

Volume 8 - 1966

RADIOCARBON



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Editors

EDWARD S. DEEVEY — RICHARD FOSTER FLINT
IRVING ROUSE

Managing Editor

CHARLOTTE BERNEY

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YALE UNIVERSITY
NEW HAVEN, CONNECTICUT

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INSTRUCTIONS TO CONTRIBUTORS

Manuscripts of radiocarbon papers should follow the recommendations in *Suggestions to Authors*, 5th ed.* All copy must be typewritten in *double space* (including the bibliography); manuscripts must be submitted in *duplicate* by December 1, 1966.

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. or B.C. The standard error following the date should express, within limits of $\pm 1\sigma$, the laboratory's estimate of the accuracy of the radiocarbon measurement, as judged on *physicochemical* (not *geologic* or *archaeologic*) grounds.

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

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

4. Occurrence and stratigraphic position in precise terms.

5. Reference to relevant publications. Citations within a description should be to author and year, with specific pages wherever appropriate, except that references (e.g. to published date lists that are frequently repeated) may be simplified by use of a code (e.g. Groningen III) that is explained in the bibliography. 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 implicitly showing that the radiocarbon measurement was worth making, belongs here, as do technical matters, e.g. chemical pretreatment, special laboratory difficulties, etc.

Illustrations, in general, should be originals, but photographic reproductions of line drawings are sometimes acceptable, and should accompany the manuscript in any case, if the originals exceed 9 by 12 inches in size.

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

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

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CONTENTS

A	<i>C. Vance Haynes, Jr., Paul E. Damon, and Donald C. Grey</i>	
	Arizona Radiocarbon Dates VI	1
B	<i>H. Oeschger and T. Riesen</i>	Bern Radiocarbon Dates V 22
Bln	<i>G. Kohl and H. Quitta</i>	Berlin Radiocarbon Measurements II 27
FSU	<i>J. J. Stipp, G. A. Knauer, and H. G. Goodell</i>	
	Florida State University Radiocarbon Dates I	46
Gak	<i>Kunihiko Kigoshi and Hiromi Kobayashi</i>	
	Gakushuin Natural Radiocarbon Measurements V	54
Gif	<i>G. Delibrias, M. T. Guillier, and J. Labeyrie</i>	
	Gif Natural Radiocarbon Measurements II	74
GSC	<i>W. Dyck, J. A. Lowdon, J. G. Fyles, and W. Blake, Jr.</i>	
	Geological Survey of Canada Radiocarbon Dates V	96
Gsy	<i>J. Coursaget and J. Le Run</i>	
	Gif-Sur-Yvette Natural Radiocarbon Measurements I	128
Gx	<i>Harold W. Krueger and C. Francis Weeks</i>	
	Geochron Laboratories, Inc. Radiocarbon Measurements II	142
I	<i>Milton A. Trautman and Eric H. Willis</i>	
	Isotopes, Inc. Radiocarbon Measurements V	161
IVIC	<i>M. A. Tamers</i>	Instituto Venezolano de Investigaciones Cientificas
	Natural Radiocarbon Measurements II	204
K	<i>Henrik Tauber</i>	Copenhagen Radiocarbon Dates VII 213
KI	<i>H. Willkomm and H. Erlenkeuser</i>	
	University of Kiel Radiocarbon Measurements I	235
KN	<i>H. Schwabedissen and J. Freundlich</i>	
	Köln Radiocarbon Measurements I	239
Lv	<i>E. Gilot, N. Aucion, and P. C. Capron</i>	
	Louvain Natural Radiocarbon Measurements IV	248
M	<i>H. R. Crane and James B. Griffin</i>	
	University of Michigan Radiocarbon Dates XI	256
MC	<i>J. Thommeret and Y. Thommeret</i>	
	Monaco Radiocarbon Measurements II	286
Mo	<i>A. P. Vinogradov, A. I. Devirts, E. I. Dobkina, and N. G. Markova</i>	
	Radiocarbon Dating in the Vernadsky Institute I-IV	292
N	<i>Fumio Yamasaki, Tatsuji Hamada, and Chikako Fujiyama</i>	
	RIKEN Natural Radiocarbon Measurements II	324
NPL	<i>W. J. Callow, M. J. Baker, and Geraldine I. Hassall</i>	
	National Physical Laboratory Radiocarbon Measurements IV	340
P	<i>Robert Stuckenrath, Jr., William R. Coe, and Elizabeth K. Ralph</i>	
	University of Pennsylvania Radiocarbon Dates IX	348
PIC	<i>Sandra J. Kowalski and Ariel G. Schrodt</i>	
	Packard Instrument Company Radiocarbon Dates II	386
Q	<i>H. Godwin and V. R. Switsur</i>	
	Cambridge University Natural Radiocarbon Measurements VIII	390
R	<i>M. Alessio, F. Bella, B. Bachechi, and C. Cortesi</i>	
	University of Rome Carbon-14 Dates IV	401
SI	<i>Austin Long and James E. Mielke</i>	
	Smithsonian Institution Radiocarbon Measurements III	413
SR	<i>J. G. Sheppard and E. R. Swart</i>	
	Rhodesian Radiocarbon Measurements II	423
TA	<i>A. Liiva, E. Ilves, and J. M. Punning</i>	
	Tartu Radiocarbon Dates I	430
TF	<i>D. P. Agrawal and Sheela Kusumgar</i>	
	Tata Institute Radiocarbon Date List IV	442
Tx	<i>F. J. Pearson, Jr., E. Mott Davis, and M. A. Tamers</i>	
	University of Texas Radiocarbon Dates IV	453
UCLA	<i>Rainer Berger and W. F. Libby</i>	UCLA Radiocarbon Dates V 467
UW	<i>A. W. Fairhall, W. R. Schell, and J. A. Young</i>	
	Radiocarbon Dating at the University of Washington III	498
V	<i>Anne Bermingham</i>	Victoria Natural Radiocarbon Measurements I 507
WIS	<i>Margaret M. Bender, Reid A. Bryson, and David A. Baerreis</i>	
	University of Wisconsin Radiocarbon Dates II	522
	<i>Minze Stuiver and Hans E. Suess</i>	On the Relationship Between Radiocarbon
	Dates and True Sample Ages	534
List of Laboratories	541

