept. Quaternary Geol., Univ. of Lund. HCl and NaOH pretreatment.

Lu-230. Bare Mosse II **8800 ± 100**
6850 B.C.
$\delta C^{13} = -23.2‰$

Charcoal from culture stratum 215 to 217 cm below present surface.

Lu-231. Bare Mosse IV **8970 ± 100**
7020 B.C.
$\delta C^{13} = -26.5‰$

Charcoal from gyttja layer 237 to 252 cm below present surface.

General Comment (S.W.): pollen-analytical age of settlement Bare Mosse IV is PB/BO1-BO1e(b) and Bare Mosse II BO1/BO2-BO2c. Compared to chronology of Nilsson (1964) greater age difference between the 2 samples was expected.

530 ± 100
Lu-232. Smedjeryd 1², charcoal **A.D. 1420**
$\delta C^{13} = -25.4$‰

Slag with charcoal from primitive iron melting furnace at Smedjeryd 1², Våxtorp parish, Halland (56° 21′ N Lat, 13° 14′ E Long). Coll. 1967 and subm. by S. Nöjd, Örkelljunga. *Comment*: HCl and NaOH pretreatment. For additional dates on similar samples from S Sweden, see: St-1696, 650 ± 65; St-1697, 740 ± 65 (Radiocarbon, 1967, v. 9, p. 427).

130 ± 100
Lu-233. Smedjeryd 1², wood **A.D. 1820**
$\delta C^{13} = -29.0$‰

Small twigs from air intake for same melting furnace as in Lu-232. Coll. 1967 and subm. by S. Nöjd.

Hagestad series

Bone and charcoal samples continued from Lund II (Radiocarbon, 1969, v. 11, p. 447-448) from excavations in Hagestad, Löderup parish, Scania. Coll. 1964 (Lu-274, Lu-275) and 1968; subm. by M. Strömberg, Hist. Mus., Univ. of Lund. HCl and NaOH pretreatment of charcoal samples. Bone samples were given following treatment: mechanical cleaning of bone surface, washing, crushing, sizing (0.3 to 2 mm), removal of all bone carbonate with cold 0.7N HCl under reduced pressure, washing, leaching of insoluble residue with cold 0.5N NaOH, repeated washing, acidification, and drying.

4230 ± 65
Lu-254. Hagestad 14⁴, Sample 2, Carlshögen **2280 B.C.**
$\delta C^{13} = -19.5$‰

Collagen from human femur from pit under floor of passage grave Carlshögen (55° 24′ N Lat, 14° 08′ E Long).

4230 ± 80
Lu-255. Hagestad 14⁴, Sample 3, Carlshögen **2280 B.C.**
$\delta C^{13} = -19.1$‰

Collagen from human femur from lower floor, Sec. D, in passage grave Carlshögen.

4210 ± 65
Lu-277. Hagestad 14⁴, Sample 9, Carlshögen **2260 B.C.**
$\delta C^{13} = -17.6$‰

Collagen from human femur from lower stratum, Sec. B, in passage grave Carlshögen.

Lu-282. Hagestad 14⁴, Grave 3, Carlshögen **3380 ± 60**
1430 B.C.
$\delta C^{13} = -18.8‰$

Collagen from human femur from upper floor, Grave 3, in passage grave Carlshögen. *Comment*: bone was treated with preservatives (zapon lacquer), removed by repeated leaching in acetone. Remaining acetone was removed by washing. To test efficiency of this purification, rest of bone used for Lu-227 (this date list) was given normal preservation treatment with zapon lacquer and 1 month later purified in same manner as Lu-282. Resulting age 4080 ± 80 (Lu-277, 4210 ± 65). Agreement is fairly good.

Lu-257. Hagestad 8², Sample 5, Ramshög **4540 ± 90**
2590 B.C.
$\delta C^{13} = -17.5‰$

Collagen from human femur from lower part of passage grave Ramshög (55° 24′ N Lat, 14° 10′ E Long).

Lu-275. Hagestad 8², Sample 7, Ramshög **4330 ± 65**
2380 B.C.
$\delta C^{13} = -18.2‰$

Collagen from human bones from Flint Deposit 4, S of passage grave Ramshög. *Comment*: bones were treated with zapon lacquer and purified in same manner as Lu-282 (this date list).

Lu-276. Hagestad 8², Sample 8, Ramshög **4520 ± 65**
2570 B.C.
$\delta C^{13} = -17.2‰$

Collagen from human femur from furrow close to wall stones in SE part of passage grave Ramshög.

Lu-278. Hagestad 8², Sample 10, Ramshög **4480 ± 65**
2530 B.C.
$\delta C^{13} = -18.8‰$

Collagen from bone fragments from (offering) pit under floor near entrance in passage grave Ramshög. *Comment*: sample was treated with zapon lacquer and purified in same manner as Lu-282 (this date list).

Lu-253. Hagestad 6² A, Sample 1 **2170 ± 55**
220 B.C.
$\delta C^{13} = -20.1‰$

Collagen from bone of cattle from upper culture stratum in Trench 4:1968, on field S of brook at coast rd., Hagestad 6² A (55° 23′ N Lat, 14° 09′ E Long).

Lu-256. Hagestad 98¹ A, Sample 4 **2430 ± 55**
480 B.C.
$\delta C^{13} = -21.7‰$

Charcoal from hearth, Trench 1:1968, Hagestad 98¹ A (55° 24′ N Lat, 14° 11′ E Long).

Lu-274. Hagestad 2² B, Sample 6 **2890 ± 60**
940 B.C.
$\delta C^{13} = -24.3‰$

Charcoal from middle of Hearth 4, adjacent to megalithic grave at Hagestad 2² B (55° 25′ N Lat, 14° 08′ E Long). *Comment*: dated to check Lu-77, 2850 ± 100 (Radiocarbon, 1968, v. 10, p. 50) from same site. Date confirms earlier date.

General Comment (M.S.): generally, dates seem to agree with archaeologic dates except Lu-256 and Lu-274, which are considerably later than assoc. finds indicate.

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LOUVAIN NATURAL RADIOCARBON MEASUREMENTS IX

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The C^{14} dates given below have been obtained by counting CH_4 at 3 atm pressure in a 0.6 L stainless steel counter. Details of procedure are given in the previous lists. Dates are reported in terms of the Libby half-life, 5570 ± 30 years; the errors quoted are based on the standard deviations in counting rate of samples and standards.

The descriptions and comments are essentially those of the submitters.

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SAMPLE DESCRIPTIONS

Sedentarization series, France

Samples from various localities from France subm. by M. Coûteaux, Lab. of Palynology, Univ. of Louvain, now at Research Center of Ecology and Prehistory, Saint André de Cruzières, Ardèche, France. Samples related to palynologic research on archaeol. sites, for the "Recherche coopérative sur Programme no. 78: La Sédentarisation (CNRS)."

General Comment: samples leached with HCl but not with NaOH; the possible, but not probable, humic contamination is not removed.

1290 ± 80
Lv-384. Malaroumet II a **A.D. 660**

Peat from Malaroumet (44° 59′ N Lat, 0° 19′ E Long) at Baleymas, Dept. of Dordogne, alt 120 m. From 501 to 511 cm below ground surface. Coll. 1968 and pollen analyzed by M. Coûteaux. *Comment*: pollen diagram shows at this level a maximum of *Carpinus* (Coûteaux, 1970). Date comparable with C^{14} dates from Belgium, where this maximum is generally dated ca. A.D. 700.

1620 ± 60
Lv-385. Malaroumet II b **A.D. 330**

Peat from 513 to 519 cm depth. *Comment*: pollen curves show an increase of *Carpinus* during a maximum of *Fagus* and *Quercus*. Date seems a little too old compared to Lv-386 and Lv-387, but confirms that the increase of *Fagus* in Aquitaine belongs to Sub-Atlantic period.

Lv-386. Malaroumet II c **1510 ± 90**
A.D. 440

Wood from 520 to 525 cm depth. *Comment*: pollen analysis shows a temporary increase of *Corylus* between 2 maxima of *Fagus*. Later than the 1st maximum of *Fagus*, confirms the Lv-387 date.

Lv-387. Malaroumet II d **1570 ± 80**
A.D. 380

Peat from 526 to 536 cm. *Comment*: dates the 1st maximum of *Fagus* lower than *Quercus* before increase of *Carpinus*. Date comparable to F I in Belgium. Some hypotheses implied an earlier increase of Fagus in Aquitaine (Paquereau, 1960).

Lv-388. Gaude **4060 ± 80**
2110 B.C.

Charcoal with sand from the Gaude cave (44° 36′ N Lat, 4° 30′ E Long) at Saint Etienne de Fonbellon, Dept. of Ardèche, alt 250 m. From Sq. 8 of the Nikitine excavating, at 8 m from upper inlet of cave, archaeolog. level 28 to 42 cm below ground surface. At this level, Chalcolithic industry. Coll. 1966 by S. Nikitine. *Comment*: archaeol. estimation between 2200 and 2000 B.C. C^{14} date confirms estimation and helps to place on the time-scale a pollen diagram which cannot be palynologically dated because there is no pollen diagram reference yet in Ardèche.

Lv-389. Francin I **3870 ± 170**
1920 B.C.

Charcoal powder scattered in a sediment from Francin (45° 30′ N Lat, 6° 01′ E Long), Dept. of Savoie, alt 288 m. Horizon 4 at 90 cm depth. In the sediment, a rich Chassean industry (Malenfant *et al.*, 1970). Coll. 1967 by M. Malenfant. *Comment*: sample too poor to be treated in normal conditions is measured at 1000 mm Hg pressure. Date seems 500 yr too young in comparison with archaeol. estimation, probably because of large scattering of sample.

Lv-390. Francin 3 **4300 ± 75**
2350 B.C.

Charcoal from Sq. 4, from a built hearth in Chassean dwelling site. Coll. 1967 by Malenfant. *Comment*: C^{14} date confirms archaeol. estimation (ca. 2400 B.C.) and helps to date the pollen diagram showing clearing and farming in the site.

Lv-391. Gare de Couze **10,900 ± 230**
8950 B.C.

Bone collagen (principally *Rangifer tarandus*) (Prat, 1962), from Couze (44° 50′ N Lat, 0° 82′ E Long) at Lalinde, Dept. of Dordogne, alt 40 m. Found at 20 to 40 cm below present ground surface, in the Magdalenian VI archaeol. level, said "level 2, grey-blackish principal archaeol. layer" (Fitte and Sonneville-Bordes, 1962), including the strat. Horizons B to G (Laville, 1964). Coll. 1965 by J. Guichard and M.

Coûteaux. *Comment*: bones are dissolved in cold HCl. 1N and collagen heated to 250°C before combustion. Date is averaged from 2 dates: 10,993 and 10,782 B.P. C^{14} date places to Alleröd-Recent Dryas transition a temperate-cold pollen sequence characterized by the sporadic occurrence of a few thermophile plants. Without local pollen diagram reference, it is not possible to check this chronologic position; nevertheless, the observed vegetation seems to exclude Alleröd and Pre-Boreal periods. From archaeol. results, an older age (500 to 1000 yr, according to Bordes) is expected, because the industry is certainly evolved but not final.

Lv-395. Chazelle, Layer VII **5660 ± 110**
3710 B.C.

Ash from Chazelle (44° 18′ N Lat, 4° 11′ E Long) at Saint André de Cruzières, Dept. of Ardèche, alt 200 m. Layer VII of the Nikitine excavation. Neolithic hearth related to Cardial pottery from Montalus (Gard). Coll. 1967 by S. Nikitine. *Comment*: dates a pollen phase from Chazelle cave. At this level, forest component is still small on the plant scenery (30% trees, principally *Quercus*); human influence is very marked: plantago up to 6%, grain up to 8%, but vine is not yet observed. C^{14} date is not in contradiction with the 1st archaeol. estimation, but a total discussion will be possible only after complete study of the excavated material by Nikitine.

Lv-396. Chazelle, Layer IV **3240 ± 120**
1290 B.C.

Charcoal from Layer IV of the Nikitine excavation in Chazelle cave. Archaeol. level attributed to Middle Bronze age. *Comment*: pollen diagram shows a treeless phase, where human influence is marked (Plantago) but grain is very rare and vine discontinuous. Date is too young according to the 1st archaeol. estimation; the results of complete study by Nikitine are expected.

Oetrange series, Luxembourg

Samples from Haed Plateau at Oetrange (49° 35′ 45″ N Lat, 6° 14′ 30″ E Long), Luxembourg. The plateau, Hettangien sandstone, is flanked by 2 valleys in which samples were found. Coll. 1932 to 1939 by N. Thill; subm. by M. Heuertz, Nat. Hist. Mus. of Luxembourg.

Lv-466. Oetrange 1 **16,070 ± 450**
14,120 B.C.

Horns of reindeer from sandy, stony and calcareous ground ca. 1 m thick, slipped down at foot of perpendicular rocks in Schlaederbâch Valley, SW of the Plateau.

Lv-467. Oetrange 2 **16,770 ± 390**
14,820 B.C.

Bones, principally horse, from filled joint in the Kakesbach valley, NE of the Plateau.

General Comment: dates on collagen extracted by sample dissolution in cold HCl-1N; NaOH-leach omitted. Fauna of Oetrange sites is characteristic of Middle and Upper Pleistocene (Ferrant *et al.*, 1942). The prehistoric industry is attributed to Upper Pleistocene (Ferrant and Thill, 1938; Baudet *et al.*, 1953). C^{14} dates confirm expectation and give minimum date of creation of joint.

Mios series, France

Samples from Mios, Dept. of Gironde, France. Coll. 1910 by B. Peyneau; subm. by J. P. Mohen, Aquitaine Mus., Bordeaux.

Lv-351. Tumulus de Pujaut **420 ± 85**
A.D. 1530

Charcoal from Tumulus G at Pujaut (44° 35′ N Lat, 0° 57′ W Long). *Comment*: C^{14} age is averaged from 2 dates: 414 and 423 yr. Date absolutely inconsistent with furniture of tumulus. Probably charcoal from a woodcutter fire.

Lv-352. Truc du Bourdiou **2810 ± 130**
860 B.C.

Charred acorns from Truc du Bourdiou (44° 35′ N Lat, 0° 55′ W Long). From Pit K at 50 cm depth under an urn-field (Peyneau, 1926). *Comment*: urn-field is late classical of 1st Iron age in Aquitaine, but potsherds found in the pits filled by charred acorns seem older and not related to 1st Iron age necropolis (Coffyn and Mohen, 1969). C^{14} date agrees with Last Atlantic Bronze age.

Elkab series, Egypt

Charcoal from Elkab (25° 08′ N Lat, 32° 47′ E Long), Prov. of Edfu, Egypt. From an Epipaleolithic hearth found in Nile R. sediments. Coll. 1968 and 1969 and subm. by P. Vermeersch, Univ. of Louvain, Lab. of Phys. Geog.

Lv-464. Elkab **7990 ± 150**
6040 B.C.

From lower layer, 70 to 80 cm below ground surface.

Lv-465. Elkab **7930 ± 160**
5980 B.C.

From upper layer, 30 to 50 cm depth.

General Comment: not leached with NaOH. Confirms date 6400 B.C. for Lv-393 (Radiocarbon, 1970, v. 12, p. 157). They are the 1st dates of prehistoric industry in Egypt between 9000 B.C. and 4600 B.C.

Lv-443. Etang de Lierneux **320 ± 70**
A.D. 1630

Oak wood from Lierneux (50° 20′ N Lat, 5° 48′ E Long), Prov. of Liege, Belgium. From emptying duct of a pond, at ca. 5 m depth under clayey schistous embankment. Coll. 1965 and subm. by J. Humblet, Univ. of Liege. *Comment*: dates building of pond by monastery nearby (now Noire-fontaine farm-house) amenable to Abbey of Stavelot.

Basse Meuse series

Wood samples from former channels of Meuse R. in Prov. of Limburg, Belgium. Coll. 1967 and 1968 and subm. by E. Paulissen, Univ. of Louvain, Lab. of Phys. Geog.

General Comment: this series dates lateral shifting of Meuse R. channel and shows that river transported gravel during the Holocene (Paulissen, 1970).

7060 ± 150
Lv-435. Leut, B 2 **5110 B.C.**

From Leut (50° 59′ 23″ N Lat, 5° 43′ 52″ E Long), alt 32 m. Overlain by 4 m alluvium.

5080 ± 120
Lv-436. Geistingen, B 3 **3130 B.C.**

From Geistingen (51° 08′ 13″ N Lat, 5° 49′ 47″ E Long), alt 27 m. Overlain by 4 m alluvium.

1550 ± 70
Lv-439. Geistingen, B 6 **A.D. 400**

From 450 m E from Lv-436, depth 5 m, in a gravel layer overlain by 1 m sandy clay.

1130 ± 75
Lv-438. Geistingen, B 5 **A.D. 820**

From 110 m SW from Lv-439, under 5 m alluvium.

5940 ± 110
Lv-437. Boorsem, B 4 **3990 B.C.**

From Boorsem (50° 56′ 46″ N Lat, 5° 42′ 53″ E Long), alt 43 m, depth 2.70 m, in gravel overlain by 1.20 m alluvium.

3810 ± 75
Lv-440. Kessenich, B 7 **1860 B.C.**

From Kessenich (51° 08′ 47″ N Lat, 5° 50′ 56″ E Long), alt 27 m, under 4 m alluvium.

1050 ± 75
Lv-441. Aldeneik, B 8 **A.D. 900**

From Aldeneik (51° 06′ 10″ N Lat, 5° 49′ 27″ E Long), alt 29 m, depth 4 m. From alluvial gravel depth 2 m.

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RIKEN NATURAL RADIOCARBON MEASUREMENTS VI

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The C^{14} dates given below are a continuation of the work presented in our previous list (Radiocarbon, 1969, v. 11, p. 451-462), and results obtained mainly during 1969 are described. A new 3.3 L copper counter was put into routine operation besides the 2.7 L stainless steel counter employed heretofore, yielding background counting rates of 8.5 and 5.5 cpm, respectively, when filled with dead CO_2 at ca. 1.8 atm.

Dates have been calculated on the basis of the C^{14} half-life of 5568 yr and 95% of NBS oxalic acid as modern standard.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Japan

N-469. Esashi **910 ± 110**
A.D. 1040

Peat from boggy flood plain of Horobetsu R., Kinkomanai, Esashi-cho, Esashi-gun, Hokkaido (45° 15′ N Lat, 142° 20′ E Long), 120 cm below surface. Coll. and subm. 1969 by J. Nakamura, Kochi Univ.

Furen series

Material from boggy flood plain of Teshio R., Furen-cho, Kamikawa-gun, Hokkaido (43° 35′ N Lat, 142° 10′ E Long). Coll. and subm. 1969 by J. Nakamura. *Comment*: larger error is due to shortage of sample.

N-470-1. Furen 1 **1950 ± 155**
A.D. 0

Peat containing volcanic gravel from 40 cm below surface.

N-470-2. Furen 2 **9470 ± 220**
7520 B.C.

Peat containing silt and sand from 100 cm below surface.

Sotoyama series

Material from terrace along Sotoyama R., Sotoyama, Morioka city, Iwate pref. (39° 43′ N Lat, 141° 2′ E Long). Coll. and subm. 1969 by J. Nakamura.

N-471-1. Sotoyama 1 **1360 ± 180**
A.D. 590

Peat containing silt and sand from 70 cm below surface.

N-471-3. Sotoyama 3 **>33,700**

Humic silt from 350 cm below surface.

N-472. Kubokawa **>37,800**

Charred cone of *Picea Polita* from Yoshimi R. terrace at Kubokawa-cho, Takaoka-gun, Kochi pref. (33° 2′ N Lat, 133° 2′ E Long). Coll. and subm. 1969 by J. Nakamura.

650 ± 105
N-598. Yamaji **A.D. 1300**

Piece of driftwood (*Quercus glauca*) from alluvium of Nakasuji R., Tosa-Nakamura city, Kochi pref. (32° 54′ N Lat, 133° 0′ E Long). Coll. 1968 and subm. by J. Nakamura.

6730 ± 160
N-599. Toyonaga **4780 B.C.**

Piece of driftwood (*Chamaecyparis* sp.) from landslide debris along Yoshino R., 10 m below surface, Toyonaga, Otoyo-mura, Nagaoka-gun, Kochi pref. (33° 50′ N Lat, 133° 45′ E Long). Coll. 1968 and subm. by J. Nakamura.

Yoshida-cho series

Peat samples from boring core obtained at Yoshida-cho, Kochi city (33° 25′ N Lat, 133° 30′ E Long). Coll. 1968 and subm. by J. Nakamura (Nakamura, 1969).

N-600. Yoshida-cho 1 **>37,800**

16.05 to 16.25 m below surface.

N-601. Yoshida-cho 2 **>37,800**

19.20 to 20.00 m below surface.

N-602. Yoshida-cho 3 **>37,800**

24.20 to 24.60 m below surface.

N-603. Yoshida-cho 4 **>37,800**

29.50 to 30.10 m below surface. *Comment* (J.N.): pollen analysis indicates material is of Ice Age.

Kaminoura series

Peat from right bank of Kokai R., Kaminoura, Fujishiro-cho, Kita-soma-gun, Ibaraki pref. (35° 53′ N Lat, 140° 8′ E Long). Coll. 1968 by T. Sato; subm. by M. Oya, Waseda Univ. (Oya, 1969).

1750 ± 110
N-610. Kaminoura 1 **A.D. 200**

67 cm below present surface of rice field.

1140 ± 100
N-611. Kaminoura 2 **A.D. 810**

From just below N-610.

2070 ± 110
N-612. Odome **120 B.C.**

Peat from right bank of Kokai R., 80 cm below surface, Odome, Ryugasaki city, Kita-soma-gun, Ibaraki pref. (35° 54′ N Lat, 140° 9′ E Long). Coll. 1968 by T. Sato; subm. by M. Oya.

1410 ± 100

N-613. Ryugasakichobu **A.D. 540**

Peat from left bank of Tone R., 30 cm below surface, Ryugasaki-chobu, Kawachi-mura, Inashiki-gun, Ibaraki pref. (35° 52′ N Lat, 140° 13′ E Long). Coll. 1968 by T. Sato; subm. by M. Oya.

17,900 ± 400

N-495. Kyu Nawa **15,950 B.C.**

Wood from Kyu Nawa, Nawa-cho, Saihaku-gun, Tottori pref., N side of Mt. Daisen (35° 29′ N Lat, 133° 31′ E Long), imbedded in thin clay layer overlain by mudflow containing pumice. Coll. 1966 and subm. by T. Kimachi, Yonago Kita High School. *Comment* (T.K.): wood ca. 1 m apart yielded 18,500 ± 400 (N-138, Radiocarbon, 1966, v. 8, p. 326).

25,300 ± 700

N-638. Ichihino **23,350 B.C.**

Piece of charred timber, 15 cm diam., 50 cm long, from Ichihino, Hiwaki-cho, Satsuma-gun, Kagoshima pref. (31° 48′ N Lat, 130° 25′ E Long), imbedded in Ito pyroclastic flow related to formation of Aira caldera. Coll. 1969 and subm. by S. Yokoyama, Toyko Univ. of Educ. *Comment* (S.Y.): other measurements on deposits are 16,350 ± 350 (GaK-473, Radiocarbon, 1966, v. 8, p. 57; Aramaki, 1965) and 23,400 ± 800 (GaK-558, Radiocarbon, 1966, v. 8, p. 57; Isshiki *et al.*, 1965).

7710 ± 130

N-618. Shitanohara **5760 B.C.**

Marine shell (*Mya* [*Arenomya*] *arenaria*) from Taito-misaki shell bed, Shitanohara, Misaki-cho, Isumi-gun, Chiba pref. (34° 57′ N Lat, 139° 50′ E Long). Coll. 1968 by S. Ohara, Chiba Univ.; subm. by K. Taira, Tokyo Univ. of Educ.

885 ± 100

N-609. Hayama **A.D. 1065**

Boat fragment from loam bed, ca. 3 m below surface, at Hayama, Hayama-cho, Kanagawa pref. (35° 20′ N Lat, 139° 36′ E Long). Coll. 1967 by K. Watanabe, Tokyo Univ. of Educ.; subm. by K. Taira.

Nansei Islands series

Fossil hermatypic corals from various localities in Nansei Is. Coll. 1967-1968 and subm. by K. Konishi, Kanazawa Univ. Some samples dated also by ionium and protactinium method at Kanazawa Univ. (Omura, pers. commun.). Io ages are corrected for presence of initial ionium in sample (Omura, Konishi, and Hamada, 1969).

5020 ± 140

N-545 a. Shirahama 1 **3070 B.C.**

N-545 b. Shirahama 2 — **4590 ± 130**
2640 B.C.

N-545 c. Shirahama 3 — **4490 ± 130**
2540 B.C.

Coral heads 20 to 40 cm diam. *in situ* 6 m below low tide, present reef flat along Shirahama coast, ca. 500 m SW of China, Okierabu-shima, Oshima-gun, Kagoshima pref. (27° 19′ N Lat, 128° 34′ E Long). Io age: 1700 ± 300, 3100 ± 300, 1700 ± 200; Pa age: 7400 ± 200, 6600 ± 200, 5700 ± 200, respectively.

N-546. Kasari 1 — **2130 ± 115**
180 B.C.

Piece of coral head, ca. 30 cm diam. from bed hitherto mapped as Riukiu Limestone, ca. 1.5 m above low tide on Kasari coast, Amami-o-shima, Oshima-gun, Kagoshima pref. (28° 29′ N Lat, 129° 42′ E Long). Io age: 2000 ± 300; Pa age: 10,100 ± 700.

N-547. Kasari 2 — **Modern**

Coral head, ca. 20 cm diam., ca. 1 m above low tide, from present reef flat, same location as N-546. Pa age: 69,000 ± 3000.

N-548. Tomori — **2270 ± 115**
320 B.C.

Piece of coral head, ca. 20 cm diam., near pedestal surface of mushroom stack ca. 1.6 m above low tide, 400 m N of Tomori, Amami-o-shima, Oshima-gun, Kagoshima pref. (28° 27′ N Lat, 129° 43′ E Long).

N-549. Sakamine 1 — **2330 ± 110**
380 B.C.

Coral head, ca. 10 cm diam., *in situ*, ca. 1 m above high tide, from raised coral reef along Sakamine coast, Kikai-shima, Oshima-gun, Kagoshima pref. (28° 20′ N Lat, 129° 58′ E Long).

N-550. Sakamine 2 — **3810 ± 120**
1860 B.C.

Coral head, ca. 30 to 40 cm diam. *in situ*, from raised coral reef, ca. 2 m above high tide, at rear of schoolyard of Sakamine Primary School, Nakaguma, Kikai-shima, Oshima-gun, Kagoshima pref. (28° 20′ N Lat, 129° 58′ E Long). Io age: 2900 ± 150; Pa age: 500 ± 30.