EDITORIAL STATEMENT

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. Conversion of published dates to this basis is accomplished 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, such as Texas IV (this volume) 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 to " Δ as defined by Broecker and Olson (Lamont VIII)" is not sufficient to do this.

Comprehensive Index. This Index, covering all published C^{14} measurements through Volume 7 of *RADIOCARBON*, and incorporating revisions made by all laboratories, will be published in 1967. Its price has not been fixed, but will probably be between 3 and 5 dollars U.S. The Index will be sent to all subscribers to *RADIOCARBON*, together with the bill, unless our office is informed that a subscriber does not wish to purchase it.

Expanded publication. Volume 9, 1967, will be published as usual in June, including papers received by 1 December 1966. Volume 10 and subsequent volumes will be published in two semi-annual issues, in February and in June, with deadlines for manuscripts on 1 September and 1 January.

Radiocarbon

1966

ARIZONA RADIOCARBON DATES VI*

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INTRODUCTION

The C^{14} measurements reported here were made in this laboratory between November 1, 1963 and November 15, 1965. Sample descriptions are classified as follows:

- I. Geochemical Samples
- II. Geologic-Paleoclimatic Samples
- III. Early Man-Alluvial Stratigraphy Samples
- IV. Archaeologic Samples

The use of CO_2 and the treatment of samples remains the same as reported previously (Arizona IV and V). With some carbonate samples it has been found that they blacken upon pyrolysis and that a carbon slime can be recovered by acid decalcification. New electronic systems, including automatic printout and alpha-discrimination, have been incorporated in two of the three counter systems. The Libby half life of 5568 yr is still used in computing dates, and all statistical counting errors are reported as one sigma.

ACKNOWLEDGMENTS

The authors are indebted to B. Bannister and C. W. Ferguson of the University of Arizona Laboratory of Tree-Ring Research for their continued cooperation in supplying dendrochronologically-dated wood specimens. Gerald A. Cole, Life Science Center, Arizona State University, is studying the limnology of Montezuma Well and has cooperated with us in our study of samples from this locality. The National Park Service also cooperated in our study of Montezuma Well. A. Long has continued to cooperate in our study of the C^{14} content of dendrochronologically dated tree rings. The C^{12}/C^{13} measurements were made by A. Long. I. E. S. Edwards of the Department of Ancient Egyptian Antiquities, The British Museum, supplied samples from Buhen for a UCLA-Arizona interlaboratory check. Richard Bennett and Benjamin Smith assisted in laboratory analyses, and Sylva Gilmore assisted in manuscript preparation.