N-551. Kunigami 1 — **3310 ± 120**
1360 B.C.

Piece of coral head, ca. 30 cm diam. from emerged reef(?), ca. 2 m above high tide, at Kunigami-misaki, ca. 2.5 km ENE of Kunigami, Okierabushima, Oshima-gun, Kagoshima pref. (27° 25′ N Lat, 128° 43′ E Long). Io age: 3600 ± 200; Pa age: 9400 ± 400.

N-556. Kunigami 2 — **Modern**

Coral head, ca. 30 cm diam. *in situ*, from present reef flat, ca. 20 cm above low tide, at the same location as N-551.

N-552. Kunigami 3 **>37,800**

Coral head, ca. 40 to 50 cm diam. *in situ*, ca. 15 m above mean high tide, ca. 2.3 km ENE of Kunigami, Okierabu-shima, Oshima-gun, Kagoshima pref. (27° 26′ N Lat, 128° 43′ E Long). Io age: 85,000 ± 3000; Pa age: 28,000 ± 1000.

N-553. Kunigami 4 **>37,800**

Coral head, ca. 20 cm diam., ca. 20 m above mean high tide, 2.2 km ENE of Kunigami, Okierabu-shima, Oshima-gun, Kagoshima pref. (27° 26′ N Lat, 128° 43′ E Long).

3980 ± 130
N-554. Okidomari **2030 B.C.**

Coral head, ca. 20 cm in diam. *in situ*, from present reef flat, ca. 10 to 20 cm above low tide, at Okidomari coast, 900 m WSW of Shinjo, Okierabu-shima, Oshima-gun, Kagoshima pref. (27° 24′ N Lat, 128° 34′ E Long).

2430 ± 120
N-555. Wanjo-hama **480 B.C.**

Coral head, ca. 20 cm in diam. *in situ*, from present reef flat, ca. 20 cm above low tide, at Wanjo-hama coast, 400 m NW of Azefu, Okierabushima, Oshima-gun, Kagoshima pref. (27° 24′ N Lat, 128° 38′ E Long).

B. Okinawa

Chinen series

Coral from raised reef exposed at Chinen, E of Naha city, S Okinawashima (26° 30′ N Lat, 128° 0′ E Long). Coll. and subm. 1968 by K. Taira.

4990 ± 120
N-628. +0.3 m **3040 B.C.**

23,600 ± 600
N-626. +1 m **21,650 B.C.**

25,700 ± 800
N-636. +2 m **23,750 B.C.**

37,300 ± 2800
N-615. +7 m **34,350 B.C.**

N-629. +13 m **>37,800**

37,200 ± 2900
N-632. +15 m **35,250 B.C.**

32,300 ± 1700
N-630. +20 m **30,350 B.C.**

29,900 ± 1300
N-637. +23 m **27,950 B.C.**

N-635. +40 m — **30,800 ± 1400** / **28,850 B.C.**

Comment: dates beyond 20,000 yr would be affected by modern carbon contamination.

Mabuni series

Coral from raised reef exposed at Mabuni, SSW of Naha city, S Okinawashima (26° 30′ N Lat, 128° 0′ E Long). Coll. and subm. 1968 by K. Taira.

N-640. +0.5 m — **32,500 ± 1900** / **30,550 B.C.**

N-641. +10 m — **>37,800**

N-643. +50 m — **36,600 ± 2800** / **34,650 B.C.**

C. Taiwan

Mainly fossil hermatypic corals from various localities in Taiwan. Coll. 1968 by T.-Y. H. Ma, Natl. Taiwan Univ., W. Hashimoto, and K. Taira; subm. by K. Taira. *Comment* (K.T.): dating of this series, as well as Okinawa and Borneo series (this list), is to establish sea-level curve during last 19,000 yr in E Asia and to investigate problem of Jomon transgression which took place in Japan in 6000 yr B.P. but is inconsistent with data of Shepard (1964) and MacFarlan (1961).

Lungkang series

Wood from several horizons of Lungkang Formation at its type locality. Taken from wave-cut low cliff, N of Wumei-chi R., Houlung, Miaoli (24° 34′ N Lat, 120° 49′ E Long). Other samples from same locality dated at Natl. Taiwan Univ. yielded 8415 ± 433 (NTU-2) and 6822 ± 308 (NTU-3) (Hsu *et al.*, 1965).

N-577. +1 m — **7360 ± 150** / **5410 B.C.**

N-576. +2 m — **7180 ± 140** / **5230 B.C.**

N-607. +1.5 m — **7380 ± 140** / **5430 B.C.**

N-608. +0.5 m — **7530 ± 150** / **5580 B.C.**

Haikou series

Reef corals from raised reef exposed at cut of natl. hwy. to Oluanpi N of Haikou, N of Hengchun, Pingtung-hsien (22° 1′ N Lat, 120° 44′ E Long). Estimated >20 m thick.

N-575. +1 m — **1370 ± 105** / **A.D. 580**

N-606. +5 m **5210 ± 125**
3260 B.C.

N-605. +15 m **4050 ± 115**
2100 B.C.

Akungtien series

Material from raised coral reef exposed at S foot of Mt. Hsiaokang-shan, NE of Kangshan, Kaohsiung-hsien (22° 48′ N Lat, 120° 17′ E Long). Outcrop of reef is ca. 4 m high, base is hidden by a corn field. Another sample from same locality dated at Natl. Taiwan Univ. yielded 7532 ± 482 (NTU-4, Hsu *et al.*, 1965).

N-568. Akungtien 1 **5560 ± 105**
3610 B.C.

Coral from 0.6 m above field.

N-570. Akungtien 2 **5610 ± 125**
3660 B.C.

Coral from 0.8 m above field.

N-569. Akungtien 3 **5510 ± 125**
3560 B.C.

Coral from 1.9 m above field.

N-574. Akungtien 4 **5470 ± 125**
3520 B.C.

Coral from 3.3 m above field.

N-580. Akungtien 5 **5370 ± 125**
3420 B.C.

Coral from 1.6 m above field.

N-604. Akungtien 6 **7070 ± 140**
5120 B.C.

Marine shell (*Ostrea* sp.) from 4 m above field.

N-578. Akungtien 7 **5800 ± 130**
3850 B.C.

Coral from 3.0 m above field.

N-614. Peinan **20,600 ± 450**
18,650 B.C.

Coral from raised reef exposed at coast, N of Peinan, NNW of Taitung (22° 48′ N Lat, 121° 10′ E Long), at ca. +100 m.

N-619. Chuanfanshih **32,600 ± 1600**
30,650 B.C.

Coral from Chuanfanshih Limestone exposed along natl. hwy., N of Chuanfanshih, SE of Henchung, Pingtung-hsien (22° 1′ N Lat, 120° 44′ E Long).

K'enting series

Material from raised coral reef ca. 7.5 km NE of Henchung, Pingtung-hsien (22° 1′ N Lat, 120° 44′ E Long).

N-620. K'enting 1 **4190 ± 115**
2240 B.C.

Coral from +12 m overlying silt, near K'enting Primary School.

N-621. K'enting 2 **7910 ± 150**
5960 B.C.

Coral from +20 m, along natl. hwy., ca. 300 m NW from N-620.

N-627. K'enting 3 **8420 ± 150**
6470 B.C.

Coral from same level of and 5 m apart from N-621.

N-624. K'enting 4 **5550 ± 125**
3600 B.C.

Marine shell (*Codakia* sp.) from same locality as N-621.

N-631. Wunchia **7470 ± 135**
5520 B.C.

Marine shell (*Ostrea* sp.) from Shikoshi Shell Beds of Tainan Formation exposed at N of Wunchia, ca. 15 km ESE of Tainan-shih, Tainan-hsien (23° 0′ N Lat, 120° 13′ E Long).

Chengkung series

Coral from raised reef exposed at coast, 2.5 km N of Chengkung (23° 6′ N Lat, 121° 22′ E Long).

N-616. +15 m **25,900 ± 800**
23,950 B.C.

N-617. +20 m **>37,800**

N-642. Wangsha **35,800 ± 2400**
33,850 B.C.

Coral from Wangsha Limestone exposed at N of Wangsha, 2 km of Hengchun, Pingtung-hsien (22° 1′ N Lat, 120° 44′ E Long).

N-645. Maashan **4570 ± 120**
2620 B.C.

Piece of stock-like Bryozoa, ca. 10 cm diam., imbedded in Maashan Formation consisting of silt, exposed along road, at N of Maashan, ca. 4.5 km SSW of Hengchun (22° 1′ N Lat, 120° 44′ E Long). *Comment* (K.T.): date does not agree with expectation Lower Pleistocene or Upper Pliocene age.

N-639. Hsiaochiang **>37,800**

Coral from Fengpitou Limestone, Erhchiao Quarry, E of Hsiaochiang, ca. 15 km SE of Kaohsiung, Kaohsiung-hsien (22° 38′ N Lat, 120° 18′ E Long).

N-644. Ssukou **20,600 ± 400**
18,650 B.C.

Coral from emerged reef, Ssukou, ca. 2 km WNW of Hengchun, Pingtung-hsien (22° 1′ N Lat, 120° 44′ E Long).

D. Borneo

Semporna series

Coral from raised reef, E coast of Semporna, Semporna Peninsula, Borneo (4° 20′ N Lat, 118° 30′ E Long). Coll. 1968 by W. Hashimoto; subm. by K. Taira.

N-715. Semporna 1 — **35,000 ± 2300** — **33,050 B.C.**

0.5 m above high tide.

N-716. Semporna 2 — **18,400 ± 340** — **16,450 B.C.**

1.5 m above high tide.

N-717. Semporna 3 — **29,200 ± 1100** — **27,250 B.C.**

1.5 m above high tide, and 2 m from N-716.

N-714. Semporna 4 — **32,400 ± 1600** — **30,450 B.C.**

2 m above high tide.

E. Australia

Lake Keilambete series

Organic and inorganic carbon from core and lakeshore outcrop of Quaternary lacustrine sediments in crater lake Keilambete, near Terang, Victoria, Australia (38° 10′ S Lat, 142° 52′ E Long). Lake water contains 903 ppm of CO_3, and core sediment contains up to 50% by weight of clay-sized carbonate; ostracod and *Coxiella* shells are present in core 4 m long from water 27 ft deep. Coll. 1968 and subm. by J. M. Bowler, Australian Natl. Univ. *Comment*: materials treated by HCl and evolved CO_2 dated as inorganic fraction. Dried residues are combusted in stream of oxygen and dated as organic fraction.

N-388. Lake Keilambete LK2 — **3820 ± 120** — **1870 B.C.**

Organic fraction of sandy peat containing *Coxiella* shells from bank of lake, 1 ft, 7 to 9 in. above 1967 water level and underlying youngest layer of indurated lake limestone.

N-389. Lake Keilambete LK3 — **8690 ± 165** — **6740 B.C.**

Organic fraction of sandy peat from bank of lake, 7 to 9 in. above 1967 water level underlying 2nd layer of indurated lake limestone.

N-390. Lake Keilambete LK1 — **1890 ± 115** — **A.D. 60**

Piece of fallen tree lying half above, and half under water with indurated lake limestone and peaty mud over it.

N-566. Lake Keilambete LK34 **29,100 ± 1250**
27,150 B.C.

Inorganic carbon from lowest of 3 marl bands in shoreline volcanic sands, disconformably overlying Tertiary limestone. Sample provides limiting age of volcanic eruption and crater formation.

N-567. Lake Keilambete LK37 **21,600 ± 650**
19,650 B.C.

Inorganic carbon from highest of 3 marl bands assoc. with N-566.

N-517-1. Lake Keilambete LK4/11 **610 ± 110**
A.D. 1340

Organic fraction, 11 to 21 cm in core.

N-517-2. Lake Keilambete LK4/11 **360 ± 105**
A.D. 1590

Inorganic fraction of above sample.

N-518. Lake Keilambete LK4/21 **935 ± 110**
A.D. 1015

Organic fraction, 21 to 33 cm in core.

N-519. Lake Keilambete LK4/55 **1970 ± 115**
20 B.C.

Organic fraction, 55 to 65 cm in core.

N-520-1. Lake Keilambete LK4/79 **2410 ± 120**
460 B.C.

Organic fraction, 79 to 90 cm in core.

N-520-2. Lake Keilambete LK4/79 **2560 ± 120**
610 B.C.

Inorganic fraction of above sample.

N-521-1. Lake Keilambete LK4/102 **2600 ± 110**
650 B.C.

Organic fraction, 102 to 112 cm in core.

N-521-2. Lake Keilambete LK4/102 **2900 ± 120**
950 B.C.

Inorganic fraction of above sample.

N-522-1. Lake Keilambete LK4/130 **2970 ± 120**
1020 B.C.

Organic fraction, 130 to 140 cm in core.

N-522-2. Lake Keilambete LK4/130 **4150 ± 190**
2200 B.C.

Inorganic fraction of above sample.

N-523-1. Lake Keilambete LK4/165 **3580 ± 125**
1630 B.C.

Organic fraction, 165 to 175 cm in core.

N-523-2. Lake Keilambete LK4/165 **5430 ± 135**
3480 B.C.

Inorganic fraction of above sample.

4200 ± 125
N-524-1. Lake Keilambete LK4/190 **2250 B.C.**
Organic fraction, 190 to 200 cm in core.

5960 ± 140
N-524-2. Lake Keilambete LK4/190 **4010 B.C.**
Inorganic fraction of above sample.

5250 ± 135
N-525-1. Lake Keilambete LK4/235 **3300 B.C.**
Organic fraction, 235 to 245 cm in core.

5680 ± 160
N-525-2. Lake Keilambete LK4/235 **3730 B.C.**
Inorganic fraction of above sample.

6440 ± 145
N-526-1. Lake Keilambete LK4/290 **4490 B.C.**
Organic fraction, 290 to 300 cm in core.

6290 ± 140
N-526-2. Lake Keilambete LK4/290 **4340 B.C.**
Inorganic fraction of above sample.

7850 ± 165
N-527-1. Lake Keilambete LK4/325 **5900 B.C.**
Organic fraction, 325 to 345 cm in core.

9860 ± 180
N-527-2. Lake Keilambete LK4/325 **7910 B.C.**
Inorganic fraction of above sample.

14,300 ± 300
N-528. Lake Keilambete LK4/395 **12,350 B.C.**
Organic fraction, 395 to 412 cm in core, containing trace of inorganic carbon, just below major disconformity. *Comment* (J.M.B.): this series forms part of a cooperative project in which Bowler is studying the Quaternary variations in lake levels believed to have been controlled by changes in climate. This sequence, back to 29,000 B.P. is the 1st from a lake core in Australia extending beyond the last glacial maximum.

Pooraka series

Samples from S bank of Dry Creek, Pooraka, S Australia (34° 50′ S Lat, 138° 37′ E Long). Coll. 1969 and subm. by G. E. Williams, Univ. of Adelaide.

34,600 ± 2600
N-633. Pooraka 1 **32,650 B.C.**
Charcoal fragments and carbonized wood from late Pleistocene alluvial sand 3 m below top of bank.

18,900 ± 450
N-634. Pooraka 2 **16,950 B.C.**
Dense nodules of calcium carbonate from calcareous soil developed within late Pleistocene alluvium, 1 m below top of bank and directly above N-633.

General Comment (G.E.W.): N-633 indicates Wisconsin age for last major episode of alluvial fan building in Adelaide region of S Australia (Williams, 1970). N-634 is consistent with stratigraphy, and suggestive of late Wisconsin for calcareous soil development.

II. PEDOLOGIC SAMPLES

Total organic carbon of humic horizon in volcanic ash soil from various localities coll. 1969 by Y. Yamada, Natl. Inst. Agric. Sci., and dated to determine relationship between soil age and properties of humus in soil.

5630 ± 120
N-669. Kamifuno Kfn-2 **3680 B.C.**

Sample from A_{12} horizon, 8 to 21 cm below surface, at Kamifuno, Funo-mura, Futami-gun, Hiroshima pref. (34° 53′ N Lat, 132° 47′ E Long).

Yokodani series

Samples from Yokodani, Funo-mura, Futami-gun, Hiroshima pref. (34° 56′ N Lat, 132° 44′ E Long).

5090 ± 130
N-670. Yokodani 1 Ykd-1 **3140 B.C.**

From A_{13} horizon, 90 to 100 cm below surface.

6070 ± 155
N-671. Yokodani 2 Ykd-2 **4120 B.C.**

From A_3 horizon, 100 to 110 cm below surface, just below N-670.

Ozota series

Samples from Ozota, Toyosaka-cho, Kamo-gun, Hiroshima pref. (34° 37′ N Lat, 132° 48′ E Long).

1950 ± 100
N-672. Ozota 1 Ozt-2 **A.D. 0**

From A_{12} horizon, 18 to 33 cm below surface.

3580 ± 130
N-673. Ozota 2 Ozt-3 **1630 B.C.**

From A_{13} horizon, 33 to 65 cm below surface, just below N-673.

970 ± 110
N-674. Hirodomeno **A.D. 980**

Sample from A_{11} horizon, 0 to 30 cm below surface, at Hirodomeno, Wakasa-cho, Yazu-gun, Tottori pref. (35° 24′ N Lat, 134° 27′ E Long).

Nashibara series

Samples from Nashibara, Saji-mura, Yazu-gun, Tottori pref. (35° 20′ N Lat, 134° 7′ E Long).

3750 ± 110
N-675. Nashibara 1 Nsb-1-2 **1800 B.C.**

From A_{12} horizon, 13 to 25 cm below surface.

N-676. Nashibara 2 Nsb-2-1 **3660 ± 120**
1710 B.C.

From A horizon, 10 to 20 cm below surface of a lower terrace, S of site from which N-675 was coll.

III. ARCHAEOLOGIC SAMPLES

A. Japan

Izuhara series

Charcoal in slag from ancient copper refinery at Izuhara-cho, Shimoagata-gun, Nagasaki pref. (34° 13′ N Lat, 129° 13′ E Long). According to documents copper mines in this area were operated during 674 to 927 A.D. and since 1486 A.D. Coll. 1968 and subm. by F. Kamiide, Taishu Mine, Toho Zinc Co.

N-559. Izuhara 1 **Modern**

From slag deposit >1.5 m thick, overlain by 40 cm surface soil.

N-560. Izuhara 2 **170 ± 105**
A.D. 1780

From exposed slag deposit 25 cm thick.

N-561. Izuhara 3 **400 ± 120**
A.D. 1550

From slag deposit 15 cm thick, overlain by 30 cm surface soil.

N-562. Izuhara 4 **Modern**

From exposed slag deposit.

B. Philippines

Aparri series

Piece of wood from sunken ship in 20 ft of water, imbedded in 2 ft sand at coast of Aparri, Luzon I., Philippines (18° 20′ N Lat, 121° 50′ E Long). Coll. and subm. 1969 by H. Ito, Soriamont Development Co.

N-656. Aparri 1 **255 ± 105**
A.D. 1695

N-667. Aparri 2 **250 ± 105**
A.D. 1700

Both samples are from separate pieces.

C. Africa

Sinde series

Charcoal from 18 in. below surface at various points of single component Iron age village site, 7 mi from Livingstone, S Province, Zambia (17° 45′ S Lat, 25° 45′ E Long). Cultural materials excavated indicate immediately post-Kalomo occupation. Coll. 1967 and subm. by J. O. Vogel, Livingstone Mus.

N-563. Sinde 1 (ZLM-23) **725 ± 105**
A.D. 1225

N-564. Sinde 2 (ZLM-24) **780 ± 110**
A.D. 1170

N-565. Sinde 3 (ZLM-25) **800 ± 110**
A.D. 1150

Comment (J.O.V.): dates confirm typologic seriation defined by Vogel (1969), in which Sinde material was described as styles of pottery already known from Kalomo-type ceramics as well as a range of types in Tonga Diaspora tradition. Cultural deposit is very shallow suggesting fairly short occupation and carbon determinations suggest median date of late 12th century.

Simonga series

Burnt wooden poles from single component Iron age village site in Simonga Forest Preserve, 12 mi from Livingstone, S Province, Zambia (17° 46′ S Lat, 25° 43′ E Long). Cultural materials indicate assoc. with Sinde and Simbusenga sites. Coll. 1967 and subm. by J. O. Vogel.

N-571. Simonga 1 (ZLM-26) **815 ± 100**
A.D. 1135

N-572. Simonga 2 (ZLM-27) **620 ± 105**
A.D. 1330

N-573. Simonga 3 (ZLM-28) **620 ± 110**
A.D. 1330

Comment (J.O.V.): dates confirm typologic seriation based on Kamangoza and Simbusenga excavations and presence of people assoc. with early Tonga tradition in Victoria Falls region by 12th century.

Mukuni series

Charcoal from 36 in. below surface, just above interface with underlying sterile Kalahari sands, at village of Mukuni, Livingstone Dist., S Province, Zambia (17° 54′ S Lat, 25° 56′ E Long). Cultural materials excavated with this sample indicate assoc. with Sinde and Simonga series with some small admixture of Kalomo elements (Vogel, 1969). Samples come from areas ca. 50 m apart. Coll. 1969 and subm. by J. O. Vogel.

N-678. Mukuni 1 (ZLM-29) **755 ± 105**
A.D. 1195

N-679. Mukuni 2 (ZLM-30) **720 ± 110**
A.D. 1230

N-668. Chundu (ZLM-31) **220 ± 170**
Modern

Charcoal fragment from 24 in. below surface, Chundu Farm, Livingstone Dist., S Province, Zambia (17° 35′ S Lat, 25° 41′ E Long), from a sealed pottery vessel assoc. with iron hoe and unidentified seeds. Vessel was Kamangoza Class 2 type (Vogel, 1969) suggesting Early Iron age context. Coll. 1969 and subm. by J. O. Vogel. *Comment*: larger error due to shortage of sample.

Mwanamaimpa series

Charcoal from various depths at Mwanamaimpa Mound, Namwala Dist., S Province, Zambia (15° 59′ S Lat, 26° 7′ E Long). Early Iron age levels overlain by later horizons containing pottery of unknown type. Coll. 1968 and subm. by B. M. Fagan, Univ. of California.

735 ± 105
N-581. Mwanamaimpa 1 (MM/RC/01) **A.D. 1215**
24 in. below surface. Assoc.: Ila.

605 ± 105
N-582. Mwanamaimpa 2 (MM/RC/03) **A.D. 1345**
50 in. below surface. Assoc.: Ila.

935 ± 110
N-583. Mwanamaimpa 3 (MM/RC/08) **A.D. 1015**
108 in. below surface. Assoc.: Mid-Iron age.

925 ± 110
N-584. Mwanamaimpa 4 (MM/RC/09) **A.D. 1025**
126 in. below surface. Assoc.: Mid-Iron age.

1370 ± 130
N-585. Mwanamaimpa 5 (MM/RC/16) **A.D. 580**
192 in. below surface. Assoc.: Early Iron age.

1170 ± 115
N-586. Mwanamaimpa 6 (MM/RC/17) **A.D. 780**
197 in. below surface. Assoc.: Early Iron age.

925 ± 110
N-578. Mwanamaimpa 7 (MM/RC/19) **A.D. 1025**
120 in. below surface. Assoc.: Mid-Iron age.

Basanga series

Charcoal from various depths at Basanga mound, Namwala Dist., S Province, Zambia (15° 50′ S Lat, 26° 5′ E Long). Early Iron age levels overlain by later horizons containing pottery of unknown type. Coll. 1968 and subm. by B. M. Fagan.

640 ± 110
N-588. Basanga 1 (BS/RC/01) **A.D. 1310**
18 in. below surface. Assoc.: Ila.

820 ± 110
N-589. Basanga 2 (BS/RC/03) **A.D. 1130**
24 in. below surface. Assoc.: Ila.

845 ± 110
N-590. Basanga 3 (BS/RC/10) **A.D. 1105**
71 in. below surface. Assoc.: Mid-Iron age.

865 ± 110
N-591. Basanga 4 (BS/RC/15) **A.D. 1085**
102 in. below surface. Assoc.: Mid-Iron age.

855 ± 105
N-592. Basanga 5 (BS/RC/22) **A.D. 1095**
108 in. below surface. Assoc.: Early Iron age.

880 ± 100
N-593. Basanga 6 (BS/RC/16) **A.D. 1070**
139 in. below surface. Assoc.: Early Iron age.

1160 ± 115
N-594. Basanga 7 (BS/RC/17) **A.D. 790**
183 in. below surface. Assoc.: Early Iron age.

1220 ± 120
N-595. Basanga 8 (BS/RC/18) **A.D. 730**
195 in. below surface. Assoc.: Early Iron age.

General Comment for Mwanamaimpa and Basanga series (B.M.F.): dates indicate Early Iron age occupation of both mounds ended in 8th century A.D.; 11th century date for main occupation of both mounds seems well established. They were probably abandoned long before present inhabitants arrived.

2640 ± 120
N-493. Nyang'oma Rock Shelter **690 B.C.**

Charcoal fragment 20 to 35 cm below surface in Nyang'oma Rock shelter, Mwanza East area, Tanzania (2° 27′ S Lat, 33° 41′ E Long), occurring with "Late Stone age" industry characterized by small crescents, assoc. with sherds of "Kansyore Ware." Coll. 1968 and subm. by R. C. Soper, Brit. Inst. Hist. and Archaeol., E Africa.

1300 ± 130
N-650. Gatare Forest **A.D. 650**

Charcoal 30 to 36 cm below surface at Gatare Forest, Mairi Track, Fort Hall Dist., Kenya (0° 44′ S Lat, 36° 47′ E Long), assoc. with obsidian industry of "Late Stone age" type and overlain by pottery-bearing horizon. Coll. and subm. 1969 by R. C. Soper.

Usangi Hospital series

Samples from site at Usangi Hospital, North Pare Mts., N Tanzania (3° 42′ S Lat, 37° 39′ E Long). Area 24 m^2 was excavated down to 70 cm from surface. Finds are homogeneous throughout showing affinities both to Kwale ware and N Tanzania A-group pottery (Soper, 1967). Suggested archaeologic date: 2nd half of 1st millennium A.D. Coll. 1969 by K. Odner; subm. by H. N. Chittick, Brit. Inst. Hist. and Archaeol., E Africa.

1030 ± 130
N-646. Usangi Hospital 1 **A.D. 920**
15 cm below surface (Sq. 1D).

N-647. Usangi Hospital 2 **5180 ± 135**
3230 B.C.

25 cm bleow surface (Sq. 6D).

N-648. Usangi Hospital 3 **1430 ± 270**
A.D. 520

Between 40 and 50 cm below surface (Sq. 2D).

General Comment (K.O.): N-646 and N-648 are consistent with archaeologic dates. Contamination is most likely explanation for early dates of N-647 as material from this level is same as that from which the other charcoal samples were taken.

N-649. Mwanga 3A **990 ± 105**
A.D. 960

Charcoal between 0 to 10 cm below surface, at iron smelting site Mwanga 3A in North Pare Mts., N Tanzania (3° 40′ S Lat, 37° 36′ E Long), assoc. with iron slag, tuyeres, quartz flakes, and parts of vessel similar to NE Tanzania B group dated at Bombo to A.D. 890 ± 110 (N-348, Radiocarbon, 1968, v. 10, p. 343). Coll. 1969 by K. Odner; subm. by H. N. Chittick.

N-651. Prospect Farm Stone Bowl site (PF-1) **2910 ± 110**
960 B.C.

Charcoal from Prospect Farm Stone Bowl site, Nakuru Dist., Kenya (0° 35′ S Lat, 36° 11′ E Long), alt. 6700 ft, occurring as a concentrated patch, 30 to 50 cm horizontal extent and 15 cm depth, within continuous layer of ash, 15 cm thick and ca. 1 m below surface, associated with concentration of bones and artifacts including stone bowl, polished stone axe, and deeply incised potsherds. Coll. and subm. 1969 by M. N. Cohen, Brit. Inst. Hist. and Archaeol., E Africa.

N-652. Deloraine Farm site (Del-1) **1070 ± 110**
A.D. 880

Charcoal from Deloraine Farm site, Nakuru Dist., Kenya (0° 11′ S Lat, 35° 48′ E Long), scattered throughout whole of 10 cm layer, 60 to 70 cm below surface, of 2 × 4 m test pit, assoc. with heavy concentration of fauna and pottery with incised and punctate decorations otherwise unknown in region. Coll. and subm. 1969 by M. N. Cohen.

Keringet Cave series

Charcoal from various depths of stone bowl cremation site near Gilgil (Brown, 1966), Nakuru Dist., Kenya (0° 21′ S Lat, 35° 40′ E Long). Coll. and subm. 1969 by M. N. Cohen.

N-653. Keringet Cave 1 (KH-3) **2910 ± 115**
960 B.C.

From depth 65 to 70 cm, scattered in Layer 14 of test pit, outside region of cremation pits. Assoc. with new type of impressed potsherds, presumably predating stone bowl assemblage.

2430 ± 110
N-654. Keringet Cave 2 (KH-1) **480 B.C.**

From 60 to 65 cm below surface of shelter, occurring as a consolidated chunk, assoc. with cremated remains and artifacts of Njoro River Cave type.

2050 ± 110
N-655. Keringet Cave 3 (KH-2) **100 B.C.**

From depth 50 to 55 cm within burial pits, assoc. with artifacts of Njoro River Cave type.

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UNIVERSITY OF PENNSYLVANIA RADIOCARBON DATES XIII

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INTRODUCTION

This date list includes those series of samples completed in this laboratory as of November 1969. The B.P. ages are based upon A.D. 1950, and are calculated with a half-life value of 5568 yr. All samples were counted at least twice for periods of not less than 1000 minutes each. Errors quoted are derived from measurement of samples, background, and modern-age calibration, but do not include any half-life error. All samples were pretreated with 3N HCl, and some, where noted, were given additional pretreatment with 2% NaOH for the removal of possible humic contaminants.

Standard calibration samples are 125-yr old oak samples which, when corrected for age, have C^{14} contents equal to 95% of the NBS oxalic acid standard. The C^{13} relationship between the oak standard and NBS limestone standard #20 is -25.7 ± 1.3‰ as measured on the University of Pennsylvania mass spectrograph.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Near East

Iran

Dinkha Tepe series, Iran

Dinkha Tepe (36° 59′ 51″ N Lat, 45° 10′ 41″ E Long) is in the Ushnu Valley, W Azerbaijan, Iran. Samples coll. during 1966 and 1968 excavations at Dinkha Tepe, carried out by the Hasanlu Project, jointly sponsored by Univ. Mus., Univ. of Pennsylvania; Metropolitan Mus. of Art of New York City and Archaeol. Service of Iran; subm. by excavation director, R. H. Dyson, Jr., Univ. Mus., Univ. of Pennsylvania. Remains of 4 major occupations have been uncovered: Dinkha I (Islamic); Dinkha II (Iron Age II equal to Hasanlu IV, ca. 1000-800 B.C.); Dinkha III (Iron Age I equal to Hasanlu V, ca. 1350-1000 B.C.) and Dinkha IV (Bronze Age equal in part to Hasanlu VI, ca. ?1900-?1350 B.C.). This chronology is based on earlier radiocarbon dates from Hasanlu and studies of relative chronology (Dyson, 1965; Ralph, 1959; Stuckenrath, 1963; Stuckenrath *et al*, 1966).

Dinkha III

3005 ± 36
P-1475. DiS 66-44, B7f(5) 1055 B.C.

Charcoal immediately overlying Wall A, in Area B7, from top of central mound. *Comment*: NaOH pretreatment.

3157 ± 55
P-1474. DiS 66-113, B8e(3) 1207 B.C.

Charcoal from shallow pit over stone foundation of Wall E in Area B8, from top of central mound. Stratigraphically earlier than Wall A and P-1475. *Comment*: NaOH pretreatment.

3099 ± 71
P-1449. DiS 66-52, B9a(7) 1149 B.C.

Charcoal from Test Trench 3 immediately above and resting on terminal Bronze age deposit (8), base of Dinkha III fill in Area B9 from N edge of central mound. Connecting trench to B8e shows (3) in that area to be closely related in time (cf. P-1474). *Comment*: NaOH pretreatment.

Dinkha IV

3285 ± 50
P-1231. DiS 66-54a, B9a(8) 1335 B.C.

Charcoal from terminal Bronze age deposit (8) directly underlying Iron age fill (7) (cf. P-1449), ca. 1 m from S balk at W edge of Test Trench 3 in Area B9, N edge of central mound. *Comment*: NaOH pretreatment.

3402 ± 50
P-1232. DiS 66-79, B10a(8) 1452 B.C.

Charcoal from main floor of final major Bronze age structure in Area B10a(8), N edge of central mound underlying terminal stratum B9a(8) (cf. P-1231). *Comment*: NaOH pretreatment.

3434 ± 61
P-1450. DiS 66-127, B10a(8)[1] 1484 B.C.

Charcoal from burned structural beams in fill near floor of final major structure of Bronze age in Area B10a(8), N edge of central mound (cf. P-1232). *Comment*: NaOH pretreatment.

3522 ± 63
P-1452. DiS 66-129, B10a(9) 1572 B.C.

Charcoal from stratum of trashy fill, Area B10a(9), N edge of mound on which final Bronze age structure in this area stands (cf. P-1232 and P-1450). Tombs B27 and B28 dug into this level.

3458 ± 59
P-1233. DiS 66-126a/2, G10g(2) 1508 B.C.

Charcoal from ashy fill (2) under clay floor (IA) and Walls G and F in Area G10g at E edge of central mound. Area not stratigraphically linked to preceding areas, but typologically (using ceramics) equal to B10a(9) (cf. P-1452). *Comment*: NaOH pretreatment.

3468 ± 59
P-1430. DiS 66-91, Hig(2) 1518 B.C.

Charcoal from floor assoc. with Wall D in Area Hlg at E end of central mound. Comparable stratigraphically to P-1233, below latest walls of probable Iron age in the area, and above earlier massive Wall H1h-E. *Comment*: NaOH pretreatment.

P-1552. H1G **3468 ± 59**
1518 B.C.

Charcoal from room fill of Big Wall, Area H1G of E edge of central mound. *Comment*: NaOH pretreatment.

P-1429/31. DiS 66-131/116, H1h(3) **3598 ± 66**
1648 B.C.

Charcoal from floor to N of Wall F and from pit cut into Wall G from (3) in Area H1h, E end of central mound. Walls F and G abutt top of earlier massive wall H1h-E, dating to earlier half of Bronze age occupation. Should thus provide an *ante quem* date for this part of the period.

General Comment: (R.H.D.) dates recovered fit stratigraphic relationships of the samples very well and, using the 5730 half-life, indicate a general range of time for the later Bronze age occupation of 1756 ± 68 to 1434 ± 52 B.C. with the following Iron Age I deposits between 1302 ± 57 and 1146 ± 37 B.C. Earlier part of Bronze age deposit must be prior to 1756 ± 68 B.C., but should be later than Hasanlu VII, radiocarbon dated to ca. 2100 B.C.

Ganj Dareh Tepe series, Iran

Ganj Dareh Tepe ("Mound of the Treasure Valley"), alt 1300 to 1400 m, ca. 20 km S of Bisitun village in Kermanshah Dist., W Iran (34° 20′ N Lat, 47° 30′ E Long), is an early Neolithic stratified mound containing solid architecture and small quantities of simple software pottery in most levels. Samples coll. and subm. 1967 by P. E. L. Smith, Univ. of Montréal, Canada (Smith, 1967, 1968; Young and Smith, 1966; Kigoshi, 1967).

P-1486. Square 17-0, depth 2.10 to 2.40 m **8888 ± 98**
6938 B.C.

Charcoal, Sample 67-27, from a room occupation floor in W part of Sq. 17-0, depth 2.10 to 2.40 m in what seems to be the 4th building phase (Level B). *Comment*: NaOH pretreatment. Sample was expected to be approx. same age as, or slightly earlier than GaK-994, 8910 ± 170 B.P. (Radiocarbon, 1967, v. 9, p. 61).

P-1485. Square 19-N, depth 4.50 m **9239 ± 196**
7289 B.C.

Charcoal, Sample 67-23, from SW corner of Sq. 19-N, depth 4.50 m, from floor deposits inside walls of what is probably a room of the 2nd architectural phase (provisionally called Level C). *Comment*: date is probably less reliable than other 2 in this series, as sample was undersized, precluding NaOH pretreatment, and necessitating low pressure counting. Excavator believed this sample to be younger than GaK-807, 10,400 ± 150 B.P. (from basal level in a 1965 sounding) but older than GaK-994, 8910 ± 170 B.P. (Radiocarbon, 1967, v. 9, p. 61).

P-1484. Square 16-N(a), depth 6.20 m **8968 ± 100**
7018 B.C.

Charcoal, Sample 67-26, from Sq. 16-N(a), depth 6.20 m, ca. 20 cm below a brick wall, at the base of the earliest certain architectural phase (Level D) but above basal deposits apparently lacking solid architecture (provisionally Level E). *Comment*: NaOH pretreatment. The level producing this sample is stratigraphically below the one producing P-1485.

Godin Tepe series, W Iran

Godin Tepe (34° 31′ N Lat, 48° 3′ E Long), in SE corner of the Kangovar Valley, at alt ca. 1400 m is mainly noteworthy for its long sequence, ca. 5500 to 600 B.C. and particularly for deposits of 2nd millennium B.C. Samples coll. by I. Winter and L. D. Levine; subm. by T. C. Young, Jr., Royal Ontario Mus., Univ. of Toronto (Young and Smith, 1966).

General Comment: all samples given NaOH pretreatment. For additional dates from levels stratigraphically below those of this list, see: GaK-1072, 4400 ± 100 B.P. and GaK-1071, 3860 ± 120 B.P. (Young, 1969).

3203 ± 50
P-1469. Operation A1, Stratum 5, floor **1253 B.C.**

Charcoal and burned soil from hearth area assoc. with Pit 4, from terminal occupation level of Period III and should date approx. end of late Bronze age in central W Iran.

2742 ± 41
P-1470. Operation A2, Stratum 5, Area 8 **792 B.C.**

Bits of charcoal and burned earth from floor debris of terminal occupation level of Period III and should date approx. end of late Bronze age in central W Iran.

P-1471. Operation A1, Stratum 5A, **2673 ± 52**
Area 5, Floor 2A **723 B.C.**

Charred grain and burned earth from badly destroyed occupation level immediately beneath foundations of Period II fortification. Date should supply *terminus post quem* for Period II, ca. 800 B.C. *Comment*: slightly undersized sample, counted at 98.74% normal pressure.

P-1472. Operation A1, Stratum 5A, **2550 ± 53**
Area 5, Floor 2A **600 B.C.**

Charcoal and burned earth from badly destroyed occupation level immediately below foundations of Period II fortification. Date should supply *terminus post quem* for Period II, ca. 800 B.C.

Turkey

Gedikli series

Gedikli (Karahöyük) (37° N Lat, 36° 37′ E Long), is a mound in Gaziantep Prov. of SE Turkey, revealing subsequent strata from Chalcolithic to Byzantine periods, whose early Bronze age cremation necropolis is of importance. Coll. 1966 by A. M. Dinçol and R. Özgürel and subm. by U. B. Alkim, Univ. of Istanbul (Alkim and Alkim, 1966; Mellink, 1965, 1966).

P-1461. C-trench, cremation area **3877 ± 57**
1927 B.C.

Charcoal from C-trench, cremation area, Samples 1, 2, and 3.

P-1464. Cremation vessel, C-trench **3676 ± 50**
1726 B.C.

Charred earth, fragments of bone and charcoal in cremation vessel, from ca. 2 m below surface of slope of mound, C-trench, cremation area, Sample 6.

P-1463. A_1-trench, IIIj **4267 ± 65**
2317 B.C.

Charred grain from A_1-trench, IIIj, Sample 5.

P-1462. A_1-trench, IIIk **4212 ± 74**
2262 B.C.

Charred grain from A_1-trench, IIIk.

Dereagzí series, Turkey

Dereagzí (36° N Lat, 29° E Long), is a middle Byzantine church near village of Dirginler (Kas Kazīsī, Antalya Vilâyeti), S Turkey. Both samples are from same beam of *Cedrus libani* (wood id. by B. F. Kukachka, Forest Products Lab., U.S. Dept. of Agric., Madison, Wisconsin) which should be contemporary with founding of church. Church can be dated between A.D. 843 and A.D. 907. Coll. and subm. 1967 by J. Morganstern, Inst. of Fine Arts of New York Univ., New York.

P-1437. Sample 1 **1156 ± 44**
A.D. 794

Wood from outer edge of beam.

P-1438. Sample 2 **1236 ± 43**
A.D. 714

Wood from outer edge of beam, but cut penetrated more deeply into interior of beam than did P-1437.

General Comment: since the 2 dates are from the same region of a single beam, and the dates are statistically consistent, an average age of A.D. 754 ± 36 can be used.

P-1395. Yassi Ada Shipwreck **333 ± 44**
A.D. 1617

Wood from hull of extremely well-preserved shipwreck of unknown date, overlying part of Late Roman shipwreck in 135 ft water at Yassi Ada, Turkey (36° 59′ N Lat, 27° 12′ E Long). Coll. and subm. 1967 by G. F. Bass, Univ. Mus., Univ. of Pennsylvania, Philadelphia.

Jordan

Tell es-Sa'idiyeh series, Jordan

Tell es-Sa'idiyeh (32° 16′ N Lat, 35° 35′ E Long), lies ca. 2 km E of Jordan R., immediately S of Wadi Kufrinje, Jordan. Coll. 1965 and 1966 during excavation of higher mound and subm. by J. B. Pritchard, Univ. Mus., Univ. of Pennsylvania, Philadelphia. Samples are from floors within a complex of buildings believed, on basis of tentative estimate for date of pottery, to have been destroyed during the centuries noted below (Pritchard, 1964a, b; 1965a, b, c; 1966a, b).

Acropolis series, Floor of Hellenistic building, 2nd century B.C.

P-1095. Area 31-C-7, Floor 1 — **2098 ± 55** / **148 B.C.**

Wood from roof beam.

P-1096. Area 31-B-8, South balk — **2199 ± 55** / **249 B.C.**

Wood from burnt beam.

P-1097. Area 31-B-8 — **2179 ± 53** / **229 B.C.**

Charcoal from beam.

P-1098. Area 31-B-6 — **2267 ± 53** / **317 B.C.**

Charcoal from beam.

P-1447. Area 31-B-6 — **2228 ± 48** / **278 B.C.**

Charcoal, over Floor 1.

General Comment: all samples received NaOH pretreatment. The 5 dates are statistically consistent, with an average date of 244 ± 53 B.C.

Floor of "Persian" Palace, 3rd or 4th century B.C.

P-1446. "Persian" palace, Area 31-E-6 — **2226 ± 50** / **276 B.C.**

Charcoal from "Persian" palace, Floor 1c. *Comment*: NaOH pretreatment.

Below "Persian" palace series

P-1442. Area 31, Room 8/7 (W) — **2415 ± 54** / **465 B.C.**

Grain, N sec., along E wall.

P-1443. Area 31, Room 5/4 — **2310 ± 100** / **360 B.C.**

Charcoal, clearing furnace, below jar in N sec. of furnace. *Comment*: this date is of single count only.

P-1445. Area 31-E-7, Floor 3 — **2141 ± 55** / **191 B.C.**

Grain, (House 4 N of S sec. of kiln).

P-1448. Area 31-E/F-7/8, Room 5/1W — **2485 ± 57** / **535 B.C.**

Grain, N sec. along E wall on or above floor.

General Comment: all samples in this series received NaOH pretreatment. Omitting, P-1445, remaining 3 dates are statistically consistent, with average date of 453 ± 73 B.C.

Trench series, Level 2, 8th century B.C.

P-1100. Area 23-E-3 **2424 ± 57**
474 B.C.

Charcoal from beam, near E wall of back room on Floor II. *Comment*: compare P-1100 with P-832, 2406 ± 52 and P-385, 2418 ± 54 (Radiocarbon, 1965, v. 7, p. 195). These 3 dates are statistically consistent, with average date of 466 ± 54 B.C.

P-1099. Area 23-G-2 **2577 ± 53**
627 B.C.

Charcoal. *Comment*: NaOH pretreatment.

P-1101. Area 23-G-4 **2609 ± 58**
659 B.C.

Charcoal from beam. *Comment*: NaOH pretreatment.

P-1444. Area 23-G-4, Floor 2 **2633 ± 60**
683 B.C.

Charcoal from Floor 2. *Comment*: NaOH pretreatment.

General Comment: compare P-1099, P-1101, and P-1444 with P-829, 2596 ± 56; P-830, 2572 ± 59; P-831, 2542 ± 46; P-833, 2537 ± 52; P-834, 2726 ± 157; and P-836, 2523 ± 53 (Radiocarbon, 1965, v. 7, p. 195). These 9 dates are statistically consistent, with average date of 640 ± 55 B.C.

Lebanon

Cedars of Lebanon series, Lebanon

Wood (*Cedrus libani*) from structures dating to early Egyptian dynasties suggested dendrochronologic correlation among several structures; also, since wood was imported originally from the Levant, possible correlation with samples found in that part of the Mediterranean. "Buried" cedar sample of sufficient antiquity (see P-WA-LEB-1), was obtained, but proved unusable for dendrochronologic purposes as ring pattern was complacent. Another sample from allegedly old specimen proved too recent to be of value for this type of correlation (see P-WA-LEB-2).

Cedars of Lebanon (P-WA-LEB-1)

Cross sec. of *Cedrus libani* buried in landslide near Chkiff, Lebanon, ca. (35° 51′ N Lat, 35° 45′ E Long). Uncovered during re-terracing in 1962. Sec. coll. 1964 and subm. by H. N. Michael, Univ. Mus., Univ. of Pennsylvania, Philadelphia.

P-890. Pith, Rings 1 to 16 **2901 ± 44**
951 B.C.

$\delta C^{13} = +0.5‰$ from Oak standard.

P-891. Rings 16 to 23 **3133 ± 36**
1183 B.C.

$\delta C^{13} = 0‰$ from Oak standard.

2837 ± 40
P-892. Rings 184 to 188 **887 B.C.**

$\delta C^{13} = -1.8‰$ from Oak standard. *Comment*: compare with I-512, 2560 ± 150 B.P. (Troutman, 1965, written commun.).

0 ± 100
P-1089. Cedars of Lebanon (P-WA-LEB-2) **A.D. 1950**

Cross sec. from trunk (*Cedrus libani*) found in cave several mi N of "les Cedres", Lebanon, (ca. 34° 20′ N Lat, 36° 10′ E Long). Coll. 1965 by G. Wahbé, Beirut; subm. by H. N. Michael. Sample was taken from sec. 20 rings inside of bark.

4290 ± 56
P-1025. Cedars of Lebanon (P-EG-DAS-1) **2340 B.C.**

Wood ("floater", *Cedrus libani*) from floor of upper chamber of Bent Pyramid at Dashur (29° 45′ N Lat, 31° 12′ E Long), at one time integral part of a beam bracing lower part of upper chamber (Fakhry, 1959, p. 52-59, pls. XII, XIII; Fakhry, 1961, p. 88-94). Presumably assoc. with construction of pyramid during reign of Sneferu (2680 to 2656 B.C.). Coll. 1965 and subm. by H. N. Michael.

B. Mediterranean

Greece

Mycenae series, Argolis, Greece

Samples are from Citadel House at Mycenae (37° 44′ N Lat, 22° 44′ E Long) Argolis, Greece. Coll. 1964 and 1966 during excavation by British School at Athens; subm. by Lord Wm. Taylour, British School at Athens.

2873 ± 57
P-1454. Gamma 21, No. 7 **923 B.C.**

Carbonized matter from pure Mycenean level, upper Hellenistic levels removed.

2974 ± 49
P-1455. Gamma 23, No. 5 **1024 B.C.**

Charcoal from pure destruction level of 13th century B.C. *Comment*: NaOH pretreatment.

3035 ± 65
P-1456. Gamma 23, No. 6 **1085 B.C.**

Charcoal from pure destruction level of 13th century B.C. *Comment*: NaOH pretreatment.

2948 ± 49
P-1457. Gamma 23, No. 9 **998 B.C.**

Fragments of burnt beam from what appears to be 13th century B.C. destruction level. *Comment*: NaOH pretreatment.

2961 ± 50
P-1459. Gamma 22, No. 1 **1011 B.C.**

Charcoal from Mycenean level.

Italy

2243 ± 48
P-1432. Le Muraglie **293 B.C.**

Wood charcoal (id. by B. F. Kukachka, Forest Products Lab., U.S. Dept. of Agric., Madison, Wisconsin, as of white oak group), from Excavation 5 assoc. with crude walls (possibly Greek) underlying Roman structure at Le Muraglie, a low plateau on SE perimeter of plain of Sybaris, Cosenza, Italy (39° 43′ N Lat, 16° 33′ E Long). Coll. 1964 and subm. by E. K. Ralph, Univ. Mus., Univ. of Pennsylvania, Philadelphia (Rainey and Lerici, 1967, p. 198-199).

1328 ± 48
P-1435. Pantano Longarini Wreck **A.D. 622**

The Pantano Longarini wreck (36° 19′ N Lat, 15° 8′ E Long) near Cape Passaro-Pachino, SE cape of Sicily, was found during winter 1963-1964, in salty marsh 600 m from present shore line, while digging drainage canal as part of reclaiming operation. Sample coll. 1965 and subm. by P. Throckmorton, Univ. Mus., Univ. of Pennsylvania, Philadelphia. Wood id. as *cyparissus semiviperens* by B. F. Kukachka. Previous sample from this wreck, dated in Germany, dated at A.D. 500 ± 150 and "combed pottery" finds indicate date of 4th to 6th century A.D. (Throckmorton and Kapitan, 1968).

2027 ± 43
P-1436. Torre Sgarrata Wreck **77 B.C.**

Torre Sgarrata (Sassole) wreck, near Taranto, Italy (40° 14′ N Lat, 17° 13′ E Long) was originally located by fishermen before World War I because some marble sarcophagi of the cargo was visible through 10 m water when storms swept away sand covering site. Sample coll. and subm. 1965, by P. Throckmorton during survey explorations of different wrecks along coast between Porto Caesareo and Taranto. Wood id. as *Pinus Halepensis* by B. F. Kukachka. Small finds indicate date ca. 200 A.D. for time of actual sinking (Throckmorton, 1969).

2161 ± 39
P-1056. Site X, Galli Islands, Salerno **211 B.C.**

Wooden core from lead anchor stock, recovered from 35 m water at Site X, Galli Is., Salerno, Italy (40° 34′ 46″ N Lat, 14° 26′ 1″ E Long). Coll. 1964 by R. E. L. Love, Jr. and Col. J. D. Lewis; subm. 1965 by J. D. Lewis, Naval War College, Newport, Rhode Island. Wood id. as one of several live oak (*Quercus*) types growing in Mediterranean region by B. F. Kukachka. *Comment* (J.D.L.): lead-stocked anchors were in use from 300 B.C. to ca. 400 A.D. (Love and Lewis, 1964; Torr, 1964; Frost, 1963; Casson, 1960; Ucelli, 1950).

C. Southwest Asia

Afghanistan

Ghar-i-Mar series, Afghanistan

Ghar-i-Mar (Snake Cave) is a rock shelter, on a high terrace of the

Balkh R. in limestone hills of Hindu Kush Mts, ca. 100 km S of Mazar-i-Sharif near the town of Aq Kupruk (36° 5′ N Lat, 66° 51′ E Long). Samples coll. 1962 by L. Dupree and subm. by R. Dyson, Univ. Mus., Univ. of Pennsylvania, Philadelphia. For additional dates from this site see Hv-425, 8650 ± 100; Hv-426, 1390 ± 60; Hv-427, 1340 ± 70; Hv-428, 7220 ± 100; and Hv-429, 7030 ± 110 (Radiocarbon, 1964, v. 6, p. 263-264; Coon, 1957; Dupree, 1959, 1964).

General Comment: all samples given NaOH pretreatment.

1276 ± 40
P-1489. Trench I, Cut 1a **A.D. 674**

Charcoal: Upper Red Earth.

1614 ± 41
P-1490. Trench I, Cut 5n **A.D. 336**

Charcoal: 220-Red Loess above Upper Gravels.

1436 ± 47
P-1491. Trench I, Cut 6p **A.D. 514**

Charcoal: 130-Red Loess above Upper Gravels.

1602 ± 48
P-1492. Trench I, Cut 6q **A.D. 348**

Charcoal: 130-Red Loess above Upper Gravels.

4414 ± 53
P-1493. Deh Morasi Ghundai **2464 B.C.**

Charcoal and fire-burned earth from 300 to 320 cm level of Deh Morasi Ghundai (31° 35′ N Lat, 65° 30′ E Long) a Chalcolithic site in S-central Afghanistan. Coll. 1951 and subm. 1960 by L. Dupree (1963). Date was expected to be comparable to that from Mundigak, C-815, 4625 ± 300 (Libby, 1955).