Financial support of the laboratory has been provided by the National Science Foundation Grant GP 2330 and a Research Corporation

* University of Arizona Geochronology Contribution No. 120.

unrestricted venture grant to Paul E. Damon; and by donations from the Amerind Foundation, Inc., Dragoon, Arizona; a National Geographic Society grant to J. O. Brew, Peabody Museum, Harvard University, Cambridge, Massachusetts; the Paleo-Indian Institute, Eastern New Mexico University, Portales; Anthropology Research Center, Southern Methodist University, Dallas, Texas.

SAMPLE DESCRIPTIONS

I. GEOCHEMICAL SAMPLES

Sequoia No. 3 series, California

Wood, tree rings, *Sequoia gigantea*, from Giant Forest, Sequoia Natl. Park (36° 35' N Lat, 118° 48' W Long). Coll. 1959 by H. N. Michael, Univ. of Pennsylvania; subm. by M. A. Stokes. *Comment*: tree began growth ca. 215 B.C. and was cut in A.D. 1950.

	$\delta C^{14}, \text{‰}$	$\delta C^{13}, \text{‰}$	$\Delta, \text{‰}$
A-540. A.D. 1500 to A.D. 1520	+21 ± 6	-21.8	+14 ± 6
A-541. A.D. 1040 to A.D. 1060	+13 ± 6	-21.9	+ 7 ± 6
A-542. A.D. 540 to A.D. 560	+13 ± 6	(-21.2)	+ 5 ± 6

Comment: δC^{13} in parentheses is average value for series.

Bristlecone Pine No. 1 series, California

Wood, *Pinus aristata*, from bristlecone pine forest, Inyo Natl. Forest, White Mountains (37° 23' N Lat, 118° 10' W Long). Coll. 1962-1964 and subm. by C. W. Ferguson, Univ. of Arizona Lab. of Tree-Ring Research, Tucson.

	$\delta C^{14}, \text{‰}$	$\delta C^{13}, \text{‰}$	$\Delta, \text{‰}$
A-416. 750 to 800 B.C.	+53 ± 7	(-22.7)	+48 ± 7
From tree specimen TRL 62-68, Sec. 6, Methuselah Walk.			
A-528. 2266 to 2278 B.C.	+106 ± 5	-21.8	+99 ± 5
From tree specimen TRL 63-53, Sec. 31, Methuselah Walk.			
A-586. 2112 to 2192 B.C.	+90 ± 7	(-22.7)	+85 ± 7
From tree specimen TRL 62- 121, Sec. 31, Pine Alpha ridge.			
A-605. 3703 to 3807 B.C.	+153 ± 7	(-22.7)	+148 ± 7
From tree specimen TRL 63-89, Sec. 32, Methuselah Walk.			

A-637. 1841 to 1856 B.C.	+79 ± 5	-23.7	+76 ± 5
From tree specimen TRL 63-43, Sec. Q, Part II, Methuselah Walk.			
A-638. 1808 to 1840 B.C.	+82 ± 5	-23.0	+78 ± 5
From tree specimen TRL 63-43, Sec. Q, Part II, Methuselah Walk.			
A-639. 161 to 206 B.C.	+31 ± 7	(-22.7)	+26 ± 7
From tree specimen F3, Methuselah Walk. δC^{13} in parentheses is average value for series.			

Buhen Old Kingdom series, Sudan

Site consisting of domestic and workshop buildings at Buhen in Nubia near Wadi Halfa on W bank of Nile (11° 51' N Lat, 31° 17' E Long). Coll. by W. B. Emery and subm. by I. E. S. Edwards, British Mus., London. See Arizona IV (1963) and UCLA IV (1965) for further details on site.

A-519. Buhen	3960 ± 30
	2010 B.C.

Charcoal from Pit 1, Level 1. For archaeological reasons should be contemporaneous with IV Dynasty (2500-2620 B.C.). Sample identical to and in good agreement with UCLA-665, 3990 ± 80 (UCLA IV).

A-521. Buhen	4020 ± 100
	2070 B.C.