D. Africa

Senegal

Kagnout series, Senegal

Lo-Oul-6 (Loudia-Oulof), Mound A, located inland near village of Kagnout (42° 33′ N Lat, 16° 37′ W Long), is one of archaeol. sites consisting of artificial shell-middens in broad delta region of the lower Casmanance R. in the SW corner of Senegal. Coll. 1966; subm. by O. Linares de Sapir, Dept. of Anthropol., Univ. of Pennsylvania, Philadelphia. Dates for 2 other sites, Lo-Oul-1: Si-489, 369 ± 68; Si-490, 893 ± 49; Si-491, 311 ± 97; Si-492, 476 ± 49; Si-493, 573 ± 136; Si-494, modern; Si-495, 379 ± 68; Si-496, 2087 ± 68 and Di-3: Si-497, 320 ± 49; Si-499, 1631 ± 78 (Linares de Sapir, 1969, written commun., 1969a, b).

1226 ± 50
P-1478. 40 to 70 cm **A.D. 724**

Charcoal, combined Samples 285-287.

1197 ± 45
P-1479. 70 to 100 cm **A.D. 753**

Charcoal, combined Samples 288-290.

P-1480. 100 to 110 cm **1175 ± 50**
A.D. 775

Charcoal, Sample 291.

P-1481. 110 to 130 cm **1292 ± 52**
A.D. 658

Charcoal, Samples 292 and 293.

P-1482. 130 to 150 cm **1263 ± 51**
A.D. 687

Charcoal, Samples 294 and 295.

P-1483. 150 to 170 cm **1606 ± 50**
A.D. 344

Charcoal, Samples 296 and 297.

General Comment: excluding P-1483, A.D. 344, remaining dates are statistically consistent, with average date of A.D. 719 ± 50, chronologically placing this shell-midden within Casmanance Period II, ca. 344 ± 50 to A.D. 719 ± 50.

E. Far East

Thailand

Chansen series, Thailand

Main occupation of Chansen (15° 7′ N Lat, 100° 27′ E Long), Takli Dist., Nakhon Province, Thailand, belongs to Dvaravati period (ca. 6th to 10th century A.D.), earliest historic period of Thailand. Samples in this series are all pre-Dvaravati, coll. 1968 and subm. by G. F. Dales, Thailand Fine Arts Dept. and Univ. Mus., Univ. of Pennsylvania, Philadelphia.

P-1507. Operation B, Level 8 **1580 ± 50**
A.D. 370

Charcoal, Sample 1, from Operation B, Level 8 (3 m sq. test pit), 145 to 164 cm beneath surface, in 5th natural stratum from surface, partly sealed by layer of hardpan. *Comment* (G.F.D.): this sample cannot be ordered in stratigraphic relation to the other samples, as area was badly disturbed by modern pot-hunting.

P-1540. Operation C, Level 6 **1573 ± 35**
A.D. 377

Charcoal, Sample 8. *Comment*: NaOH pretreatment.

P-1541. Operation C, Level 7 **1595 ± 52**
A.D. 355

Charcoal, Sample 9, 190 cm beneath ground surface. *Comment*: NaOH pretreatment.

P-1509. Operation C, Level 7, hearth **1503 ± 43**
A.D. 447

Charcoal, Sample 3, W side of excavations, 204 to 210 cm beneath ground surface. *Comment*: NaOH pretreatment.

P-1538. Operation C, Level 7 **1540 ± 47**
A.D. 410

Charcoal mixed with powdery ash, Sample 4, from same hearth as P-1509, 210 to 215 cm beneath ground surface. *Comment*: NaOH pretreatment.

P-1539. Operation C, Level 7 **1491 ± 47**
A.D. 459

Charcoal, Sample 5, from bottom of same hearth as P-1509 and P-1538, 215 to 220 cm beneath ground surface. *Comment*: NaOH pretreatment.

P-1543. Operation C, Level 7 **2145 ± 36**
195 B.C.

Charcoal, Sample 10, in small pit containing burnt sherds and a large animal bone. *Comment*: NaOH pretreatment.

P-1508. Operation C, Level 9 **1830 ± 47**
A.D. 120

Charcoal, Sample 2, from control pit in SE corner, 220 to 230 cm beneath ground surface. Stratigraphically sealed beneath layer of marl and concretion, 200 cm beneath ground surface. *Comment*: NaOH pretreatment.

P-1512. Operation D, a, Level 9 **1890 ± 41**
A.D. 60

Charcoal, Sample 6, from "midden" deposit containing a smashed skull and snail shell 225 cm beneath ground surface. *Comment*: NaOH pretreatment. (G.F.D.): assoc. with ivory comb which is earliest known ivory object from Thailand.

II. GEOLOGIC SAMPLE

A. Scandinavia

Finland

P-1542. Linnansuo Bog **5183 ± 56**
3233 B.C.

Wood from core of Linnansuo Bog, market town of Imatra, Finland (61° 11′ N Lat, 28° 48′ E Long), from top of peat layer, beneath clay formed on bog at time of formation of present outlet (Vuoksi R.) of Lake Saimaa. According to pollen analysis this occurred earlier than Zone Boundary VIII/IX (Hellaakoski, 1936; Lappalainen, 1962). Coll. 1967 by M. Saarnisto; subm. by J. J. Donner, Univ. of Helsinki, Finland.

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UNIVERSITY OF CAMBRIDGE NATURAL RADIOCARBON MEASUREMENTS IX

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The University of Cambridge Radiocarbon Dating Laboratory has been completely rebuilt and modernized, incorporating new techniques developed here for the various stages of measurements. Sample radioactivity is measured in gas proportional counters after conversion to highly purified CO_2. Four counters are mounted within a single anticoincidence shield consisting of plastic scintillation material. This is surrounded by a graded cosmic ray shield of low radioactive steel, boron loaded wax, and finally, about 16 tons of ancient low radioactive lead blocks. The electronics are all solid state devices except for the stabilized high voltage supplies.

A large plastic anticoincidence shield, in which it is possible to place several proportional counters of differing sizes, has been developed and functions well. It is 105 cm long and 40 cm in diameter with minimum wall thickness of 7.5 cm at any point; it completely encloses the sample counters with scintillation material so that even axial radiation is detected. Cosmic-ray produced charged particles are detected with 100% efficiency and the shield has high efficiencies for γ-rays and neutrons. It gives better shielding than the normal Geiger or multiple anode anticoincidence shields since their detection efficiencies for uncharged particles are relatively low. Scintillations are detected by two 25 cm diameter photomultiplier tubes operating in coincidence, to reduce noise, and the resultant pulses are used in anticoincidence with the pulses from the sample counters.

Pure copper is used for the proportional counter bodies; two have tin oxide coated quartz inner liners to which the E.H.T. is applied. They are normally operated at 2 atm pressure of CO_2. Plateaux at least 1200 volts long with slopes of 0.4% per 100 volts are routinely typical of the 2 counters that are at present used for dating purposes.

All samples are subjected to pretreatment, unless otherwise stated, to attempt to remove contamination due to carbon non-contemporary with the sample. Pretreatment consists of boiling the shredded sample with 1% hydrochloric acid solution for at least 1 hr and a similar treatment with 1% solium hydroxide solution. Following each of these reagents, the sample is boiled with distilled water, finally filtered and dried, either at 110°C or in the vacuum oven.

Oxidation of the samples is carried out very rapidly and efficiently with high pressure oxygen in a specially developed combustion bomb. This consists of a 5L stainless steel cylinder with a gas-tight lid carrying inlet and outlet tubes for the gases and held in position with a spin ring. Our experiments have shown that small volume, higher pressure bombs are not as effective, as the combustion flame is quenched and material remains unburned. Samples of 20 g are easily combusted with 8 atm pressure of oxygen when an electric current is passed through a thin wire covered by the sample held in a quartz or nickel crucible. The reaction is over within a few seconds as shown by the pressure gauge returning to its original reading. The great heat dissipated is removed rapidly by an external jacket with a flow of cooling water.

Boiled water placed in the combustion bomb removes most of the sulphur and nitrogen oxides from the reaction products and the CO_2 may easily be purified to the stringent requirements for proportional counting. The purification line contains all dry reagents operating under reduced pressure; it is semi-automatic and requires little attention during the hour or so taken from the initial firing of the combustion bomb to the production of a fairly pure sample of solid CO_2. A final purification line consisting of several *in vacuo* distillations through furnaces containing finely divided copper catalyst on a silica/alumina support and silver metal yield the pure counting gas.

The pulses from the anticoincidence shield and each counter are amplified and passed through pulse-height analyzers prior to being counted on fast scalers. Separate scalers also record the selected anticoincidence, *i.e.*, radiocarbon, pulses for each channel. Accumulated counts and the time required in minutes are printed out at pre-set intervals on a teletypewriter which can also produce punched paper tape for computer use. Experiments are normally conducted overnight for 1000 min and throughout the weekend. Usually sufficient runs are made on each sample to accumulate at least 10,000 disintegrations above background so that the statistical uncertaintly is reduced to $<1\%$. The laboratory modern standard is the activity of the 1850 growth ring of oak tree grown in the Cambridgeshire Fens and this is compared with 95.0% of the activity of the N.B.S. oxalic acid. The background is that given by a sample of Welsh Anthracite. The ages of samples are calculated using the conventional half life of 5568 ± 30 years and the uncertainty is stated in terms of one standard deviation of the counting statistics.

A full description of the laboratory and processes used is in preparation for publication elsewhere.

The dating program of the new laboratory is maintaining the policy of directing assays largely toward projects under investigation in the University Sub-Department of Quaternary Research. In 1969 these projects included dating of pollen zone boundaries, of Scottish tree stump horizons, and of archaeologic sequences in the Somerset levels.

ACKNOWLEDGMENTS

It is with pleasure that we acknowledge the encouragement and advice of H. Godwin during the rebuilding of the laboratory, as well as the practical help of colleagues N. J. Shackleton and G. A. Sutton, whose post of Technical Asst. was recently filled by M. A. Hall. Mr. Hall has carried a large proportion of the work in the final setting up and testing of the equipment. Our thanks are given to A. P. Ward and C. Devine who now share the task of maintaining the standards of the laboratory.

Financial support for the development projects in the laboratory has been provided by the Science Research Council and the Natural Environmental Research Council to whom we express our thanks.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

British Isles

Pollen Zone Boundary Determinations (Red Moss) series

The vertical sequence through a raised bog, Red Moss near Horwich, Lancashire (53° 35′ N Lat, 2° 35′ W Long, Nat. Grid. Ref. SJ 631103) has been subjected to careful pollen analysis. A monolith of peat was transferred to the laboratory and each major zone boundary was identified and marked. Two or three peat samples were taken as thin slices at each boundary and at intermediate points corresponding to significant changes in the pollen diagram. These were carefully pretreated to remove contaminants and combusted in pure oxygen. They extend from Zone III of the Late-Weichselian period to Zone VIIb of the Flandrian. The results are discussed in detail by Hibbert and Switsur (ms. in preparation). Collection and pollen analysis are by F. A. Hibbert and radiocarbon measurements by V. R. Switsur. The pollen zones are those currently in use in England and Wales.

The results from the site, apart from the lowest sample, are internally consistent and comparable with those obtained at Scaleby Moss (Godwin, Walker, and Willis, 1957).

The separate samples are identified by depth in the pollen diagram.

4370 ± 80
Q-910. Red Moss, 114 to 116 cm **2420 B.C.**

2 cm slice of *Sphagnum-Eriophorum-Calluna* peat. Pollen curves at this level show recovery in *Ulmus* and *Tilia* with a fall in weeds and grass pollen, possibly indicating the end of a Landnam occupation phase.

4715 ± 80
Q-911. Red Moss, 124 to 126 cm **2765 B.C.**

2 cm slice of *Sphagnum-Eriophorum-Calluna* peat. Pollen diagrams show *Ulmus* at very low frequency but the weed pollen is high, possibly indicating a Landnam occupation.

5010 ± 80
Q-912. Red Moss, 132 to 134 cm **3060 B.C.**

2 cm slice of moderately humified *Sphagnum-Eriophorum-Calluna* peat. The pollen diagram here indicates boundary of Zone VIIa/VIIb; *Ulmus* pollen falls to very low frequencies here.

5060 ± 80
Q-913. Red Moss, 139 to 140 cm **3115 B.C.**

2 cm slice of *Sphagnum-Eriophorum-Calluna* peat. Pollen diagram indicates close of Zone VIIa by beginning of decline of *Ulmus* pollen frequencies.

5399 ± 100
Q-914. Red Moss, 158 to 160 cm **3449 B.C.**

2 cm slice of *Sphagnum-Eriophorum-Calluna* peat. Pollen curves for *Fraxinus* and *Tilia* exhibit maxima here.

6880 ± 100
Q-915. Red Moss, 225 to 227 cm **4930 B.C.**

2 cm slice of *Sphagnum-Eriophorum-Calluna* peat. Pollen curves for *Fraxinus* and *Tilia* begin here and rapid expansion of *Alnus* ends.

7107 ± 120
Q-916. Red Moss, 230 to 232 cm **5157 B.C.**

2 cm slice of *Sphagnum-Eriophorum-Calluna* peat. There is a very rapid rise of *Alnus* pollen frequencies in the diagram here indicating boundary of Zones VI/VIIa, generally recognized as Boreal/Atlantic transition.

7460 ± 150
Q-917. Red Moss, 237 to 239 cm **5510 B.C.**

2 cm slice of *Sphagnum-Eriophorum-Calluna* peat. The pollen diagram shows the beginning of the rise in *Alnus* pollen marking the end of Zone VI.

8196 ± 150
Q-918. Red Moss, 259 to 261 cm **6246 B.C.**

2 cm slice of fen peat. Pollen frequencies of *Pinus* exceed those of *Betula*. This increase is before the *Alnus* rise.

8742 ± 170
Q-919. Red Moss, 269 to 271 cm **6793 B.C.**

2 cm slice of wood peat. At a level of falling pollen frequencies of *Corylus* and rising frequencies of *Ulmus* and *Quercus*.

8790 ± 170
Q-920. Red Moss, 290 to 293 cm **6840 B.C.**

2 cm slice of wood peat. At level where rapid rise of *Corylus* pollen frequencies in a very short depth denotes Zone V/VI boundary.

8880 ± 170
Q-921. Red Moss, 296 to 298 cm **6930 B.C.**

2 cm slice of wood peat. Pollen diagram indicates the beginning of the rise of *Corylus* at this level, denoting the end of Zone V.

9456 ± 200
Q-922. Red Moss, 305 to 307 cm **7506 B.C.**

2 cm slice of fen peat. *Betula* pollen frequencies increase at Zone IV/V boundary.

Q-923. Red Moss, 310 to 312 cm **9586 ± 200**
7636 B.C.

2 cm slice of fen peat. At this point the curve of *Juniperus* is falling, indicating end of Zone IV.

Q-924. Red Moss, 320 to 322 cm **9798 ± 200**
7848 B.C.

2 cm slice of fen peat. Pollen diagram shows maximum frequencies of *Juniperus* pollen in Zone IV.

Q-925. Red Moss, 325 to 330 cm **9508 ± 200**
7558 B.C.

5 cm slice of organic lake mud, immediately above clay deposits of Zone III and marks the beginning of organic deposition at Zone III/IV boundary. Age of this sample does not fit the excellent consistency of the remainder of the series. An identical sample from a duplicate core yielded the same results for age. The sample is at the contact of clay and mud. Perhaps the lateral movement of ground water along such a contact has introduced younger carbon into the mud. Further investigations are required for this point.

Scottish Tree Stump series

Part of an investigation of the stratigraphy of horizons of tree stumps commonly found in Scottish peats (Birks, 1969). Samples were gathered from 2 main areas, the Eastern Highlands and the Galloway Hills in SW Scotland. Three sites were studied by Lewis (1905-7, 1911) who described forest and arctic plant beds in the Merrick-Kells dist. and the Eastern Highlands. Samuelson (1910) correlated Scandinavian tree layers with those in Scotland and applied the climatic sequence of Blytt and Sernander to the British Isles. Samples for pollen analysis and radiocarbon assay were coll. 1965 and 1966 by H. H. Birks and radiocarbon assays were made by V. R. Switsur.

Eastern Highland area

Q-886. Allt na Feithe Sheilich **4425 ± 100**
2475 B.C.

Birch and heather twigs form indistinct horizon at 150 cm, probably indicating a dry period on peat surface. Pine wood from an horizon 180 cm below surface was previously dated (K-1419, 6960 ± 130 B.P.). This is one of original Lewis sites of blanket peat on the Spey-Findhorn watershed at 1950 ft alt (57° 19′ N Lat, 3° 54′ W Long, Nat. Grid Ref. 28/8526).

Q-881. Loch Einich, 120 cm **5880 ± 100**
3930 B.C.

Fossil mor humus 'soil' at 120 cm forming a stratigraphic horizon between the pine stumps at this site. Alt 1650 ft (57° 05′ N Lat, 3° 48′ W Long, Nat. Grid Ref. 28/919001). Pine stump from this layer was previously dated (K-1418, 5970 ± 120 B.P.).

Q-883. Loch Einich, 80 cm **4150 ± 100**
2200 B.C.

Birch twigs from 80 cm layer.

Q-887. Coire Bog, 255 cm **6980 ± 100**
5030 B.C.

Bark from pine stump at 255 cm assoc. with ill-defined charcoal layer above *Sphagnum* peat at 215 cm. Alt 1400 ft (57° 51′ N Lat, 4° 25′ W Long, Nat. Grid. Ref. 28/582857).

Q-888. Coire Bog, 190 cm **6731 ± 100**
4781 B.C.

Birch wood from 190 cm depth contained in humified peat.

Q-889. Coire Bog, 160 cm **5005 ± 100**
3055 B.C.

Birch wood from 160 cm depth, a separate layer from that at 190 cm.

Galloway area

Q-871. Cooran Lane, 110 cm **7471 ± 120**
5521 B.C.

Pine stump from decayed, highly humified, blanket-bog peat at depth 110 cm. Alt 850 ft (55° 7′ N Lat, 4° 23′ W Long, Nat. Grid. Ref. 25/480843).

Q-873. Cooran Lane, 120 cm **6805 ± 200**
4855 B.C.

Blanket-bog peat from 120 cm corresponding to peak of *Pinus* pollen in pollen diagram.

Q-874. Cooran Lane, 140 cm **7541 ± 120**
5591 B.C.

Blanket-bog peat from 140 cm. Fluctuations in pollen curves and presence of charcoal fragments in peat suggest occurrence of a fire at this level.

Q-876. Loch Dungeon Peat, 125 cm **7165 ± 180**
5215 B.C.

Pine stump from 125 cm just beneath highly humified amorphous black layer which may be a fossil soil. Alt 1250 ft (55° 7′ N Lat, 4° 19′ W Long, Nat. Grid. Ref. 25/5284).

Q-877. Loch Dungeon Peat **6787 ± 200**
4837 B.C.

Pure organic fossil mor humus soil assoc. with Q-876 pine wood.

Q-878. Clatteringshaws Loch, 87 cm **5080 ± 100**
3130 B.C.

Pine stump at 87 cm depth in layer of wood peat. Alt 800 ft (55° 4′ N Lat, 4° 17′ W Long, Nat. Grid. Ref. 25/5477).

General Comment (H.H.B.): the dates show that the pine stumps are of different ages in the Eastern Highlands and the Galloway Hills and are of different ages within each of these areas. The relationship of the stumps to the pollen stratigraphy from each site is consistent with these results. From the available dates, and studies of local vegetational events by pollen analysis and peat stratigraphy, no climatic conclusions may be drawn from the occurrence of these pine stumps to support the Blytt-Sernander scheme of climatic periods.

II. ARCHAEOLOGIC SAMPLES

Somerset Levels series, SW England

Excavations of the prehistoric trackways of the Somerset Levels (Godwin, 1960) has been continued by J. M. Coles and his students from the Dept. of Archaeol. and Anthropol., University of Cambridge (Coles and Hibbert, 1968). The Sub-Dept. of Quaternary Research is also assoc. with the work through the participation of F. A. Hibbert who checked the peat stratigraphy and carried out pollen analyses, and through V. R. Switsur who made the radiocarbon analyses. The number of trackways discovered continues to grow and forms a veritable arterial road system between Westhay and Catcott Burtle, the oldest such system in Europe. Samples were coll. between August 1967 and September 1968 by Coles and Hibbert to obtain precise correlation between tracks in this area.

3964 ± 60
Q-908. Abbot's Track Peat **2014 B.C.**

Sphagnum-Eriophorum-Calluna peat underlying the Abbot's track, overlying layers of wood and fen peat (51° 7′ Lat, 2° 50′ W Long, Nat. Grid Ref. ST 417427). This agrees very well with wood from the track itself (Q-926).

4018 ± 80
Q-926. Abbot's Track Peg **2068 B.C.**

Wooden peg used to stabilize the track which lies in ombrogenous peat ca. 40 m W of Honeygore track (Q-909), and in a stratigraphically younger position in the peat (51° 11′ N Lat, 2° 50′ W Long, Nat. Grid Ref. ST 417427). Date agrees well with peat underlying the track (Q-908), and with other determinations of age of track (LU-298, 3940 ± 65; Gak-1950, 4040 ± 90). It does not agree, however, with our previous determination, Q-674, and we now disregard this date for technical reasons assoc. with its dating.

4570 ± 80
Q-927. Bell Track 'A' **2620 B.C.**

Birch stump rooted beneath Trackway 'A', severed during construction of the track, which should date the surface upon which it was lain (51° 11′ N Lat, 2° 50′ W Long, Nat. Grid Ref. ST 428422). Date falls between those of the Abbot's and Honeygore, and agrees with its stratigraphic position.

Q-909. Honeygore Trackway Peg **4773 ± 80**
2823 B.C.

Wooden peg from track in *Sphagnum-Eriophorum-Calluna* peat (51° 10′ N Lat, 2° 50′ W Long, Nat. Grid Ref. ST 417428), parallel to the Abbot's track but lower stratigraphically. Lund radiocarbon date for this track is 4760 ± 65 (LU-297) and our previous determination Q-431 was 4750 ± 130; they agree well but disagree with the Gakushuin date 5640 ± 120 (Gak-1939) by ca. 1600 yr.

Q-948. Morton, Fife **6735 ± 180**
4785 B.C.

Small sample of charcoal from Morton near Tayport, Fife, Scotland (56° 25′ N Lat, 2° 52′ W Long, Nat. Grid Ref. NO 467257), assoc. with hearths of Mesolithic occupation levels, in sands at depth 16 to 19 in. below grass, 8 to 11 in. below plough-disturbed soil. Sands rest on volcanic bluff overlooking Tentsmuir Sands at ca. 39′ O.D. Archaeologic program concerns investigations of earliest traces of man in Scotland. This is earliest date for Mesolithic in Scotland. Morton contains the largest known stone industry and will probably serve as a type site. Coll. 1969 by J. M. Coles, Dept. of Archaeol. and Anthropol., Univ. of Cambridge.

Q-950. Myrtos 1, Crete **3805 ± 85**
1855 B.C.

Wood charcoal (35° 00′ N Lat, 25° 36′ E Long) from 0.5 m below surface in black burnt earth in a small room with stone walls on 3 sides and filled with large pottery store jars. Myrtos settlement belongs to Early Minoan II and is on the SW coast of Crete. Date is related to destruction of the settlement. Coll. 1968 by P. Warren, Dept. of Archaeol., Univ. of Durham.

Q-953. Myrtos 2, Crete **4142 ± 80**
2192 B.C.

Wood charcoal from a further room of settlement at Myrtos lying on the natural bedrock in clayey, heavily burnt, black earth 1 m below surface. Expected archaeol. date. Coll. by P. Warren.

III. CHECK SAMPLES

Q-970. Scaleby Moss, 176.5 to 178.5 cm B **7401 ± 120**
5451 B.C.

A re-determination of Q-165 (7432 ± 350) of peat from Zone VI/VIIa boundary.

Q-971. Scaleby Moss, 178.5 to 180.5 cm B **7451 ± 120**
5501 B.C.

A re-determination of Q-167 (7361 ± 146) of a 2 cm slice of peat just below previous sample.

Q-972. Scaleby Moss, 69.5 to 71.5 cm C **10,200 ± 200**
8250 B.C.

A re-determination of Q-152 (10,160 ± 193) of a 2 cm slice of coarse detritus mud just above Zone III/IV boundary. Above samples were measured before unknown samples were undertaken to compare performance of the new apparatus with known data.

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UNIVERSITY OF ROME CARBON-14 DATES VIII

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This list includes age measurements carried out from December 1968 to October 1969. Archaeologic samples are from Italian and Swat (W Pakistan) territories. All geologic samples come from Italian territory. Chemical techniques remain the same (Bella and Cortesi, 1960; Alessio, Bella, and Cortesi, 1964).

At present four counters are used for dating: of which three of 1.5 L, 1 L and 0.5 L, respectively, have been described (Bella and Cortesi, 1960; Alessio, Allegri, and Bella, 1960; Alessio *et al.*, 1968). A new 1 L counter, similar to the previous one, was recently constructed of suitable materials. All samples are measured by two different counters.

The activity of our "modern standard," wood grown near Rome between 1949 and 1953, was checked with 95% of the counting rate of NBS oxalic acid, and measurements were found coincident within 1σ. For each sample of CO_2, the counting rate was corrected according to mass-spectrometrically measured C^{13}/C^{12} ratio, as described previously (Alessio *et al.*, 1969). Age was calculated using the Libby half-life of 5568 ± 30 yr, with 1950 as the standard year of reference.

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC AND HISTORIC SAMPLES

A. Italy

Riparo Tagliente series

In 1961 F. Tagliente discovered archaeol. deposit in rock shelter at foot of W slope of Mt. Trignago, Lessini Mts., left side of Progno di Valpantena R., Stallavena di Grezzana, ca. 11 km N Verona, Veneto (45° 32′ 25″ N Lat, 11° 00′ 20″ E Long) at +250 m. First diggings in deposit were carried out 1962-64 (Zorzi, 1962; Zorzi and Mezzena, 1963; Pasa and Mezzena, 1964; Mezzena, 1964). Since 1967 excavations have been led by P. Leonardi, Dir., G. Bartolomei, and A. Broglio, Ist. di Geol., Univ. of Ferrara, and A. Mezzena, Mus. Civico di Storia Naturale of Verona (Leonardi and Ruffo, 1967-1969). Two trenches were dug; 5 layers were distinguished, and archaeol. horizons id. containing Upper-and-Middle Paleolithic flint industry, some hearths and bones of wild animals. From top downward: V) disarranged layer, 0 to 100 cm. IV) uneven layer with cavities containing remains of historic flint industry. III) prehistoric layer, Cuts 1 to 20, ca. 1.80 m thick, of rubble lenses, series of superimposed hearths with charcoal and mostly flint implements, bone bits, food refuse, and remains of micromammals. Flint industry belongs to a unit of Evolute Epigravettian including older lower level, Cut 15, with still very rare "à cran" blades and upper levels, Cut 5, characterized by short nail-shaped scrapers, backed-and-truncated blades and points, backed blades, and "piquant-trièdre" (Broglio, 1969). Fauna is from top downward as follows: Cuts 4 to 10, abundant *Cervus elaphus*, frequent *Capreolus*, sparse *Rupicapra, Marmota,* and *Sus;* Cuts 11 to 14, abundant *Alces alces*, frequent *Capra ibex* and *Marmota*, sparse *Bos, Cervus,* and *Ursus* sp.; micromammal fauna is being studied. II) coarse fluvial gravels, 10 to 50 cm thick, sterile. I) aeolian layer of unknown thickness, containing flint implements of not yet studied Middle Paleolithic industry; rocky bottom of shelter not reached (Leonardi and Ruffo, 1967-1969; Broglio, 1969). Charcoal from hearths of Layer III coll. 1967-1969 by G. Bartolomei, A. Broglio, and F. Mezzena; subm. 1968 and 1969 by P. Leonardi.

R-371. Riparo Tagliente Tr. 1, III, 8-10 **12,040 ± 170**
10,090 B.C.
$\delta C^{13} = -24.3‰$

Charcoal from Cuts 8-10, Layer III, Trench I; middle level of Evolute Epigravettian series.

R-604. Riparo Tagliente Tr. 1, III, 14 **12,000 ± 400**
10,050 B.C.
$\delta C^{13} = -23.4‰$

Charcoal from Cut 14, Layer III, Trench 1, considered same level as Cut 13 with hearth.

R-605. Riparo Tagliente Tr. 1, III, 15-16 **13,330 ± 160**
11,380 B.C.
$\delta C^{13} = -24.1‰$

R-605α. Riparo Tagliente Tr. 1, III, 15-16 **13,430 ± 180**
11,480 B.C.
$\delta C^{13} = -23.7‰$

Charcoal from hearth in Cuts 15 and 16, Layer III, Trench 1; lower level of Evolute Epigravettian series. *Comment*: R-605 only pretreatment with 10% HCl was given; R-605α additional leaching with 6% NH_4OH was given: sample appears uncontaminated.

General Comment: C^{14} dates can be accepted for Evolute Epigravettian culture. Different assocs. of hunting mammal fauna present at various levels of Layer III seem to indicate transition through 3 climatic phases: a) arid steppe, Cuts 16 to 15; b) damp and colder "taiga" type climate, Cuts 14 to 11; c) damp and warm increasing to more temperate forest climate, Cuts 10 to 4. a) and b) phases should be dated to period of ca. 1500 yr.

C^{14} ages of Riparo Tagliente can be compared with dates of Evolute Epigravettian industry in deposits of Central and S Italy from 14,000 to 10,000 yr, e.g., Grotta Romanelli, Apulia, R-56, 11,960 ± 320 (Bella *et al.*, 1958); and R-58, 11,800 ± 600 (Radiocarbon, 1964, v. 6, p. 79-80); Grotta Ortucchio, Abruzzo, Pi-23, 12,619 ± 410 (Radiocarbon, 1959, v. 1, p. 106); Grotta La Punta, Abruzzo, Pi-153, 10,581 ± 100 and Pi-152, 14,488 ± 800 (Radiocarbon, 1961, v. 3, p. 99-100); Grotta della Madonna, Calabria, Upper Paleolithic levels, R-289, 10,300 ± 100; R-292, 10,850 ± 100, and R-293, 12,100 ± 150 (Radiocarbon, 1967, v. 9, p. 356-357); Grotta del Romito, Calabria, Epipaleolithic layers, R-221, 10,960 ± 350 (Radiocarbon, 1966, v. 8, p. 405); R-298, 10,250 ± 450; R-299, 11,500 ± 200, and R-300, 11,150 ± 150 (Radiocarbon, 1967, v. 9, p. 358); Palidoro, Lazio, R-83, 13,000 ± 700 (Radiocarbon, 1966, v. 6, p. 79). For Lower Epigravettian industry "à cran" implements, one C^{14} date is available so far: Grotta del Romito, lower level of Upper Paleolithic layer, R-297, 18,750 ± 350 (Radiocarbon, 1967, v. 9, p. 358).

R-458. Chiozza di Scandiano P-E **6000 ± 200**
4050 B.C.
$\delta C^{13} = -25.2‰$

Excavations, 1939-41, in clay quarry at Chiozza di Scandiano, 16 km SSE Reggio nell'Emilia (44° 35′ 30″ N Lat, 10° 41′ 13″ E Long) uncovered Neolithic hut settlement with pits and underlying inhumation tombs: cultural horizons could not be id. with certainty. In 1968, new excavations were made by Ist. di Paletnol., Univ. of Rome, The British School of Rome, and Soprintendenza alle Antichità dell'Emilia on SW side of enlarged clay quarry of Fabbrica Laterizi Alboni. One archaeol. level, at 80 cm depth, resting on compact clay layer, again revealed Middle Neolithic open-air settlement: flint implements and pottery of types peculiar to Chiozza culture and Fiorano type, with "figulina" yellowish unpainted pottery of Ripoli culture were found (Gentili, 1968; Manfredini, 1970). Charcoal from Pit E coll. and subm. 1968 by A. Manfredini and A. Palmieri, Ist. di Paletnol., Univ. of Rome. *Comment*: chronologic sequence of Fiorano and Chiozza cultures, particularly at Chiozza site, is not clearly defined (Barfield and Broglio, 1965, 1966; Peroni and Radmilli, 1963; Radmilli, 1954; Manfredini, 1970). R-458 is from Pit E where only coarse, reddish, atypical pottery was found; date agrees with Fiorano culture in deposit and can be compared with C^{14} ages of prehistoric settlements of Fiorano or related cultures: Ripoli culture, prehistoric village of Ripoli, Hut 3, dated by Pisa Lab. (unpub.), 5100 ± 120 (Cremonesi, 1965); Grotta dei Piccioni, Abruzzo, Level 1 with pottery of early phase of Middle Neolithic culture, Pi-46, 6247 ± 130 (Radiocarbon, 1961, v. 3, p. 100); Grotta dei Piccioni, Level 3 with Ripoli-type pottery, Pi-49, 4770 ± 110 (Radiocarbon, 1961, v. 3, p. 100-101); Penne di Pescara, Abruzzo, older level with impressed and Ripoli-type pottery of beginning of Middle Neolithic, Pi-101, 6578 ± 135 (Radiocarbon, 1961, v. 3, p. 100); Luni archaeol. site, Lunigiana, level with pottery of Sasso type, St-1344, 5395 ± 80 (Radiocarbon, 1965, v. 7, p. 285; Ostenberg, 1967). See also Ripabianca di Monterado, this list.

Grotta del Prete series

Grotta del Prete is a small shelter in Senonian limestone at foot of N slope of Mt. Civitella, 737 m high, near W mouth of Gola di Frasassi, right side of Sentino R., Pianello di Genga, 8 km NNE Fabriano, prov. of Ancona, Marche (43° 24′ 16″ N Lat, 12° 56′ 39″ E Long) at +228 m. Excavations were carried out 1962 by D. G. Lollini, Soprintendenza alle Antichità delle Marche, and 1966 by G. Bartolomei, A. Broglio, and D. G. Lollini. Deposit inside shelter, at present 1.50 m thick, formed by limestone rubble from crumbling of vault; it is connected outside shelter with minute debris cones and partly underlies clayey cone deposits formed by water percolating down slope and resting against right wall of shelter; latter deposit is of Holocene age and contains Sub-Eneolithic pottery. Deposit inside shelter, from surface downward, consisted of 3 thin archaeol. horizons with upper hearth, Cuts 1, 3, and 5, and lower one, Cut 6; rocky soil of shelter not reached. Statistical study of flint implements found in Levels 1, 5, and 6 showed one Evolute Epigravettian complex with similar characteristics in all levels: a few burins, sparse scrapers, and many thick, retouched implements, mainly backed points and backed-and-truncated blades, very sparse geometrics. Modest fauna remains (*Capra ibex, Marmota marmota, Cervus elaphus,* and *Sus* sp.) present in all levels, rare micromammal fauna (Lollini, 1964a, 1966; Broglio, pers. commun., 1969).

5910 ± 50
R-644α. Grotta del Prete B′-1 **3960 B.C.**
$\delta C^{13} = -24.9‰$

Charcoal from hearth in upper Layer 1, Zone B′. Coll. 1962 by D. G. Lollini and subm. 1969 by G. Bartolomei, A. Broglio, and D. G. Lollini. *Comment*: C^{14} date far too young; to be discarded due to incompatibility with Evolute Epigravettian industry and fauna in deposit. Sample presumably was mixed with younger materials.

9990 ± 190
R-645. Grotta del Prete G-6 **8040 B.C.**
$\delta C^{13} = -25.8‰$

Charcoal from hearth in lowest Layer 6, Zone G. Coll. 1966 and subm. 1969 by G. Bartolomei, A. Broglio, and D. G. Lollini. *Comment*: C^{14} age acceptable as regards industry of deposit (compare Riparo Tagliente, this list).

Ripabianca di Monterado series

In 1962 and 1964 excavations were made in archaeol. deposit 800 m W Mulino di S Costanzo, left side of Cesano R., Ripabianca di Monterado, prov. of Ancona, Marche (43° 43′ 03″ N Lat, 13° 05′ 48″ E Long) at +40 m. Complex of cavities excavated in sterile agricultural soil and filled with archaeol. materials brought to light within an area 10 × 8 m wide. Three human skeletons in distinct burials outside boundary of archaeol. area were found (Corrain and Capitanio, 1968). Archaeol. finds, of one cultural horizon, comprise a) flint blades with new-type burin classified as variety of angle burin (Broglio and Lollini, 1963); b) impressed and "figulina" pottery with red-painted bands without black edge. Pottery assoc. attributes cultural horizon of deposit to early phase of Middle Neolithic (De Sanctis, 1961; Broglio and Lollini, 1963; Lollini, 1962a, 1964b, 1962-1965). Charcoal from largest and deepest cavity coll. 1962, 1965 and subm. 1969 by D. G. Lollini.

R-598. Ripabianca di Monterado 2 **6210 ± 75**
4260 B.C.
$\delta C^{13} = -25.1‰$

R-598α. Ripabianca di Monterado 2 **6140 ± 70**
4190 B.C.
$\delta C^{13} = -25.3‰$

Charcoal from upper part of archaeol. deposit in largest and deepest cavity. *Comment*: only 10% HCl pretreatment was given R-598; additional leaching with 6% NH_4OH was given R-698α; consistent dates show abundant humic fraction removed was not contaminating but belonged to charcoal humic fraction.

R-599α. Ripabianca di Monterado 3-b **6260 ± 85**
4310 B.C.
$\delta C^{13} = -25.1‰$

Charcoal from bottom of archaeol. deposit in largest and deepest cavity.

General Comment: R-598 and R-599 dates are consistent and agree with archaeol. attribution of deposit: Early phase of Middle Neolithic. Comparable to age for lower cultural Horizon 1 of Grotta dei Piccioni, Abruzzo, where pottery of same type was found: Pi-46, 6247 ± 130 (Radiocarbon, 1961, v. 3, p. 100).

R-643α. Maddalena di Muccia S-4, 6 **6580 ± 75**
4630 B.C.
$\delta C^{13} = -24.7‰$

Charcoal from archaeol. cavity S, Cuts 4 and 6, in Neolithic deposit on fluvial terrace, right side of Chienti di Gelagna R., Maddalena, ca. 2 km ESE of Muccia, prov. of Macerata, Marche (43° 04′ 26″ N Lat, 13° 03′ 48″ E Long) at +425 m. Coll. 1965 and subm. 1969 by D. G. Lollini. Deposit consisted of numerous cavities filled with archaeol. materials: they do not appear to be dwelling remains, but must be related to similar cavities in "Bandkeramik villages" of Central Europe. Archaeol. finds: a) flint industry of Paleo-Mesolithic tradition, b) impressed pottery with lustred black pottery and keeled vases. Pottery assoc. attributes cultural horizon to a late phase of Neolithic with impressed pottery (Lollini, 1962b, 1962-65, 1965). Sparse bones of one human skeleton were also found (Corrain and Capitanio, 1968). *Comment*: C^{14} date agrees with attribution and age of prehistoric village of Penne di Pescara, Abruzzo, where impressed and "figulina" unpainted pottery were found: Pi-101, 6578 ± 135 (Radiocarbon, 1961, v. 3, p. 100) and with more recent age for Ripabianca di Monterado deposit, Marche, containing impressed pottery of more evolute type (see R-598, R-598α, and R-599, this list).

Cattedra di S. Pietro series

The Cattedra di S. Pietro (Chair of St. Peter), an ancient wooden seat adorned with ivories, was until recently of uncertain origin, since there was no documentary evidence about its early history. Between XIIth and XIVth centuries it was believed to date back to the apostolic age and became an object of veneration. It is known to have been kept in the old St. Peter's and then moved to the new Basilica where, in 1667, it was enclosed in Bernini's bronze chair adorning the apse. In 1867 the Chair was inspected, especially the style and iconography of the narrow bands of carved and perforated ivory, probably applied originally as ornament to the wooden structures. The Chair was first id. as a Carolingian throne from the time of Charles the Bald (Garrucci, 1873-1881; De Rossi, 1867); in the last years it was further studied. (Schramm, 1956; Balboni, 1967). In July 1968, a committee from various nations under direction of Mons. M. Maccarrone, Pres. Comitato Pontificio di Sci. Storiche, aided by F. Vacchini, Head of the office of Rev. Fabbrica di S. Pietro, was empowered by Pope Paul VI to undertake a new examination of Chair and subject it to historical, archaeol., artistic, and scientific-technical tests, including dendrochronologic and radiocarbon dating of some wooden parts. Conclusions are as follows (Maccarrone, Ferrua, and Romanelli, 1969): it was confirmed that the Chair was originally a Carolingian throne from 2nd half of the 9th century A.D.; presumably brought to Rome by Charles the Bald for his coronation as Emperor and was left by him as a gift for Pope John VIII. At present, the Chair consists of original throne enclosed in wood structures, later added as work of restoration. Wood from different parts of Chair sampled and subm. 1969 by M. Maccarrone and F. Vacchini.

800 ± 50
R-600. Cattedra di S. Pietro R.F. 1 **A.D. 1150**
$\delta C^{13} = -25.4‰$

Light wood (*Pinus* sp. *pinea* group) id. by M. Follieri (pers. commun.) from outer front-left upright; sample removed from inner side of upright in contact with throne, ca. 30 cm from the ground. *Comment*: wood tissue not impaired but worm-eaten; sample carefully chosen, portion pulverized by wood worm being discarded. True sample age: 740 ± 50, A.D. 1210 (Stuiver and Suess, 1966). Contrary to earlier opinion (De Rossi, 1867), the outer structure consisting of 4 uprights of light pine-wood linked by cross-pieces and fitted with iron rings is believed to be a later addition to protect and facilitate transport of

Carolingian throne. C^{14} date agrees with presumed age of outer restoration, ca. 12th-13th centuries A.D.

890 ± 50
R-600A. Cattedra di S. Pietro R.F. 1 **A.D. 1060**
$\delta C^{13} = -25.5‰$

Pulverized material, filling cavities made by wood worm in Sample R.F. 1. *Comment*: as expected, date agrees with wood R-600; true sample age: 800 or 740 ± 50, A.D. 1150 and 1210 respectively.

950 ± 50
R-601. Cattedra di S. Pietro R.F. 2 **A.D. 1000**
$\delta C^{13} = -25.5‰$

Well-preserved wood (*Castanea sativa* Mill.) id. by M. Follieri (pers. commun.) from rear supporting cross; sample removed from upright, ca. 5 cm below the arms. *Comment*: true sample age: 890 ± 50, A.D. 1060. Wood also belongs to a later portion of restoration work to Chair. Age does not differ significantly from date measured for outer pine-wood upright, R-600 and R-600A samples.

1520 ± 50
R-602. Cattedra di S. Pietro R.F. 3 **A.D. 430**
$\delta C^{13} = -22.1‰$

Well-preserved wood (*Cupressus sempervirens* L.) id. by M. Follieri (pers. commun.) near right end of cross-piece supporting the 4 boards joined together and inserted later between inner front uprights, carrying the 18 panels of engraved ivory once formed part of a more ancient object. *Comment*: true sample age probably 1470 or 1420 ± 50, A.D. 480 and 530, respectively. Style and iconography of panels, representing the labors of Hercules and 6 animals or fantastic beings, suggest origin in Egypt of later classical antiquity, 6th-7th centuries A.D. C^{14} date suggests wooden cross-piece could either belong to original supporting structure of ivory panels, or, more likely, be made by reusing older wood.

925 ± 50
R-603. Cattedra di S. Pietro R.F. 4 **A.D. 1025**
$\delta C^{13} = -25.0‰$

Wood (*Quercus* sp. *caducifolia* group) id. by M. Follieri (pers. commun.) from inner lower, back-right upright; from front side of upright below seat insertion and below a narrow groove (on the upright itself) ca. 20 cm from ground. *Comment*: the wood somewhat worm-eaten, sample was carefully chosen from well-preserved part; true sample age probably 860 or 750 ± 50, A.D. 1090 and 1200, respectively. Inner oak uprights are thought to belong to original Carolingian throne assigned to 2nd half of 9th century A.D. C^{14} age is ca. 2 to 3 centuries younger than expected.

R-352. Grotta del Cavallo E, II-I **>31,000**
$\delta C^{13} = -25.0‰$

Charcoal from Layer E, Levels II-I, with Middle or Evolute Uluzzian industry of Grotta del Cavallo (or delle Giumente), Uluzzo Bay, Ionian

Coast of Penisola Salentina, ca. 3 km NW Santa Caterina di Nardò, prov. of Lecce, Apulia (40° 09′ 15″ N Lat, 17° 57′ 36″ E Long) at ca. +5 m. Coll. 1966 and subm. 1967 by A. Palma di Cesnola, Ist. Italiano di Preistoria e Protostoria. Excavations were carried out from 1963 to 1966. Deposit, ca. 7.35 m thick, revealed numerous Paleolithic cultural horizons, wild fauna remains, food refuse, and hearths. From bottom upward: N, Tyrrenian beach, max. thickness 1.15 m, hard-cemented limestone block and pebble conglomerate. Lower strata, M to F, total thickness ca. 4.40 m, with Mousterian industries of La Quinoid, denticulate, etc. type (Palma di Cesnola, 1967). Middle strata, E to D, with archaic Upper Paleolithic industries of Uluzzian facies, total thickness ca. 80 cm. Upper strata B and A, total thickness ca. 1.50 m, with Upper Paleolithic and Mesolithic industries of Romanellian facies (Palma di Cesnola 1963a, 1963b, 1964, 1966b; Palma di Cesnola and Borzatti von Löwenstern, 1964). *Comment*: Uluzzian culture, facies of archaic Leptolithic in Apulia, named from Uluzzo Bay where 1st recognized, can be considered peculiar Mediterranean facies of Châtelperron cultures of W Europe. Three facies were distinguished: a) Lower or Archaic Uluzzian (Stratum E, III) comprises abundant implements, scrapers, denticulated etc., still of Mousterianoid type, with rare coarse 1st Leptolithic elements of Upper Paleolithic type. b) Middle or Evolute Uluzzian (Stratum E, II-I), increase of Leptolithic implements on fine flint of Upper paleolithic type; small half-moon backed points, bone industry, rough cylindric-conic lance points, are also present. c) Upper or Late Uluzzian (Stratum D), flint limestone and quartzite implements, decrease of elements peculiar to Middle Uluzzian, implements recalling Aurignacian types, and abundant denticulates. Faunal data suggest changes of climatic conditions during Uluzzian period (Palma di Cesnola, 1965, 1966a, 1967). C^{14} date represents upper limit of Middle Uluzzian, assuming its survival into very early Upper Paleolithic time. Compare with date for charred bones from Level VIII, evolute Châtelperron industry, of Grotte du Renne, Arcy-sur-Cure, Yonne, France: Gro-1736, 33,500 ± 400 and Gro-1742, 33,640 ± 250 (or GrN-1742, 33,680 ± 250) (Movius, 1960; Leroi-Gourhan, A., 1961; Radiocarbon, 1963, v. 5, p. 166; Pradel, 1966).

B. Sardinia

R-492. Grotta A.S.I. or Pirosu — **2770 ± 60**, **820 B.C.**, $\delta C^{13} = -25.7‰$

R-492α. Grotta A.S.I. or Pirosu — **2680 ± 60**, **730 B.C.**, $\delta C^{13} = -25.8‰$

Charcoal from soil of inner votive chamber, so-called "Tempio ipogeo di Santadi", in Grotta A.S.I. formerly Grotta Pirosu, Benatzu, ca. 5 km S Santadi, prov. of Cagliari (39° 03′ 03″ N Lat, 8° 42′ 19″ E Long) at ca. +180 m. Coll. by A. Assorgia, Assoc. Speleologica Iglesiente, for C. Maxia, Ist. di Sci. Antropol., Univ. of Cagliari; subm. 1968 by C. Maxia. Exploration carried out by speleologists of A.S.I. of this karst cave in Cambrian dolomite revealed an inner small chamber id. as a votive place, probably an hypogean nuragic temple for magic religious rites; sole discovery of this kind made intact in Sardinia. More than 1800 used small pottery vases destined as votive offering were arranged in 3 heaps near imposing stalagmite used as altar on ledge of which were laid a variety of used metal nuragic objects, largely of copper, also destined as votive offerings. Much charcoal was heaped on rocky soil of cavity (Maxia, 1968, 1969a, 1969b). *Comment*: R-492 received standard pretreatment with 10% HCl; R-492α received additional leaching with 6% NH_4OH: 2 measurements were consistent; abundant humic fraction removed should not be regarded as contaminating but as belonging to humic charcoal. Since magic religious rites were celebrated in nuragic hypogeum temple in 1st millennium B.C. but before Carthaginian invasion, 500 B.C., C^{14} date agrees with presumed age.

R-677. Grotta dell'Acqua Calda — **3690 ± 60**, **1740 B.C.**, $\delta C^{13} = -23.5‰$

Charcoal from archaeol. layer (burial) of deposit in inner chamber of Grotta dell'Acqua Calda, karst cave in Senonian-Eocene limestone, near Marchesa Mine, 500 m NE Acquacadda, Nuxis, prov. of Cagliari (39° 10′ 37″ N Lat, 8° 45′ 18″ E Long). Coll. 1968 and subm. 1969 by M. L. Ferrarese Ceruti, Ist. di Antichità, Archeol. e Arte, Univ. of Cagliari. Deposit showed one archaeol. level consisting of sepulchral layer with human bones, probably in secondary burial, resting on charcoal level, and pottery, mainly fragments of large vases of Monte Claro culture type. *Comment*: Monte Claro culture is mainly diffused in SW Sardinia, Sulcis and Campidano areas, as far as Oristano (Atzeni, 1959-1961; Atzori, 1958-1959; Lilliu, 1967; Lilliu and Ferrarese Ceruti, 1958-1959). Date agrees with C^{14} age for same culture at Nuraghe Brunku Màdili or Madugui near Gesturi: Gsy-243, 3770 ± 250 (Radiocarbon, 1966, v. 8, p. 86). Two dates available place Monte Claro culture among Sardinia pre-Nuragic cultures.

C. Egadi Islands

R-566. Levanzo — **11,180 ± 120**, **9230 B.C.**, $\delta C^{13} = +2.8‰$

Shells (*Patella ferruginea*) from lower layer with Epigravettian industry in outer chamber of Grotta dei Genovesi at foot of limestone cliffs, W coast of Levanzo I., Egadi Archipelago, ca. 15 km off W coast of Sicily, prov. of Trapani (38° 00′ N Lat, 12° 20′ E Long) at +30 m. Coll. 1953 and subm. 1969 by P. Graziosi, Ist. Italiano di Preistoria e Protostoria. Cave consists of 2 wide chambers, the front one connected by narrow shaft to inner chamber with walls bearing pictures, mainly black schematic figures, attributed to Eneolithic or Bronze age (Graziosi, 1950). In fore-chamber archaeol. excavation, 1953, revealed from surface downwards: a) superficial disturbed layer, 40 cm thick; b) upper layer, 50 cm thick, with charcoal, fauna of domestic animals with abundant fresh water (*Helix*) and marine (*Patella, Trochus*) mollusc shells, food refuse; blade flint industry and Neolithic pottery of Diana type; c) lower layer, 80 cm thick, with abundant wild fauna (*Cervus elaphus, Bos primigenius, Equus asinus hydruntinus*) with marine mollusc shells of *Patella ferruginea*; blade flint industry of Epigravettian type. In deeper level of c) layer a limestone block with engraving of ox on flat surface of Upper Paleolithic type (Graziosi, 1954): 1st evidence of cave dwelling at this level; d) underlying sandy-clay sediment, sterile. In 1950 naturalistic engravings of wild animals, and some male figures, belonging to Upper-Epipaleolithic prehistoric art of "Provincia mediterranea" style were identified on walls of inner chamber (Graziosi, 1960, 1962, 1968). *Comment*: 35% of weight of shells were destroyed by dilute HCl before using material for dating. Since engraved stone of lower layer in fore-chamber with *Patella ferruginea* shells is believed related to engravings on walls of inner chamber, C^{14} age dates Paleolithic art of "Provincia mediterranea" style at Levanzo and agrees with dates hitherto available for other sites in Italy where same prehistoric art was found: Grotta Romanelli, Apulia, R-56, 11,960 ± 320 (Bella *et al.*, 1958-1961) and R-58, 11,800 ± 600 (Radiocarbon, 1964, v. 6, p. 79-80); Grotta del Romito, Calabria, R-300, 11,150 ± 150 (Radiocarbon, 1967, v. 9, p. 358). Shells (*Patella ferruginea*) from same level of Levanzo deposit were dated: Pi-119, 9694 ± 110 (Radiocarbon, 1961, v. 3, p. 99).

D. Pakistan

From 1960 to 1965 Italian Archaeol. Mission of IsMEO in Pakistan carried out excavations in urban settlement of Barama and pre-Buddhist necropolises of Butkara II, Loebanr I, and Katelai I, all belonging to same archaeol. area along Jambil and Saidu R. valleys near Saidu Sharif and Mingora towns, Swat (W Pakistan) (Silvi Antonini, 1963; Faccenna, 1964; Stacul, 1966; Castaldi, 1968; Silvi Antonini Colucci and Stacul, 1969). All charcoal coll. at Barama and available burnt bones found in cremation tombs of Butkara II as well as some cremation tombs of Katelai I and Loebanr I necropolises were dated at Rome Lab. (Radiocarbon, 1966, v. 8, p. 408-409; 1967, v. 9, p. 360-362). As already mentioned in previous lists (Alessio *et al.*, 1966, 1967), in all necropolises, structures of graves and funerary rites are essentially the same with handsome grave furniture in cremation and inhumation tombs. One cultural horizon was acknowledged for all; but different typological groups of grave furniture place them in archaic, middle, and late cultural phases (Stacul, 1966, 1969a). Anthropologic studies on human bones from 3 necropolises are being made (Alciati, 1967; Alciati and Viscoli, 1970). More recently discovered cemeteries in neighboring regions of Swat seem to be contemporary with Butkara, Loebanr, and Katelai (Stacul, 1967, 1969b). This list contains dates of presently available burnt bones from additional cremation tombs of Loebanr and Katelai necropolises.

Following pretreatment was given: carefully chosen bits of compact bone tissue were dissolved (10%) by leaching them with 5% HCl and solution discarded; their mineral component were destroyed by treatment with hot dilute HCl; blackish residual matter to be dated was nearly insoluble in 6% NH_4OH.

R-474. Loebanr I T-21 **2390 ± 70**
440 B.C.
$\delta C^{13} = -19.6‰$

Burnt human bones from Cremation Tomb 21 of Loebanr I necropolis, between Loebanr village and left bank of Jambil R., ca. 4 km upstream from Mingora; Swat, W Pakistan (34° 54′ 55″ N Lat, 72° 23′ 30″ E Long). Coll. 1962 by C. Silvi Antonini, Ist. Orientale, Univ. of Rome; subm. 1966 by D. Faccenna, Head of Mus. of Oriental Art in Rome, for G. Tucci, Pres. of IsMEO. In 1962 1964-65, 183 cremation and mostly inhumation tombs were excavated, some superimposed (Silvi Antonini, 1963; Faccenna, 1964; Stacul, 1966). *Comment*: based on furniture typology, Tomb 21 was classified as archaic phase of necropolis. C^{14} date agrees with ages obtained for Tombs 28 and 87, judged to belong to middle phase: R-276, 2460 ± 50 and R-278, 2380 ± 50, respectively (Radiocarbon, 1967, v. 9, p. 362).

Katelai I series

Burnt human bones from cremation tombs of Katelai I necropolis, halfway up hills overlooking Katelai village, on left side of Saidu R. beyond its confluence with Jambil R., ca. 1 km S Mingora, Swat, W Pakistan (34° 46′ 10′ N Lat, 72° 21′ 08″ E Long). In 1962-1965 237 cremation and mostly inhumation tombs were explored (Silvi Antonini, 1963; Faccenna, 1964; Stacul, 1966; Castaldi, 1968; Silvi Antonini Colucci and Stacul, 1969). Particularly at Katelai tombs are repeatedly superimposed near each other and hardly fit shape of terrain.

R-479. Katelai I T-39 **2250 ± 50**
300 B.C.
$\delta C^{13} = -19.9‰$

Burnt human bones from Cremation Tomb 39. Coll. 1962 by C. Silvi Antonini; subm. 1966 by D. Faccenna for G. Tucci. *Comment*: C^{14} date agrees with age for other sample from same Tomb 39: R-279, 2120 ± 45 (Radiocarbon, v. 9, p. 361). Two ages, although somewhat young, agree with dates of other tombs judged, as Tomb 39, to belong to middle phase (see R-474 comment, this list).

R-477. Katelai I T-48 **2870 ± 60**
920 B.C.
$\delta C^{13} = -18.7‰$

R-477A. Katelai I T-48 **2750 ± 50**
800 B.C.
$\delta C^{13} = -19.2‰$

Burnt human bones from Cremation Tomb 48. Coll. 1963 by E. Castaldi, Ist. Paletnol., Univ. of Rome; subm. 1966 by D. Faccenna for

G. Tucci. *Comment*: R-477 was formed from chosen bits of compact bone tissue, R-477A from fragments of spongy bone tissue more difficult to separate from contaminant materials; the 2 dates are consistent and assign Tomb 48, without furniture, to archaic phase of necropolis.

R-476. Katelai I T-64 — **3150 ± 150**
1200 B.C.
$\delta C^{13} = -20.0‰$

Burnt human bones from Cremation Tomb 64. Coll. 1963 by E. Castaldi; subm. 1966 by D. Faccenna for G. Tucci. *Comment*: date assigns Tomb 64, without furniture, to archaic phase of necropolis and is oldest age measured for cremation tombs at Katelai and Loenbanr necropolises.

General Comment: for Katelai Necropolis, all dates at Rome Lab. confirm expected long life-cycle, >millennium, of cemetery. Age is not maximum since tombs held to belong to more recent cultural phase have not been dated. For Loenbanr I necropolis similar long period of use is shown: tombs dated at Rome Lab., average age ca. 2400 B.C., belong to middle cultural phase (see R-474 comment, this list); tombs belonging to archaic phase, dated at British Mus. Lab., gave: BM-195, LI, T-54, 2950 ± 150 and BM-196, LI, T-61, 2850 ± 150 (Radiocarbon, 1969, v. 11, p. 292; Stacul, 1969a). Comparison can be made also with ages measured at Heidelberg Lab. for bones of 2 human skeletons in double Burial 101 of Timargarha cemetery, Dir., W Pakistan, whose furniture seems to correspond to cultural phase of archaic tombs of Swat necropolises: 3380 ± 60 and 2805 ± 60 (Dani, 1968; Stacul, 1969a).

II. GEOLOGIC SAMPLES

Italy

R-617A. Colle del Sestrière, Val Chisone — **2870 ± 50**
920 B.C.
$\delta C^{13} = -23.6‰$

R-617α. Colle del Sestrière, Val Chisone — **2930 ± 50**
980 B.C.
$\delta C^{13} = -24.4‰$

Slightly darkened wood (*Piceoxilon Gothan* ex *Larix decidua* Mill.) id. by G. Charrier (1967) from wood horizon at −100 cm underlying peat bog of Colle del Sestrière, Val Chisone, Alpi Cozie, prov. of Turin, Piedmont (47° 57′ 16″ N Lat, 6° 53′ 36″ E Long) at +2030 m. Coll. 1965 and subm. 1969 by G. Charrier, Ist. di Giacimenti Minerari, Politecnico of Turin. Profile is from surface downward: 0 to −10 cm, actual surface soil; −10 to −50, sand sediment with interbedded thin levels of peat; −50 to −90 peat layer, more compact and dark toward bottom, mainly formed by leaf remains of marsh *Cyperaceae* and *Gramineae*; −90 to −110 wood horizon resting on thin clay layer, latter transition to underlying moraine. Sestrière peat bog belongs to series of

Lowmoor bogs. *Comment*: R-617A received no pretreatment, R-617α was pretreated with 5% HCl and additional leaching with 6% NH_4OH. R-617A and R-617α complete dating of peat layer overlying wood horizon: R-53, 2020 ± 100 (Radiocarbon, 1964, v. 6, p. 86) and confirms climatic and vegetation history indicated by pollen and stratigraphical analyses (Charrier, 1967). *Larix* wood dated ca. 1380 B.C. (R-617A, R-617α) belongs to Sub-Boreal and proves existence of *Laricetum* above present forest line. Wood probably carried into basin of Colle del Sestrière during transition from Sub-Boreal to Sub-Atlantic. Peat layer overlying wood, as shown by pollen analysis, belongs to early Sub-Atlantic (Zone X, Firbas) and validates further stage of vegetation dynamics in progress. Wood horizon was believed much older than overlying peat layer and, thus, earlier than 1000 B.C. (Charrier, 1967); dates agree with expectation.

680 ± 50
R-619. Lago delle Rovine, Valle Gesso **A.D. 1270**
$\delta C^{13} = -24.7‰$

Well-preserved wood (*Cedroxylon* Kraus ex *Abies alba* Mill.) id. by G. Charrier (pers. commun.) from core of R1 drilling, 2.50 to 2.90 m below top of core, water depth 16.90 m, in bottom sediments of Lago delle Rovine, Alta Valle Gesso, Alpi Marittime, prov. of Cuneo, Piedmont (44° 10′ 42″ N Lat, 7° 19′ 29″ E Long) at +1522 m; coordinate system U.T.M. 32-TLP-67779325. Coll. 1968 and subm. 1969 by G. Charrier. Core R1, one among 10 core drillings made by ENEL, 1968, in area of Lago delle Rovine, was 13.90 m long and revealed from lake bottom surface downward: 0 to −0.40 m, silt; −0.40 to −2.12 m, sandy-silt, more compact toward lower level; −2.12 to −2.50 m, interbedded silty-sandy thin layers; −2.50 to −2.90 m silt containing wood fragments of various species and other plant remains; −2.90 to −9.42 m silt and sand thickly interbedded; −9.42 to −13.90 m, interbedded silt, sand, and gravel; rock bottom or boulder at −13.90 m. Core R1 being studied by G. Charrier. *Comment*: C^{14} dates presence of *Abies alba* in Upper Gesso R. Valley at end of secondary Post-Glacial climatic optimum and gives further chronologic datum in history of *Abies alba* in Piedmont previously established by pollen analysis (Charrier, pers. commun.).

790 ± 50
R-618A. Cava Crosetto, Moncalieri **A.D. 1160**
$\delta C^{13} = -24.6‰$

900 ± 50
R-618. Cava Crosetto, Moncalieri **A.D. 1050**
$\delta C^{13} = -25.1‰$

Well-preserved wood (*Salix alba*) from large trunk, 7 m long and 1.60 m diam., id. by G. Charrier (pers. commun.) in alluvial Layer VI with large trunks, S boundary sec. at gravel and sand quarry of Crosetto and Co., in recent alluvial plain on right side of flood river-bed of Po R., near Cascina Molinello, Moncalieri, prov. of Turin, Piedmont

(44° 58′ 36″ N Lat, 7° 41′ 30″ E Long) at +222 m. Coll. 1968 by L. Peretti, Ist. di Giacimenti, Politecnico of Turin; subm. 1969 by G. Charrier. Sec. in quarry, 7 m deep, shows profile of alluvial formation (differs somewhat in various exposures) from top downwards: I) 221 to 219.10 m above sea level, disturbed surface layer; II) 219.10 to 217.70, silty sand; III) 217.70 to 216.70, silty fine sand; IV) 216.70 to 215.50, interbedded sand layers and cross-bedding pebble-and-gravel lenses; V) 215.50 to 214 and downwards, coarse gravel and pebble together with thin sand layer including numerous large sub-fossil trunks (*Salix, Quercus*) lying in nearly horizontal position, some up to 13 m long. At 218.20 to 217 m, a blue-gray silty-clay lens containing bivalve shells as *Unio pictorum* is interbedded with surface of erosion on top. At various levels peat beds are also present. Excavation below 214 m exposed mammal fauna (*Elephas antiquus* and *Cervus* cfr. *megaceros*). *Comment*: R-618 pretreated with 5% HCl, R-618A was not pretreated. See discussion of date in R-622, Cascina Monache, general comment, this list.

R-622A. Cascina Monache, Casale Monferrato **1580 ± 50**
A.D. 370
$\delta C^{13} = -24.7‰$

R-622α. Cascina Monache, Casale Monferrato **1595 ± 50**
A.D. 355
$\delta C^{13} = -25.8‰$

Slightly darkened wood (*Quercus robur* L. *pedunculata* Ehrh.) id. by G. Charrier (pers. commun.) in gravel III, sec. through sand and gravel quarry, alluvial Holocene plain left side and ca. 2 km from present stream bed of Po R., near Cascina Monache, Grassi, Casale Monferrato, prov. of Alessandria, Piedmont (45° 09′ 40″ N Lat, 8° 26′ 48″ E Long) at +112 m. Locality is ca. 20 km downstream from Crosetto quarry at Moncalieri (see R-618). Quarry sec., 11 m high, shows following average stratigraphic series, from surface downwards: I) 112 to 111.50 m above sea level, sandy-silty colluvial brown soil, partially disturbed; II) 111.50 to 107 m, gray silty sand; III) 107 to 101 m, interbedded sand and coarse gravel beds, which include several large sub-fossil trunks lying nearly horizontal, many up to 7.5 m long. *Comment*: R-622A not pretreated; R-622α 5% HCl pretreated with additional leaching with 6% NH_4OH. *General Comment*: dates of R-618 and R-622 exclude correlation believed possible between large trunks at Moncalieri and similar wood horizon at Cascina Monache. Discrepancy indicates succession of 2 distinct alluvial phases in Po plain during recent Atlantic: at beginning, ca. 400 A.D. (Moncalieri), and towards end, ca. 1070 A.D. (Casale), of secondary Post-Glacial climatic optimum.

Cava Nocentini and Buoncompagni, S. Leo, series

Heavily darkened wood fragments from lower part of sec. throughout Würm terrace in sand and gravel quarry Nocentini and Buoncompagni, S. Leo, 4 km W Arezzo, Tuscany (43° 28′ 20″ N Lat, 11° 05′ 00″

E Long) at +321 m. Coll. 1965 by G. A. Ferrari, F. Mancini, and G. Sanesi, Ist. di Geol. Applicata, Univ. of Florence; subm. 1965 by M. Follieri, Ist. di Botanica, Univ. of Rome. Eight m sec. in quarry showed following profile of Würm terrace, from top downward: 0 to 2.50 m, gray-brown podzolic Alfisol with clear textural differentiation between A and B horizons; lower part intense calcium carbonate accumulation indicated by hard, irregularly shaped concretions; 2.50 to 7-8 m, gradual transition to gravels and pebbles of limestone and marl, size of which increases downward, in yellowish coarse sand. In lower level, 2 m thick, wood pieces up to 70 cm long and up to 15 cm diam. are present often partially covered by silt and grayish clay cemented by iron sulfides, many id. by M. Follieri (pers. commun.). Series presents variable thickness in different sites and in general overlies lacustrine clay of Pleistocene age; it constitutes a terrace considered of Würm age along valleys of many rivers in Tuscany and represents main morphologic unit visible over present alluvial plain from which it is clearly separated by a well-preserved escarpment.

R-227. Cava Nocentini Buoncompagni, S. Leo 2 **>47,000**
$\delta C^{13} = -27.5‰$

R-227α. Cava Nocentini Buoncompagni, S. Leo 2 **>47,000**
$\delta C^{13} = -27.6‰$

Heavily darkened wood (*Larix* sp.) id. by M. Follieri (pers. commun.).

R-228α. Cava Nocentini Buoncompagni, S. Leo 3 **>47,000**
$\delta C^{13} = -26.7‰$

Heavily darkened wood (*Larix* sp.) id. by M. Follieri (pers. commun.).

R-229α. Cava Nocentini Buoncompagni, S. Leo 4 **>40,000**
$\delta C^{13} = -28.7‰$

Heavily darkened wood (*Corylus* sp.) id. by M. Follieri (pers. commun.).

R-231. Cava Nocentini Buoncompagni, S. Leo 6 **>47,000**
$\delta C^{13} = -27.9‰$

R-231α. Cava Nocentini Buoncompagni, S. Leo 6 **>47,000**
$\delta C^{13} = -28.5‰$

Heavily darkened wood (*Ulmus* cfr. *montana* Stokes in With.) id. by M. Follieri (pers. commun.).

General Comment: no carbonate present in all evenly darkened wood fragments; very abundant Fe^{++}, Fe^{+++} and SO_4^{--} soluble in water, probably $FeSO_4$ and $Fe_2(SO_4)_3$ as oxidation products of ferrous sulfides originally present in woods. By boiling with hot dilute HCl some H_2S and SO_2 evolved Fe^{++} and Fe^{+++} ions, presumably present as humates, were completely removed. α-labeled samples were given additional leaching with 6% NH_4OH: abundant humic fraction removed appeared not contaminating.

Dates measured for defining age of formation of terraces; ages obtained indicate upper limit and agree well with field observations and with general outline of history of Tuscan rivers; terraces long considered of Early Würm age.

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[RADIOCARBON, VOL. 12, NO. 2, 1970, P. 617-639]

UNIVERSITY OF TEXAS AT AUSTIN RADIOCARBON DATES VIII

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This list reports C^{14} measurements made in projects completed in the year ending October, 1969, and some measurements for projects still in progress. Age calculations are based on C^{14} half-life of 5568 years and a modern standard of 95% of NBS oxalic acid. Deviations reported are based on counting statistics of sample, background, and modern, and are $\pm$ 1σ except that when sample count approaches either modern or background, 2σ limits are reported. The laboratory uses liquid scintillation counting of benzene, with Li_2C_2 and vanadium activated catalyst in preparation. Chemical yields average 88%.

Valastro is in charge of technical operations in the laboratory; he and Davis share administrative responsibilities. Davis handles sample screening and archaeologic appraisal, and has compiled this list.

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I. CHECK SAMPLE

In addition to sample below, see Tx-680, in Archaeologic Samples.

23,880 ± 490

Tx-693. Danvers, Illinois **21,930 B.C.**

Wood chips from bed of woody peat, 1.4 m below top of Farmdale silt, 3 mi SW of Congerville, 5 mi NW of Danvers, Illinois (40° 35′ 12″ N Lat, 89° 14′ 40″ W Long). Sample was split and the 2 parts prepared and counted separately: 23,520 $\pm$ 640, 24,230 $\pm$ 750. Another part of same sample dated as ISGS-12, 23,900 $\pm$ 200 (Kim, pers. commun.). Subm. by S. M. Kim, Ill. State Geol. Surv., Urbana. *Comment*: excellent agreement.

II. OCEANOGRAPHIC SAMPLES

A. South Gulf Coast, Texas

Padre Island Beach series, Texas

Shells (*Mercenaria mercenaria*) from back shore surface, beach of Padre I., ¼ mi N of Mansfield Pass channel (26° 34′ N Lat, 97° 17′ W Long). Shells represent large source of beach material. Source area seems to be offshore Gulf of Mexico. Dated to see whether such an unlikely habitat for this species has existed recently or if shells represent reworking of Pleistocene deposits outcropping offshore. Coll. 1968 by Behrens and Frishman; subm. by E. W. Behrens, Univ. of Texas Marine Sci. Inst., Port Aransas, Texas.

Tx-718. Padre Island Beach, 1 **7180 ± 120**
5230 B.C.

Tx-719. Padre Island Beach, 2 **6840 ± 120**
4890 B.C.

Tx-720. Padre Island Beach, 3 **4590 ± 70**
2640 B.C.

Tx-721. Padre Island Beach, 4 **1240 ± 70**
A.D. 710

Tx-722. Padre Island Beach, 5 **2150 ± 90**
200 B.C.

Tx-723. Padre Island Beach, 6 **5600 ± 100**
3650 B.C.

Tx-724. Padre Island Beach, 7 **5760 ± 100**
3810 B.C.

Tx-725. Padre Island Beach, 8 **6280 ± 110**
4330 B.C.

Tx-726. Padre Island Beach, 9 **5480 ± 100**
3530 B.C.

Tx-727. Padre Island Beach, 10 **5500 ± 100**
3550 B.C.

General Comment: (E.W.B.): dates establish existence on continental shelf of an old source for Recent Gulf-beach shell material. Probably shells are being eroded from lagoon sediments deposited during lower stand of sea level.

Tx-760. Laguna Madre Land Cut #7 **30,860 ± 1710**
28,910 B.C.

Shell (*Mercenaria mercenaria*) from surface of spoil bank, E side Intracoastal Canal, opposite Banderia Point, Laguna Madre, Texas (26° 53′ 45″ N Lat, 97° 27′ 40″ W Long). Originally dredged from ca. −3.4 m. From interglacial, interstadial or Holocene beach rock (part of Ingleside Barrier complex?) Several mm. of surface material removed with HCl before submission, to eliminate coatings of younger carbonate and weathered, leached surfaces. Coll. 1968 by Behrens and Kessler; subm. by Behrens. *Comment* (E.W.B.): date establishes major age difference between 2 very similar deposits: present Padre I. Gulf beach and beach-rock within Laguna Madre. Date agrees with high stand of sea level postulated by Milliman and Emery (1968).

North Padre Island series, South Texas

Shells (*Mulinia* sp.) from general depth of 18.9 m on N part of Padre I. (South Bird quad.), 10 mi S of Bob Hall pier (27° 27′ N Lat, 97° 18′ W Long). Samples are rotary drill cuttings from shell bed at base of Padre I. sand. Coll. 1968 and subm. by K. A. Dickinson, Office of Marine Geol. and Hydrol., U.S. Geol. Survey, Corpus Christi, Texas.

Tx-800. North Padre, 04-1 **27,380 ± 1100**
25,430 B.C.

Tx-801. North Padre, 04-2 **29,980 ± 1070**
28,030 B.C.

Comment (K.A.D.): shell bed is believed to represent lagoon deposition during last Pleistocene sea-level rise. Dates fit Shepard's (1963, Fig. 3) curve showing sea level ca. 15.2 m below present from 30,000 to 26,000 B.P. Shell bed is probably from about same horizon as Fisk's *Mulinia* sp. bed with C^{14} age of 23,400 ± 1800 (0-630, Sample 19; Fisk, 1959, p. 123, 149). Fisk considered this age anomalously young.

Oolite coating series, Baffin Bay, Texas

Oolites are sand grains with concentric $CaCO_3$ coatings. Assays in table below result from development of method whereby coatings can be serially removed from sand grain nucleus and coating fractions dated. Oolites were taken from 0.25 to 0.30 mm fraction of sand, chosen for its high percentage of oolitic grains, few uncoated shell fragments and foraminifera tests, and maximum number of grains with non-carbonate nuclei. Serial stripping of coatings was accomplished by calculating volume of 3N HCl necessary to dissolve a desired weight of $CaCO_3$ from previously weighed sand sample. Examination of thin secs. verified nearly uniform removal of coatings. For complete statement of technique, see Frishman (1969).

Material is from swash zone along windward shore at Kleberg Point, Baffin Bay, a normally hypersaline bay on S Gulf coast of Texas (27° 17′ N Lat, 97° 37′ W Long). Coll. 1968 and subm. by S. A. Frishman and E. W. Behrens, Dept. Geol. Sciences, Univ. of Texas, Austin.

General Comment (S.A.F.): except for Tx-698, 713, and 716, agreement of triplicate samples indicates uniformity of stripping process. Average age of total carbonate in each sample (Tx-702, -703), obtained by dissolving entire sample in excess of acid, is older than average age of coatings, since older carbonate nucleus is included. C^{14} enrichment (ave. $\delta C^{14} = +54.7 \pm 1.8‰$) in outer 1/5 of coatings means that at least some of coatings (ca. 27% by weight) were formed after beginning of nuclear bomb testing in early 1950's. In general, dates show that coating has proceeded sporadically for 730 yr, the extrapolated age of initiation of oolite formation in this sample. This extrapolation is made on a plot of C^{14} vs. % coating removed by acid leaching.

B. Baffin Bay sediment study, South Texas coast

Sediments deposited in Baffin Bay, S Gulf coast of Texas, in study of Holocene depositional history of bay. Coll. by Behrens and assocs.; subm. by E. W. Behrens.

TABLE 1

Sample name and coating fraction (by weight)	C^{14} age (yr)	δC^{14} (‰)
Tx-697. BB-a, outer 1/5	anomalous	61.0 ± 9.1
Tx-712. BB-b, outer 1/5	anomalous	55.0 ± 8.2
Tx-715. BB-c, outer 1/5	anomalous	48.0 ± 7.6
Tx-698. BB-a, middle 2/5	230 ± 70	−28.5 ± 6.2
Tx-713. BB-b, middle 2/5	90 ± 60	−11.4 ± 5.6
Tx-716. BB-c, middle 2/5	70 ± 50	−9.1 ± 5.0
Average, middle 2/5	130 ± 40	
Tx-699. BB-a, inner 2/5	500 ± 70	−60.5 ± 7.0
Tx-714. BB-b, inner 2/5	530 ± 70	−64.0 ± 6.0
Tx-717. BB-c, inner 2/5	550 ± 70	−66.2 ± 5.7
Average, inner 2/5	530 ± 40	
Tx-702. BB-a, total $CaCO_3$	410 ± 80	−50.2 ± 6.8
Tx-703. BB-b, total $CaCO_3$ (2 runs)	500 ± 60	−60.5 ± 5.4
	440 ± 70	−53.6 ± 6.1
(average	470 ± 50	
Average, total $CaCO_3$	440 ± 50	

Tx-568. Baffin Bay 3, 94 to 97 cm **2310 ± 60** **360 B.C.**

Carbonate from marl 94 to 97 cm below sediment-water interface, 15.2 m N of Marker 58, Baffin Bay Channel, Lower Baffin Bay (27° 17′ N Lat, 97° 28′ W Long). Marl (18.5% terrigenous clay, 81.5% $CaCO_3$) was a layer within core of regularly laminated bay-center mud from hypersaline bay. Sample split into 2 parts, prepared and counted separately; 2440 ± 80, 2170 ± 90. *Comment*: see comment on Baffin Bay Core series, below.

Baffin Bay Core series

Shells, mixture of small species native to grass flats, from cores obtained 10 mi ESE of Riviera Beach near mouth of Baffin Bay, Texas coast (27° 15′ 00″ N Lat, 97° 30′ 00″ W Long). From Holocene sediments deposited on grass flat, unconformably overlying Pleistocene surface and overlain by restricted hypersaline bay mud. Coll. 1968. In sample titles, letter indicates core, and numbers are depth(cm) below bay bottom.

Tx-755. Baffin Bay D, 220 to 230 **3480 ± 80** **1530 B.C.**

Tx-754. Baffin Bay D, 230 to 240 **4860 ± 190** **2910 B.C.**

Tx-753. Baffin Bay D, 240 to 250 **6670 ± 550**
4720 B.C.

Tx-752. Baffin Bay D, 250 to 260 **5770 ± 140**
3820 B.C.

Tx-751. Baffin Bay D, 260 to 270 **5800 ± 100**
3850 B.C.

Tx-748. Baffin Bay D, 270 to 300 **5640 ± 100**
3690 B.C.

Tx-761. Baffin Bay D, 300 to 325 **6060 ± 140**
4110 B.C.

Tx-762. Baffin Bay D, 325 to 350 **5420 ± 220**
3470 B.C.

Tx-763. Baffin Bay D, 350 to 375 **6080 ± 120**
4130 B.C.

Tx-756. Baffin Bay E, 202 to 233 **5620 ± 120**
3670 B.C.

Tx-757. Baffin Bay C, 350 **3750 ± 80**
1800 B.C.

General Comment on Baffin Bay 3 and Core series (E.W.B.): dates indicate shelly, muddy sands deposited on grass flats under nearly normal salinity ca. 6000 to 5000 B.P. (Tx-761-763, 748, 751-756). Grass flats seldom flourish in water deeper than 1 m, so sea level was ca. 4 m below present level; this agrees well with results in Florida (Scholl *et al.*, 1969). Between 5000 and 3500 B.P. (Tx-754, 755, 757) major circulation change caused bay to become restricted and hypersaline, which it still is. Marls of Tx-568, 758 represent time of especially intense precipitation of non-skeletal $CaCO_3$ under these conditions.

Kleberg Point series

Shell (mostly *Anomalocardia cuneimeris*) from genetically related group of spits at Kleberg Point, N shore Baffin Bay, between Alazan Bay and Cayo del Grullo (27° 17′ N Lat, 97° 37′ W Long). Coll. 1967. Some samples split and 2 parts prepared and counted separately, as shown. Samples listed in presumed order of increasing age, based on detailed mapping.

Tx-733. Kleberg Point G **960 ± 60**
A.D. 990

Tx-728. Kleberg Point A **1440 ± 90**
A.D. 510

Tx-729. Kleberg Point B **840 ± 50**
A.D. 1110

830 ± 60 and 850 ± 70.

Tx-730. Kleberg Point C **1960 ± 50**
10 B.C.

1950 ± 90 and 1970 ± 60.

Tx-731. Kleberg Point D **1960 ± 60**
10 B.C.

1060 ± 90 and 1950 ± 80.

Tx-735. Kleberg Point 2a **2220 ± 70**
270 B.C.

Tx-732. Kleberg Point F **2280 ± 90**
330 B.C.

Tx-734. Kleberg Point 1a **2280 ± 60**
330 B.C.

2200 ± 80 and 2350 ± 80.

Tx-747. Kleberg Point 3a **2900 ± 90**
950 B.C.

General Comment: see comment for Kleberg Lagoon series, below.

Kleberg Lagoon series

Marl from bottom of lagoon at Kleberg Point (see Kleberg Point series, above). From base of closed-lagoon-algal mat sequence that began when sand spits closed lagoon from Baffin Bay. Sequence underlain by open-bay shelly mud and overlain by algal mat-evaporite sediments. Coll. 1968.

Tx-759. Kleberg Lagoon RBB 62 **1100 ± 100**
A.D. 850

From 62 cm below bottom in core near center of lagoon.

Tx-758. Kleberg Lagoon BB 100 **2660 ± 270**
710 B.C.

From 100 cm below sediment-water interface in core S of center of lagoon.

General Comment on Kleberg Point and Kleberg Lagoon series (E.W.B.): dates indicate a group of shelly spits grew from 2900 to 1440 B.P. (Tx-728 through 732, 734, 735, 747), forming Kleberg Lagoon and separating it from Baffin Bay; algal mats then flourished within lagoon. Four discrepancies exist: 1) Tx-729 out of order; unexplained but might be sampling error, 2) current active spit dates 960 B.P. (Tx-733); probably indicates old shells retained in active spit, 3) older spit (Tx-747) has older date than underlying marl (Tx-758); if age of spit is corrected for old shells incorporated in it, as in 2), above, discrepancy disappears, 4) coring has shown that algal mats began to flourish immediately after formation of spit dating 2280 B.P. (Tx-734), but at base of mat sequence is marl dating 1100 B.P. (Tx-759). No reason to believe there was no deposition during this 1100 yr interval. If old-shell correction is applied to age of this spit, as in 2), above, marl formation follows spit formation within ca. 200 yr.

C. Florida

Reef tract sand series, Florida keys

Carbonate sand (abraded fossil debris and mud pellets) from reef tract near Plantation and Upper Matecumbe Keys, Florida. Dated to study age of sands of outer Florida reef tract relative to age of sands near Florida Keys which show less evidence of early diagenesis. Coll. 1966 by P. Braithwaite; subm. by B. W. Boyer, Dept. of Geol. Sci., Univ. of Texas, Austin.

2260 ± 70
Tx-834. Plantation Key, 571 **310 B.C.**

From surface of sediment; water depth ca. 6.1 m; 2.9 mi SE of Plantation Point, Plantation Key (24° 55′ N Lat, 80° 33′ W Long).

1890 ± 100
Tx-836. Plantation Key, 567 **A.D. 60**

From top 2.5 cm of sediment; water depth ca. 4.6 m; 1.8 mi SE of Plantation Point, Plantation Key (24° 56′ N Lat, 80° 33′ W Long).

1610 ± 90
Tx-835. Upper Matecumbe, 514 **A.D. 340**

From surface of sediment; water depth ca. 4.0 m; 1.3 mi SE of Islamorada, Upper Matecumbe Key (24° 55′ N Lat, 80° 36′ W Long). *General Comment* (B.W.B.): dates suggest back reef sands become older farther offshore from keys. Dates do not seem consistent with hypothesis that lithified pellets and diagenetically altered skeletal debris, which form large percentage of some samples, are relict Pleistocene material.

III. GEOLOGIC SAMPLES

FM 1144 caliche series, South Texas

Calcite caliche samples from cuts in top of hill on Farm Rd. 1144, 6 mi W of Karnes City, Texas (28° 52′ 31″ N Lat, 97° 59′ 00″ W Long). Present soils are silty clay loams of subhumid climate, developing from caliche, relict soil material formed under arid conditions from soft silty Catahoula Tuff bedrock. Caliche is of 2 types: firm massive caliche capping a rounded hill, and soil-joint fillings and horizontal tributary veins in bedrock slightly downhill. Coll. 1967 by Eargle, Ingerson, and Valastro; subm. by D. H. Eargle, Uranium Sec., Branch of Rocky Mt. Mineral Resources, U.S. Geol. Survey, Austin, Texas.

19,730 ± 430
Tx-461. FM 1144, A: vein caliche **17,780 B.C.**

Vein caliche, .6 to .9 m below surface.

16,350 ± 280
Tx-462. FM 1144, B: caliche matrix **14,400 B.C.**

Caliche matrix .6 to .9 m below surface.

13,750 ± 230
Tx-634. FM 1144, #1: vein caliche **11,800 B.C.**

Vein, .9 to 1.1 m below surface.

17,870 ± 350
Tx-635. FM 1144, #2: caliche matrix **15,920 B.C.**

Massive caliche 1.1 m below surface, ca. 30.5 m from Tx-634.

18,190 ± 340
Tx-636. FM 1144, #3: caliche matrix **16,240 B.C.**

Massive caliche 1.1 m below surface, ca. 35 m from Tx-634.

20,310 ± 430
Tx-637. FM 1144, #4: joint filling **18,360 B.C.**

Joint filling .9 to 1.1 m below surface, near Tx-634.

16,920 ± 310
Tx-638. FM 1144, #5: vein caliche **14,970 B.C.**

Vein, .9 to 1.1 m below surface, same place as Tx-634.

General Comment (D.H.E.): relative uniformity of dates from massive caliche matrix reflects its uniform structure and impervious nature. Greater variation in dates from veins and joint fillings indicates variable admixtures of $CaCO_3$ derived from calcareous bedrock. Dates refer to time of very dry climate of late Wisconsin, indicated by geologic evidence in SW U.S. and N Mexico.

Lacustrine Samples, West Texas and Chihuahua

Samples coll. and subm. by C. C. Reeves, Jr., Dept. of Geosciences, Texas Tech Univ., Lubbock; comments by C.C.R., Jr.

32,550 ± 1600
Tx-639. Blackwater Draw HAL-1 **30,600 B.C.**

Carbonate rock from W side Blackwater Draw ca. 10 mi N of Amherst, Lamb Co., Texas (35° 10′ N Lat, 102° 25′ W Long), about halfway up from bottom of draw. Assoc. with ponding of Blackwater Draw. Coll. 1968. *Comment*: shows ponding during Terry Subpluvial and desiccation during Rich Lake Interpluvial.

25,460 ± 860
Tx-689. Mound Lake, W **23,510 B.C.**

Lacustrine carbonate (dolomite) from deep erosional cut, W side playa of Mound Lake, Terry Co., Texas (33° 14′ N Lat, 102° 05′ W Long), immediately S of Cities Service brine pit. Dolomite is overlain by Tahoka clay, underlain by Rich Lake clay. See also Tx-270-273 (Radiocarbon, 1966, v. 8, p. 459), Tx-327 and 328 (*ibid.*, 1968, v. 10, p. 387), Tx-549-552 (*ibid.*, 1970, v. 12, p. 252). Coll. 1968. *Comment*: fixes maximum age for Tahoka Pluvial; dates Rich Lake dolomite.

16,810 ± 820
Tx-749. Rich Lake, Texas **14,860 B.C.**

Shells from erosional cut at N end of Rich Lake, 7 mi NE of Brownfield, Terry Co., Texas (33° 18′ N Lat, 102° 12′ W Long). Apparently in Tahoka Clay sec. Coll. 1968. *Comment*: dates age of enclosing clay.

Tx-750. Loop 289-1 basin **15,640 ± 1730**
13,690 B.C.

Shells from clay zone near top of lacustrine sec., E side of Loop 289 basin, SW side of Lubbock, Texas (33° 35′ N Lat, 101° 58′ W Long). From lacustrine clay with mammoth bones. Coll. 1968. *Comment*: dates time of last filling of this type of basin.

Tx-640. Lake Palomas, Chihuahua, B **>37,000**

Carbonate rock from middle terrace of pluvial lake in Lake Palomas Basin, Chihuahua, Mexico, at La Mota Point (31° 20′ N Lat, 107° 30′ W Long). Terrace is Pleistocene, expected age: <10,000 yr old. Coll. 1967. *Comment*: carbonate is spring deposit over Pleistocene shore, source of carbonate being Paleozoic strata to the W. Cf. Tx-464, 27,150 ± 1060 (Radiocarbon, 1968, v. 10, p. 389) from high La Mota shoreline in same lake basin.

IV. PALEOBOTANICAL SAMPLES

Boriack Peat Bog series

Peat samples from 2 cores in Boriack Peat Bog, 6.7 mi SW of Lexington, Lee Co., central Texas, on N bank of Owens Branch, a tributary of Yegua Creek (30° 21′ 48″ N Lat, 97° 05′ 92″ W Long). Coll. 1969 by Bryant and Valastro; subm. by V. M. Bryant, Jr., Dept. Botany, Univ. of Texas, Austin.

Tx-837. Boriack Core I, 40 to 50 cm **3700 ± 90**
1750 B.C.

Tx-838. Boriack Core I, 240 to 250 cm **9850 ± 160**
7900 B.C.

Tx-839. Boriack Core I, 440 to 450 cm **13,810 ± 210**
11,860 B.C.

Tx-840. Boriack Core I, 500 to 527 cm **15,460 ± 250**
13,510 B.C.

Tx-841. Boriack Core II, 40 to 50 cm **3850 ± 80**
1900 B.C.

Tx-842. Boriack Core II, 240 to 250 cm **10,010 ± 160**
8060 B.C.

Tx-843. Boriack Core II, 440 to 450 cm **14,410 ± 220**
12,460 B.C.

General Comment (V.M.B.): dates indicate following vegetational sequence for central Texas: before 14,000 B.P., temperate deciduous woodland with some conifers; 14,000 to 10,000 B.P., transition to parkland; after 10,000 B.P., loss of parkland elements, replacement by oak savannas; 7000 to 4500 B.P., hot and/or dry altithermal conditions; 4500 B.P. to present, increasing aridity. This record and that of Hershop Bog ca. 70 mi SSW of Boriack (Tx-837-843, this list) indicate trend toward less mesic conditions in central Texas during the past 10,000 yr.

V. ARCHAEOLOGIC SAMPLES

A. George C. Davis site, East Texas

Charcoal samples from George C. Davis site (41CE19), E side Neches R. valley 6 mi SW of Alto, Cherokee Co., Texas (31° 35′ N Lat, 95° 10′ W Long). Site is a mound and village site of Alto focus, early Caddoan; stylistic cross-dating suggests it may be earliest Caddo site known. Major excavations in 1939-41 (Newell and Krieger, 1949) limited to small portion of site (Mound A and vicinity), was source of previous dated samples, all from same house: C-153, 1553 ± 175 (Libby, 1955, p. 108); M-1186, 655 ± 75 (Radiocarbon, v. 5, 1963, p. 241); Tx-105, 1120 ± 90 (Radiocarbon, v. 6, 1964, p. 155). Present samples are from different portion of site (Mounds B and C and vicinity) but ceramics indicate same cultural affiliation. Coll. 1968-69 and subm. by D. A. Story, Dept. Anthropol., Univ. of Texas, Austin; comments by D.A.S. except as noted. In titles, "F" stands for "Feature."

Geo. Davis site, Feature 120 series

Feature 120 is small circular structure overlain by washed fill of Mound B; thought to be earliest structure excavated thus far under Mound B.

790 ± 70
Tx-914A. Geo. Davis 52, F120, corn **A.D. 1160**

1060 ± 60
Tx-914B. Geo. Davis 52, F120, wood **A.D. 890**

Tx-914 sample was from fill of Post Mold 2. Sorted under low magnification; Tx-114A believed to be mostly or entirely corn, Tx-914B wood. *Comment* (S.V., Jr.): discrepancy about as expected; our experience is that corn produces dates ca. 300 yr too recent.

1150 ± 70
Tx-925. Geo. Davis 69, F120 **A.D. 800**

Combined sample from fill of Post Molds 1 through 6.

General Comment: Tx-914B and Tx-925 in good agreement; house probably dates in 9th century. A.D.

Geo. Davis site, Feature 115 series

Feature 115 is subrectangular structure overlain by Mound B fill and washed Mound B fill.

1150 ± 70
Tx-920. Geo. Davis 60, F115, subfloor **A.D. 800**

Scattered charcoal from midden-stained soil underlying prepared floor.

1020 ± 100
Tx-923. Geo. Davis 67-71, F115 **A.D. 930**

From fill of Post Molds 1 and 2.

General Comment: dates agree within 1σ; house probably dates in 9th or 10th century A.D. Midden, as expected, dates slightly earlier.

Geo. Davis site, Feature 108 series

Feature 108 is a subrectangular structure overlain by washed fill of Mound B.

900 ± 70
Tx-916. Geo. Davis 55, F108 **A.D. 1050**

Scattered charcoal from thin midden overlying prepared floor.

830 ± 70
Tx-915. Geo. Davis 54, F108 **A.D. 1120**

Scattered charcoal from midden just outside Feature 108 and same elevation as Tx-916.

General Comment on Tx-916, Tx-915: good agreement between samples; house probably dates in latter part of 11th century A.D.

Geo. Davis site, Feature 111 series

Feature 111 is large circular structure (probably ceremonial) underlying fill of Mound B.

870 ± 160
Tx-911. Geo. Davis 49, F111 **A.D. 1080**

From fill of Post Mold 20.

870 ± 70
Tx-912. Geo. Davis 50, F111 **A.D. 1080**

Charred horizontal beam in depression along exterior wall.

810 ± 70
Tx-918. Geo. Davis 57, F111 **A.D. 1140**

Charred horizontal beam in depression along exterior wall between Posts 17 and 21.

980 ± 70
Tx-917. Geo. Davis 56, F111 **A.D. 970**

From fill of several small wall posts in depression along exterior wall.

850 ± 100
Tx-905. Geo. Davis 28, F111, overburden **A.D. 1100**

Scattered charcoal from midden overlying prepared floor.

950 ± 70
Tx-921. Geo. Davis 65, F111, overburden **A.D. 1000**

Scattered charcoal from midden overlying prepared floor.

General Comment: dates in good agreement; house probably dates between A.D. 950 and A.D. 1100.

Geo. Davis site, Feature 112 series

Feature 112 is circular structure underlying Mound B fill; believed contemporary with other sub-Mound B structures except Feature 120.

1310 ± 80
Tx-919. Geo. Davis 58, F112 **A.D. 640**
From fill of Post Mold 10.

940 ± 70
Tx-924. Geo. Davis 68, F112 **A.D. 1010**
Combined sample from fill of Post Molds 1 through 11.

830 ± 70
Tx-910. Geo. Davis 37, F112 **A.D. 1120**
From fill in probable post trench (Feature 114).

General Comment: Tx-924 and Tx-910 agree within 1σ; house probably dates between A.D. 950 and 1150. Tx-919 anomalous, presumably not relevant; no explanation for discrepancy.

Geo. Davis site, sub-Mound B midden series

Samples from cultural zone just below Mound B and washed Mound B fill.

1420 ± 100
Tx-674. Geo. Davis 4, sub-Mound B **A.D. 530**
From below Feature 108, Excav. Unit 3A, elev. 99.26 to 99.06 m.

1010 ± 80
Tx-675. Geo. Davis 10, sub-Mound B **A.D. 940**
Excav. Unit 3C, 99.36 to 99.16 m.

1120 ± 80
Tx-676. Geo. Davis 11, sub-Mound B **A.D. 830**
Excav. Unit 3B, 99.17 to 99.06 m.

1070 ± 70
Tx-677. Geo. Davis 12, sub-Mound B **A.D. 880**

General Comment: except for Tx-674, dates form good stratigraphic series. Tx-674 seems early, but lower part of sub-Mound B midden poorly sampled.

1430 ± 160
Tx-678. Geo. Davis 22, Excav. Unit 4 **A.D. 520**

From lower part of occupation zone in village remains S of Mound B. Large error quoted due to small sample size. *Comment*: date early, cannot be unequivocally taken as true age unless other similar dates are obtained. Assoc. ceramics are Alto focus.

1150 ± 80
Tx-913. Geo. Davis 51, Feature 119 **A.D. 800**

Scattered charcoal from introduced layer of greenish sand at bottom of shaft burial with elaborate offerings, Feature 119, in Mound C; thought to be earlier than Mound B. Assoc. of charcoal with burial not certain, but lack of other midden debris suggests charcoal was deliberate inclusion. *Comment*: if date does apply to burial, burial dates well before Mound B.

Geo. Davis site, Feature 110 series

Feature 110 is scattered series of post molds in Excavation Unit 6, representing at least one structure, near edge of terrace S of Mound B. Samples are from just below plow zone.

Tx-906A. Geo. Davis 29, F110, corn **710 ± 70**
A.D. 1240

Tx-906B. Geo. Davis 29, F110, wood **1130 ± 160**
A.D. 820

Tx-906 was from fill in lower part of Post Mold 1. Sorted under low magnification into corn sample and wood sample. *Comment* (S.V., Jr.): discrepancy between corn and wood is somewhat larger than expected from our experience. Tx-906B should be proper radiocarbon age of sample; large error due to small sample size.

Tx-926. Geo. Davis 70, F110 **1000 ± 60**
A.D. 950

From fill in lower part of Post Mold 1; should be same age as Tx-906B.

Tx-907. Geo. Davis 30, F110 **960 ± 70**
A.D. 990

From fill in lower part of Post Mold 2.

Tx-922. Geo. Davis 66, F110 **1070 ± 70**
A.D. 880

From fill in lower part of Post Mold 2. Sample was split and 2 parts prepared and counted separately: 1000 ± 70, 1140 ± 100.

Tx-908. Geo. Davis 31, F110 **1230 ± 100**
A.D. 720

From fill in lower part of Post Molds 7 and 17.

Tx-909. Geo. Davis 32, F110 **1170 ± 120**
A.D. 780

From fill in lower part of Post Mold 17.

General Comment: principal overlap of 1σ ranges is between A.D. 700 and 1000; dates suggest more than one structure is represented.

General Comment on Davis site dates: long span of occupation indicated. Village remains underlying Mound B and at terrace edge S of Mound B appear to date between A.D. 700 and 1200, with Mound B construction beginning ca. A.D. 1200. Features 108, 111, and 112 immediately under Mound B were probably constructed between A.D. 1000 and 1200. Feature 115 is slightly older, and Feature 120 is at least 100 or 200 yr earlier. Earliest sub-Mound B date, Tx-674, is from midden debris not assoc. with a structure and is out of stratigraphic sequence.

B. Other Texas sites

Tx-666. Tuck Carpenter site, Texas **360 ± 70**
A.D. 1590

Charred logs from Burial 10, Tuck Carpenter site (41CP5), 3 mi E of Pittsburg, Camp Co., NE Texas (32° 59′ 41″ N Lat, 94° 54′ 53″

W Long). Site is a Titus focus (late prehistoric Caddoan) cemetery. Pottery styles suggest 2 time periods; if so, Burial 10 is of the later period. Sample was from near feet of individual. Coll. 1963 by R. L. Turner, Jr.; subm. by E. M. Davis. *Comment* (E.M.D.): 1st date from a classic Titus focus site; agrees with estimates of age (A.D. 1500-1700) from Whelan complex (early Titus focus): Tx-83, Tx-84 (Radiocarbon, 1964, v. 6, p. 156); Tx-199, Tx-202 (*ibid.*, 1965, v. 7, p. 309-310); Tx-238 through Tx-241 (*ibid.*, 1966, v. 8, p. 461-462). Time spans of complexes may be too small to distinguish on basis of C^{14} assays.

Sam Kaufman series, Northeastern Texas

Charcoal samples from House 3, Sam Kaufman site (X41RR1), right bank of Red R. 5.2 mi NW of State Hwy 37 bridge, in Red River Co., Texas (33° 54′ N Lat, 95° 07′ W Long). Assigned to Sanders focus, Gibson aspect Caddoan (Skinner *et al.*, 1969). Coll. 1968 and subm. by S. A. Skinner and R. K. Harris, Dept. Anthropol., Southern Methodist Univ., Dallas, Texas.

870 ± 70
Tx-882. Sam Kaufman 43 **A.D. 1080**

1000 ± 70
Tx-883. Sam Kaufman 44 **A.D. 950**

910 ± 70
Tx-884. Sam Kaufman 64 **A.D. 1040**

900 ± 70
Tx-885. Sam Kaufman 65 **A.D. 1050**

General Comment (S.A.S. and R.K.H.): dates indicate house was occupied in 11th century A.D., which is consistent with archaeologic evidence.

Price Daniel series, Southeastern Texas

Human bone fragments from Price Daniel site (41LB3), E side Trinity R. flood plain, 2 mi N of Liberty, Texas (30° 05′ 30″ N Lat, 90° 47′ 30″ W Long). In immediate vicinity of bones were sandy-paste potsherds, fired clay lumps, 2 probable Neo-American arrowpoints, one partial dart point. Subm. by C. D. Tunnell and J. M. Malone, State Archaeologist's office, Austin, Texas. Dating was done on carbonate in bone apatite, following Haynes (1968).

4080 ± 430
Tx-887. Price Daniel 29-30 **2130 B.C.**

From Test 1, Levels 1 and 2. Coll. 1967 by Jensen and Tunnell.

4500 ± 160
Tx-896. Price Daniel 2 **2550 B.C.**

From Area 1, Levels 3 and 4. Same excavation area as Tx-887 (above) and almost certainly same burial. Coll. 1969 by J. M. Malone. *General Comment* (J.M.M., E.M.D., S.V., Jr.): from what little is now known, pottery first appears after A.D. 1 in this region (Ambler, 1967, p.

78-79); thus these dates are at least 2000 yr older than expected. No burial pit visible, so that primary assoc. of bones with potsherds now seems questionable.

Spanish Moss series, Southeastern Texas

Rangia shell samples from near E edge of cut on N face of Spanish Moss site (41GV10), shell midden on S side Clear Lake ca. 3000 ft W of mouth of Robinson's Creek at SW edge of Houston, Texas (29° 32′ N Lat, 95° 06′ W Long). Site has sandy paste pottery of general Goose Creek type, also some sherd-tempered pottery. Coll. 1968 by T. R. Hester and J. E. Corbin; subm. by E. M. Davis.

740 ± 70
Tx-690. Spanish Moss, upper **A.D. 1210**

From near surface of midden. Sandy-paste pottery and some sherd-tempered pottery.

2450 ± 70
Tx-691. Spanish Moss, lower **500 B.C.**

From bottom of midden. Sandy-paste pottery; no sherd-tempered pottery.

General Comment (T.R.H., J.E.C.): dated sample pairs of charcoal and *Rangia* from nearby Wallisville Reservoir (Radiocarbon, 1970, v. 12, p. 263) indicate *Rangia* gives ages 200-300 yr older than charcoal in this environment, although sometimes disparity is less. Two Wallisville charcoal dates (Tx-400, 1990 ± 90; Tx-401, 1780 ± 100; *ibid.*, p. 265) indicate earliest pottery there is ca. A.D. 100. Present date Tx-691 suggests pottery appeared in this area a few centuries earlier.

Kyle site, Series 2: snail shells

Snail shells from Kyle rock shelter (41HI1), E edge of Brazos R. valley SE of Blum, Hill Co., Texas (32° 02′ N Lat, 97° 25′ W Long). Site was stratified; Austin focus lower, Foyah focus higher (Jelks, 1962). For previous dates from site see Radiocarbon, 1964, v. 6, p. 149. Present series dates by M. A. Tamers and F. J. Pearson, Jr., 1963-64 at this lab, but not reported until now; dated to study validity of C^{14} dates on terrestrial snail shells (Tamers, 1970). Coll. 1959-60 and subm. by E. B. Jelks, Texas Archaeol. Salvage Project, Univ. of Texas, Austin.

1140 ± 130
Tx-742. Kyle 71, shell **A.D. 810**

Stratum 5; late to middle Toyah focus.

1980 ± 80
Tx-743. Kyle 104, shell **30 B.C.**

Stratum 4; Austin-Toyah focus transition.

1350 ± 110
Tx-744. Kyle 163, shell **A.D. 600**

Upper Stratum 1; middle Austin focus.

1680 ± 140
Tx-745. Kyle 147, shell **A.D. 270**

Middle Stratum 1; early Austin focus.

1550 ± 140
Tx-746. Kyle 159, shell **A.D. 400**

Lower Stratum 1; very early Austin focus.

General Comment (E.M.D.): dates are unrealistically old (except perhaps Tx-746) but in varying amounts. Significance of variation is discussed by Tamers (1970).

Smith Shelter, Series 3: snail shells

Snail shell samples from Smith rock shelter (41TV42) on Onion Creek S of Austin, Texas (30° 12′ N Lat, 97° 43′ W Long). Site is stratified, with 11 layers; deepest is Transitional Archaic, most recent is Toyah focus (Suhm, 1957). Present series dated by M. A. Tamers and F. J. Pearson, Jr., 1963-64 at this lab, but not reported until now; dated to study validity of C^{14} dates on terrestrial snail shells (Tamers, 1970). Coll. 1954-55 and subm. by D. A. Story, Dept. Anthropol., Univ. of Texas, Austin.

1390 ± 150
Tx-736. Smith 2, shell **A.D. 560**

Sq. N1-N2; B-C; 0 to 15 cm below surface; mixed layers X and XI, Toyah focus with some European materials.

1150 ± 110
Tx-737. Smith 33, shell **A.D. 800**

Sq. 0-N1; C-D; 106 to 122 cm below surface, mixed layers III and IV, Austin focus.

1400 ± 80
Tx-738. Smith 36, shell **A.D. 550**

Sq. 0-S1; D-E; 229 to 244 cm below surface. Layer I, Transitional Archaic.

1730 ± 70
Tx-739. Smith 19, shell **A.D. 220**

Sq. 0-S1; D-C; 152 to 168 cm below surface. Layer II; little cultural material but should be either Transitional Archaic or early Austin focus.

1260 ± 70
Tx-740. Smith B, shell **A.D. 690**

Sq. S1-S2; C-D; 91 to 106 cm below surface. Layer II, Austin focus.

1090 ± 90
Tx-741. Smith C, shell **A.D. 860**

Sq. S1-S2; C-D; 46 to 61 cm below surface. Layer IX, Austin focus.

General Comment (D.A.S.): these and other shell dates from site (Radiocarbon, 1970, v. 12, p. 271) are so inconsistent with stratigraphic sequence and with charcoal dates (*ibid.*, 1964, v. 6, p. 145-146) that they are of no archaeologic significance.

Loeve series, Laneport Reservoir

Charcoal samples from Loeve site (41WM133), 3.9 mi SE of Granger, Williamson Co., Texas, on left bank of San Gabriel R. (30° 39′ N Lat, 97° 24′ W Long). Site, buried in flood plain deposit, represents early part of local sequence—short-term camps immediately beside river channel. Samples are from Unit II, clay, and underlying Unit III, basal gravels. No cultural assocs. except for hearths and flint flakes. Coll. 1968 and subm. by F. W. Eddy, Texas Archaeol. Salvage Project, Balcones Research Center, Univ. of Texas, Austin.

7000 ± 160
Tx-802. Loeve 37 **5050 B.C.**

From Fire Hearth 3 in Unit II, just above contact with Unit III. Sample was divided and 2 parts prepared and counted separately: 6810 ± 160 and 7190 ± 80.

6900 ± 110
Tx-805. Loeve 30 **4950 B.C.**

From Fire Hearth 2 in Unit III.

General Comment (F.W.E.): site evidently in use ca. 5000 B.C., thus during local Archaic stage.

Dobias-Vitek series, Laneport Reservoir

Charcoal samples from Dobias-Vitek site (41WM118), 4.2 mi SE of Granger, Texas, on left side San Gabriel R. (30° 30′ N Lat, 97° 00′ W Long). Site, in Catalpa soil in top of Recent-age flood-plain deposit, represents later part of local sequence—seasonal camps located back from main drainage. Neo-American and Transitional Archaic artifacts found throughout 3.8 ft thick alluvial soil. Coll. 1968-1969 and subm. by F. W. Eddy.

1350 ± 70
Tx-804. Dobias-Vitek 6 **A.D. 600**

From Fire Hearth 1, Test Pit 1, 0.2 m below surface of plowed field. Four sand-tempered sherds found in same dug level as hearth. Should date end of Transitional Archaic stage.

770 ± 70
Tx-806. Dobias-Vitek 57 **A.D. 1180**

From Fire Hearth 3, Test Pit 4, 0.3 to 0.6 m below undisturbed surface. Perdiz arrowpoint and bone-tempered potsherd immediately overlay hearth. Should date middle of Neo-American stage at site.

General Comment (F.W.E.): dates not inconsistent with archaeologic chronology as now known. More such dates will help us understand relationship between local fluvial history and cultural events.

700 ± 160
Tx-688. Agarita site, Texas **A.D. 1250**

Charcoal from Feature 4, Unit 16, Area B, Agarita site (41CK30), at confluence of Salt Creek and Colorado R., 6.8 mi W of Robert Lee, Coke Co., Texas, in Robert Lee Reservoir basin (31° 55′ N Lat, 100°

37′ W Long). Site has 2 living surfaces, both with Neo-American components; sample is from more recent surface, which had side-notched and unnotched arrowpoints. Combination of point forms suggests earlier time than ca. A.D. 1500 ascribed to sites 100 mi N of here with side-notched points and Rio Grande Glaze V pottery (Parson, 1967). *Comment* (H.J.S.): date supports archaeologic estimate.

190 ± 80
Tx-679. Pavo site, Texas **A.D. 1760**

Charcoal assoc. with ash pit, Feature 5, at Pavo site (41CK129) on low bluff at N edge of Colorado R. flood plain, 6 mi NW of Robert Lee, Coke Co., Texas, in Robert Lee Reservoir basin (31° 50′ N Lat, 100° 30′ W Long). Assoc. with "cloud blower" pipe, presumably of SW origin. Coll. 1968 and subm. by H. J. Shafer. *Comment* (H.J.S.): date agrees well with Kidder's (1932, p. 169-182) dating of similar pipes at Pecos, A.D. 1500 to 1838.

La Jita series, Texas

Charcoal samples from La Jita site (41UV21), E side Sabinal R., in La Jita Girl Scout Camp, 3 mi S of Utopia in extreme NE corner of Uvalde Co., Texas (29° 34′ N Lat, 99° 31′ W Long). Site is 3 burned rock middens and cultural debris in surrounding terrace fill. Principal occupation Middle Archaic (Montell and especially Pedernales dart points); below is Early Archaic with corner-notched (Martindale-like) dart points; above is Late Archaic (Ensor, Frio dart points) and Neo-American (Edwards, Scallorn, Perdiz arrow points) with pottery. Coll. 1967 and subm. by T. R. Hester, Dept. Anthropol., Univ. of Texas, Austin, via E. M. Davis. Samples listed in presumed chronologic order, recent to older, based on type assocs.

660 ± 70
Tx-687. La Jita 49 **A.D. 1290**

N15/E35, Level 2. Neo-American: Scallorn and other side-notched arrow points; bipointed knife.

810 ± 50
Tx-684. La Jita 176 **A.D. 1140**

N25/E40, Level 3. Mixed Neo-American and Archaic: Sabinal arrow points (local type similar to Scallorn), Pedernales points triangular thinned biface. Sample split and 2 parts prepared and counted separately: 800 ± 60, 810 ± 90.

710 ± 70
Tx-664. La Jita 86 **A.D. 1240**

Test Pit 6, Level 1. Neo-American and Archaic: Perdiz, Ensor-like, Marshall-like points. From thin deposit near edge of site; occupations probably mixed.

910 ± 80
Tx-665. La Jita 29 **A.D. 1040**

N10/E40, Level 2. Mixed early Neo-American and Late Archaic: Montell, Edwards, arrow point fragments.

990 ± 60
Tx-681. La Jita 137 **A.D. 960**

N15/E35, Level 3. Mixed early Neo-American and Late Archaic. Frio dart points, Edwards points and arrow point fragments.

1100 ± 70
Tx-685. La Jita 72 **A.D. 850**

N20/W50, Level 3. Mixed early Neo-American and Late Archaic: Edwards and Pedernales types.

1460 ± 80
Tx-686. La Jita 147 **A.D. 490**

N60/E40, Level 2. Late Middle Archaic: Frio point.

1850 ± 180
Tx-692. La Jita 32 **A.D. 100**

N10/E40, Level 4. Late Archaic or Late Middle Archaic: Montell, Pedernales, Marshall-like point.

920 ± 70
Tx-682. La Jita 55 **A.D. 1030**

N15/E35, Level 4. Middle Archaic: Pedernales points.

650 ± 50
Tx-683. La Jita 160 **A.D.1300**

N20/E35, Level 2. Middle Archaic: Pedernales point and other dart point fragments. Sample split; 2 parts prepared and counted separately: 600 ± 80, 690 ± 70.

General Comments (T.R.H.): these are 1st dates from SW edge of Edwards Plateau. In general, Neo-American occupations agree in age with those of central Texas (Jelks, 1962, p. 98) though Scallorn points may have lasted much longer here. Edwards seems to be earliest arrow point type, dating from 10th century; Sabinal local type may appear later. Late Archaic dates indicate that period ended ca. A.D. 1000, much later than in either Amistad Reservoir to W or central Texas to NE. Dates on Montell specimens here are much later than those in Amistad Reservoir where they are from 2100 to 2800 B.P. (see comments with Tx-570; Radiocarbon, 1970, v. 12, p. 270). Best date for Pedernales type may be Tx-692; other much later dates, especially Tx-682 and Tx-683, were from rather mixed upper levels containing random Pedernales specimens. Dates of pottery at site not pin-pointed, but Tx-644 is most applicable. (E.M.D.): dates in general are so recent that one suspects some mixture of material.

Parker Midden #1 series, Texas

Charcoal samples assoc. with central slab-lined cooking pit at Parker Midden #1 (41CX30), ring midden on plateau at head of Simson Creek, 5 mi NE of Pecos R. near Iraan, in NW Crockett Co., Texas (31° 00′ N Lat, 101° 48′ W Long). Small unifacial scrapers directly assoc. with cooking pit. Ensor point was in burned rock area on S side of midden, presumably same age as cooking pit or later. Coll. 1968 by A. W. Sommer and J. W. Greer; subm. by E. M. Davis.

1160 ± 70
Tx-645. Parker Midden #1, 3 **A.D. 790**

40 to 50 cm below surface, Sqs. K, K-1-E, J, J-1-W.

1050 ± 70
Tx-646. Parker Midden #1, 4 **A.D. 900**

50 to 60 cm below surface, Sqs. K, K-1-E, K-1-W.

970 ± 70
Tx-647. Parker Midden #1, 5 **A.D. 980**

Sqs. K, K-1-E, K-1-W, J, J-1-E, J-1-W, in and adjacent to pit. *Comment* (E.M.D., J.W.G.): date of site appears to be between A.D. 800 and 1000; agrees with estimate by Greer (1968) of probable age of such features.

Arenosa Shelter, Series 3

Charcoal from Arenosa Shelter (41VV99), right bank of Pecos R., 1 mi upstream from confluence with Rio Grande (29° 42′ N Lat, 101° 22′ W Long). For previous series from this site see Radiocarbon, 1967, v. 9, p. 441-445, and 1970, v. 12, p. 268. Coll. 1968 and subm. by D. S. Dibble, Texas Archaeol. Salvage Project, Balcones Research Center, Univ. of Texas, Austin.

2230 ± 80
Tx-696. Arenosa 653, Stratum 9 **280 B.C.**

From matrix of upper 1/3 of Stratum 9; dates earlier part of Ensor and Frio point occurrence at site.

3220 ± 70
Tx-701. Arenosa 659, Stratum 21 **1270 B.C.**

From all levels of Stratum 21; point assocs. principally Langtry, Val Verde, and "Shumla-like" (large barbed form with some morphologic and stratigraphic differences from classic Shumla at this site).

4670 ± 70
Tx-773. Arenosa 655, Stratum 30L **2720 B.C.**

From lower 1/2 of Stratum 30L; earliest occurrence of Pandale points.
General Comment (D.S.D.): dates are close to expectations in terms of previous dates from site. This series and previous dates indicate relatively rapid accumulation of cultural debris and overbank alluvial deposits through late Early Archaic and Middle and Late Archaic periods.

C. Louisiana and New Mexico

3000 ± 90
Tx-680. Poverty Point, Louisiana **1050 B.C.**

Burned cane from shallow pit below midden exposed in caving W bank of Bayou Macon, N Sec., Ridge 2, Poverty Point site (41CW2;

Ford and Webb, 1956), ca. 7 mi E of Epps, W Carrol Parish, Louisiana (34° 38′ N Lat, 91° 24′ W Long). Represents early occupation by Poverty Point people in this part of site, before construction of geometric ridges. Coll. 1968 by M. Hillman; subm. by C. M. Webb, 1560 Line Ave., Shreveport, La. *Comment* (E.M.D.): date agrees within 1σ with M-403, 2850 ± 250 (Crane and Griffin, 1958); L-195, 2860 ± 90 (Broecker *et al.*, 1956); O-66, 3150 ± 120 (Brannon *et al.*, 1957); and is close to several others from site (Ford and Webb, 1956, p. 121-122). However, Webb (1968, p. 318) suggests site may have been established considerably before this time. Present sample is of cane, raising question of possible fractionation, which might make date erroneously young by as much as 2 centuries (Bender, 1968).

2930 ± 60
Tx-886. Yucca Cave, New Mexico **980 B.C.**

Wooden stick from crossed arrangement of sticks partly under large breakdown rock at Yucca Cave (Site C-27), large collapse sink in convex slope of Capitan Excarpment, ½ mi SW of mouth of Yucca Canyon, Carlsbad Caverns Natl. Monument, New Mexico (30° 05′ 44″ N Lat, 104° 35′ 27″ W Long). Sticks had been partly crushed by breakdown rock, on top of which is stalagmite 80 cm high and 15 cm average diam. No cultural assocs. Coll. 1969 by E. R. Anderson; subm. by P. F. van Cleave, Acting Supt., Carlsbad Caverns Natl. Monument, New Mexico. *Comment* (E.M.D.): date is maximum for fall of breakdown rock, and time of human use of cave.

D. Mexico

La Calsada series, Nuevo Leon

Charcoal samples from La Calsada site (NL103), overlooking Río Pilón valley, Ejido de Casillas, Municipio de Rayones, Nuevo Leon, Mexico (ca. 25° 00′ N Lat, 100° 05′ W Long). Site has 5 principal stratigraphic units: Unit 1-2 (highest) with arrow points and double-side-notched dart points; Unit 3 with earliest side-notched points, broad oval and triangular (Tortugas) dart points; Unit 4, stemmed dart points; Unit 5, Lerma and double-stemmed points; Unit 6, diamond-shaped and small leaf-shaped points. Each unit excavated in 10 cm levels numbered from top downward within unit. Samples coll. on screen. Coll. 1965 by C. R. Nance; subm. by Nance and J. F. Epstein, Dept. Anthropol., Univ. of Texas, Austin. Samples listed in order of increasing depth; in titles, "U" is unit, "L" is level.

580 ± 60
Tx-707. La Calsada C-5: U1-2, L2 **A.D. 1370**

1050 ± 80
Tx-706. La Calsada C-4: U1-2, L3 **A.D. 900**

4400 ± 90
Tx-709. La Calsada C-11: U3, L8 **2450 B.C.**

Tx-710. La Calsada C-12: U3, L9 — **5400 ± 100**
3450 B.C.

Tx-708. La Calsada C-10: U3, L9 — **4310 ± 90**
2360 B.C.

Tx-764. La Calsada C-18: U4, L3 — **4790 ± 90**
2840 B.C.

Tx-768. La Calsada C-20: U4, L2 — **5940 ± 160**
3990 B.C.

Tx-767. La Calsada C-19: U4, L4 — **6520 ± 150**
4570 B.C.

Tx-711. La Calsada C-13: U4, L1 — **5710 ± 120**
3760 B.C.

Tx-765. La Calsada C-14: U4, L2 — **4460 ± 120**
2510 B.C.

Tx-769. La Calsada C-24: U5, L2 — **7040 ± 180**
5090 B.C.

Tx-766. La Calsada C-23: U5, L2 — **7990 ± 130**
6040 B.C.

Tx-354. La Calsada C-3: U5, L2 — **7920 ± 190**
5970 B.C.

Tx-770. La Calsada C-27: U5, L5 — **9310 ± 160**
7360 B.C.

Tx-771. La Calsada C-28: U5, L7 — **8610 ± 100**
6660 B.C.

Tx-353. La Calsada C-2: U5, L7 — **9270 ± 150**
7320 B.C.

Tx-352. La Calsada C-1: U6, L2 — **9940 ± 150**
7990 B.C.

Tx-772. La Calsada C-30: U6, L2 — **9670 ± 70**
7720 B.C.

Tx-875. La Calsada C32-33: U6, L5 — **10,640 ± 210**
8690 B.C.

Tx-895. La Calsada C-43: U6, L12-13 — **9550 ± 130**
7600 B.C.

General Comment (C.R.N.): dates provide good series, although some mixing within units is evident, and Unit 3 and 4 dates overlap. Estimated times of units are: Unit 1-2, A.D. 900 to historic; Unit 3, 2500 B.C. to after 1200 B.C. (by comparison with Cueva de la Zona de Derrumbes where earliest Tortugas points are post-1200 B.C.; see Tx-147, Radiocarbon, 1965, v. 7, p. 312); Unit 4, 4000 B.C. to 2500 B.C.; Unit 5, 7500 B.C. to after 5000 B.C.; Unit 6, before 8700 B.C. to 7500 B.C.

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UNIVERSITY OF WISCONSIN RADIOCARBON DATES VIII

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Radiocarbon dates obtained since August 1969 are included in this report. The procedures followed and equipment used have been described previously (Radiocarbon, 1966, v. 8, p. 522-533).

The dates reported have been calculated using 5568 as the half-life of C^{14}, 1950 as the reference year. The standard deviation quoted is the 1σ limit based on the counting statistics of background, sample, and standard counts. Since C^{12}/C^{13} ratios of only a few samples were measured, the dates as listed are not corrected for fractionation. Corrections are, however, included in the text for those samples for which the ratios were obtained.

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Iowa

Jackson County, Iowa (13JK20)

Charcoal samples from Henry Schnoor Rock Shelter on Maquoketa R. in Jackson Co., Iowa (42° 10′ N Lat, 90° 48′ W Long) coll. 1969 by M. Jaehnig, Univ. of Wisconsin-Madison; subm. by D. A. Baerreis. Two earlier dates, WIS-344 and WIS-345 (Radiocarbon, 1970, v. 12, p. 335-345) were 170 (28 to 30 in. deep) and 970 A.D. (8 to 12 in. deep), respectively.

1140 ± 60
WIS-395. Jackson County, Iowa (13JK20) A.D. 810

Sample from Sq. N7B, Level 4, 14 to 16.5 in. deep.

1830 ± 55
WIS-396. Jackson County, Iowa (13JK20) A.D. 120

Sample from Sq. S4B, Level 4, 14 to 16 in. deep.

3680 ± 70
WIS-407. Jackson County, Iowa (13JK20) 1730 B.C.

Charcoal from Sq. S5A, Levels 26 to 29, 52 to 58 in. deep. Levels are 2.5 ft below culture-bearing horizons but are at beginning of snail fauna sequence to be used in micro-habitat reconstruction.

Robert Battey Rock Shelter site (13JK21)

Charcoal samples from midden accumulation beneath overhang of rock shelter in town of South Fork, Jackson Co., Iowa (42° 07′ N Lat, 90° 47′ W Long). Coll. 1969, by M. Jaehnig; subm. by D. A. Baerreis.

WIS-400. Robert Battey Rock Shelter site (13JK21) **1400 ± 55 A.D. 550**

Sample from Sq. G1, 0 to 5 ft from shelter wall, Level 4, 12 to 16 in. deep.

WIS-399. Robert Battey Rock Shelter site (13JK21) **1470 ± 55 A.D. 480**

Sample from Sq. G1, Level 6, 20 to 24 in. deep.

WIS-401. Robert Battey Rock Shelter site (13JK21) **1360 ± 50 A.D. 590**

Sample from Sq. F2, 5 to 10 ft from shelter wall, Levels 4 and 5, 14 to 18 in. deep. Artifacts from levels indicate Late Woodland to Early Late Woodland occupation.

WIS-398. Robert Battey Rock Shelter site (13JK21) **7240 ± 80 5290 B.C.**

Sample from Sq. G3 and H3, 14 to 15 ft from shelter wall, Levels 11 and 12, 34 to 38 in. deep.

4730 ± 50
WIS-392. Rock Run Shelter series (13CD10) **2780 B.C.**

Charcoal from 64 to 72 in. depth of Rock Run Shelter site in Cedar Co., Iowa (41° 42′ N Lat, 91° 11′ W Long) coll. 1968 by R. Alex, State Univ. of Iowa; subm. by D. A. Baerreis. Other dates from this site were reported previously (Radiocarbon, 1969, v. 11, p. 229) and (Radiocarbon, 1970, v. 12, p. 335-345).

B. Illinois

Cahokia site, Mound 51

Uncharred bone of white-tailed deer (*Odocoileus virginianus vir.*) from 6 natural zones of aboriginal deposition in large refuse-filled pit below base of Mound 51 of Illinois Archaeol. Survey Site S-34-2 (38° 39′ 30″ N Lat, 90° 03′ 34″ W Long), St. Clair Co., Illinois. Coll. 1967 by C. J. Bareis; subm. by W. W. Chmurny, both Univ. of Illinois, Urbana-Champaign. The C^{12}/C^{13} ratios of these samples were measured with a precision of ± 0.2‰ and were calculated relative to the Chicago PDB standard. The radiocarbon dates are corrected in the text for C^{12}/C^{13} ratio deviations from the accepted average of −25‰ for wood (based on the PDB standard). *Comments* (C.J.B. and W.W.C.): close agreement of all dates except WIS-355 substantiates hypothesis that pit was filled within short time. Hypothesis is also supported by homogeneity of ceramic sample, absence of weathering between zones, and presence in all zones of faunal and plant remains of same, limited range of species. Omitting WIS-355, mean of other uncorrected dates, A.D. 1200, is 200 yr later than that expected for ceramic assemblage recovered from pit.

710 ± 45
WIS-350. Cahokia site, Mound 51 **A.D. 1240**

Specimen UI 106 from Zone E, Grid S50-53, E385-388, at depth

126.350 to 125.350 m above sea level. Corrected for δC^{13} of –22.4‰, date is 750 ± 50, A.D. 1200.

740 ± 55
WIS-351. Cahokia site, Mound 51 **A.D. 1210**

Specimen UI 107 from Zone F, Grid S50-53, E385-388, at depth 126.270 to 125.175 m above sea level. Corrected for δC^{13} of –22.0‰, date is 780 ± 60, A.D. 1170.

750 ± 60
WIS-352. Cahokia site, Mound 51 **A.D. 1200**

Specimen UI 123 from Zone H, Grid S51-52, E389-392, at depth 124.910 to 124.420 m above sea level. Date corrected for δC^{13} of –22.1‰ is 800 ± 65, A.D. 1150.

610 ± 55
WIS-355. Cahokia site, Mound 51 **A.D. 1340**

Specimen UI 122 from Zone G, Grid S50-53, E389-392, at depth 125.200 to 124.810 m above sea level. Date corrected for δC^{13} of –21.1‰ is 680 ± 60, A.D. 1270.

770 ± 45
WIS-356. Cahokia site, Mound 51 **A.D. 1180**

Specimen UI 116 from Zone D-1, Grid S50-53, E389-392, at depth 126.480 to 125.070 m above sea level. Date corrected for δC^{13} of –22.5‰ is 810 ± 50, A.D. 1140.

780 ± 55
WIS-360. Cahokia site, Mound 51 **A.D. 1170**

Sample from Zone D-2, Grid S47-50, E381-384, at depth 126.782 to 125.422 m above sea level, UI 135. Date corrected for δC^{13} of –22.8‰ is 815 ± 60, A.D. 1135.

Three samples of nut hulls of *Carya laciniosa* (Michx. f.) Loud., shellbark hickory, from pit beneath base of Mound 51 were also dated to check dates obtained from bone samples. Coll. 1967 by C. J. Bareis; subm. by W. W. Chmurny. The C^{12}/C^{13} ratios of these samples were measured; dates corrected for C^{12}/C^{13} deviations from –25‰ are included in the text.

940 ± 45
WIS-389. Cahokia site, Mound 51 **A.D. 1010**

Specimen UI 123F from Zone H, Grid S51-52, E389-392, 124.910 to 124.420 m above mean sea level. Date corrected for δC^{13} of –27.2‰ is 900 ± 50, A.D. 1050.

920 ± 50
WIS-390. Cahokia site, Mound 51 **A.D. 1050**

Specimen UI 122F from Zone G, Grid S50-53, E389-392, 125.200 to 124.810 m above mean sea level. Corrected for δC^{13} of –27.1‰ date is 890 ± 55, A.D. 1060.

WIS-391. Cahokia site, Mound 51 **880 ± 60**
A.D. 1070

Specimen UI 135F, from Zone D2, Grid S47-50, E381-384, 126.782 to 125.422 m above mean sea level. Date corrected for δC^{13} of −27.3‰ is 850 ± 65, A.D. 1100.

II. GEOLOGIC SAMPLES

WIS-388. Rock County, Wisconsin **12,680 ± 120**
10,730 B.C.

Spruce at base of 7.5 ft marsh deposits overlying sand. Dates initial vegetation after glaciation. Coll. 1968 in Rock C., Wisconsin (42° 50′ N Lat, 89° 00′ W Long) by J. H. Elliott; subm. by R. F. Black, Univ. of Wisconsin-Madison.

Lunkaransar Salt Lake, Rajasthan, India

Fine, disseminated carbon concentrated from lacustrine silty clay from pit in bed of Lunkaransar Salt Lake, Dist. Bikaner, Rajasthan, India (28° 50′ N Lat, 73° 80′ E Long). Coll. 1968 by Gurdip Singh, Birbal Sahni Inst. of Palaeobot., Lucknow, India; subm. by R. A. Bryson. Samples are related to pollen chronology of Rajasthan lake deposits (Singh, 1968) and history of Rajasthan Desert.

WIS-387. Lunkaransar Salt Lake **5060 ± 70**
3110 B.C.

Sample (B.S.I.P. 1023A/RC-14) from 120 to 130 cm depth. Level marks top of lower Cerealia pollen zone.

WIS-386. Lunkaransar Salt Lake **5420 ± 70**
3470 B.C.

Sample (B.S.I.P. 1023A/RC-13) from 130 to 140 cm depth. Level is within lower zone of Cerealia pollen.

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* Inactive Laboratories.

[1] The H^3—Laboratorium of this institute (directed by Klaus Fröhlich) should be addressed separately.

[1a] Lists from this laboratory have not been submitted to RADIOCARBON. See Gdansk I, Acta Physica Polonica, vol. 22, p. 189, 1962; Gdansk II, ibid., vol. 32, p. 39, 1967.

[2] This designation Gif supersedes both Sa (Saclay) and Gsy (Gif-sur-Yvette). The only Gsy date list to be published is Gsy I (Coursaget and Le Run, RADIOCARBON, v. 8).

[3] From January 1, 1961 the Gro numbers have been replaced by GrN numbers. "New" dates are referred to the NBS oxalic-acid standard.

[4] Early dates from this laboratory were given a code designation that represents the name of the sponsoring institution, e.g. I ((AGS) for American Geographical Society (Heusser, RADIOCARBON SUPPLEMENT, v. 1).

[5] Formerly Hazelton Nuclear: code designation HNS has been dropped.

[6] Some dates from this laboratory were published with the code designation S (Pringle and others, 1957, Science, v. 125, p. 69-70).

[7] See SM.

[8] See Gif.

[9] Some dates from this laboratory have been published with the code designation RC (Flint and Gale, 1958, AM. JOUR. SCI., v. 256, p. 698-714). The code designation MP published in volume 1 of the RADIOCARBON SUPPLEMENT (1959, p. 216) has been changed to SM in conformity with the wishes of the laboratory, and is explained by the change of the company's name from Magnolia Petroleum Company to Socony Mobil Oil Company, Inc.

[10] Formerly Texas-Bio-Nuclear, then Kaman Instruments. The laboratory is no longer operating.

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