Charcoal from Pit 2, Level 1. Should also be contemporaneous with IV Dynasty (2500-2620 B.C.). Sample identical to and in good agreement with UCLA-666, 4090 ± 80 (UCLA IV).

A-520. Buhen	3720 ± 80
	1770 B.C.

Charcoal from Pit 1, Level 2. Archaeologically, sample should be Archaic. Sample is identical to UCLA-667, 3970 ± 80 (UCLA IV). *General Comment:* these samples were dated by both UCLA and Arizona because previous Arizona results from this site had yielded consistently younger ages than expected for IV or V Dynasty samples (A-330, 3960 ± 60; A-331, 3960 ± 60; A-332, 3820 ± 50) or for II Dynasty samples (A-333, 4190 ± 60; A-334, 4090 ± 50). This interlaboratory check confirms discrepancy between archaeological dates and C^{14} dates. This discrepancy is almost identical with discrepancy between C^{14} dates and dendrochronologic dates for tree-ring samples (Arizona V).

Both Arizona dates and UCLA dates for interlaboratory check have been corrected for fractionation. Correction is small, -15 to 30 yr. δC^{13} analyses, expressed as difference from the Chicago PDB standard, were

carried out through courtesy of A. Long, Smithsonian Inst., Washington, D. C.

	$\delta C^{13}, \text{‰}$
A-519	-26.45
A-521	-26.35
A-520	-25.96

4200 \pm 90

2250 B.C.

A-569. Tarkhan II linen

Linen from Mastaba 2050 at Tarkhan near Cairo, Egypt (29° 40' N Lat, 31° 13' E Long). Coll. by W. M. Flinders Petrie; subm. by I. E. S. Edwards, British Mus., London. Sample is thought to date from I Dynasty. *Comment:* because linen is composed of flax which grew during one season, sample was considered to be good for another UCLA-Arizona interlaboratory check. Result is in excellent agreement with UCLA-739, 4265 \pm 80. See UCLA IV for further details.

Montezuma Well series, Arizona

Tufa, turtle and subaerial plants from Montezuma Well, Montezuma Castle Natl. Monument, ca. 10 mi N of Camp Verde, Yavapai Co. (34° 39' N Lat, 110° 45' W Long). Montezuma Well is a sink in Plio-Pleistocene fresh water limestone, with diam of ca. 400 ft and depth of 130 ft including 55 ft from bottom to water level. Artesian water enters through deep fissures at rate of ca. 5600 m³/day.

C¹⁴ data for aquatic plants and water were given in Arizona V. The C¹⁴ content of bicarbonate from the artesian water was only 6.46‰ modern (A-440 apparent C¹⁴ age is 21,420 \pm 220 yr). Aquatic plants were receiving almost all of their CO₂ content from water rather than from atmosphere and consequently had approximately same apparent age as water.

Present suite of samples was collected to further evaluate effect of this significant source of old CO₂ on C¹⁴ content of immediate environment.

A-515. Modern Aquatic Plant

$\delta C^{14} = +590 \pm 6\text{‰}$

Scirpus (probably *validus*) an emergent bullrush growing on S side of Montezuma Well. Only parts above water used. Coll. Sept. 1963 by G. A. Cole and W. L. Minckley, Arizona State Univ., Tempe; subm. by G. A. Cole.

A-516. Tree Leaves

$\delta C^{14} = +483 \pm 5\text{‰}$

Populus fremonti growing at edge of pond, no part except perhaps roots under water. Coll. Sept. 28, 1963 by G. A. Cole and W. L. Minckley; subm. by G. A. Cole.

A-529a. Tufa, carbonate fraction

$\delta C^{14} = -870 \pm 3\text{‰}$

Carbonate precipitating from Montezuma Well water just before irrigation ditch turns into Rim Ranch near Weir. Coll. Dec. 5, 1963 and

subm. by P. E. Damon and G. A. Cole. Sample demonstrates presence of "old" carbon from artesian water in modern tufa. Apparent age is 16,400 yr.

A-529b. Tufa, organic fraction

$$\delta C^{14} = -531 \pm 22\%$$

Organic material separated from above carbonate. Grass rootlets were removed but probably not completely. Apparent C^{14} age is 6090 \pm 380 yr.

A-530. Grass

$$\delta C^{14} = +770 \pm 25\%$$

Grass growing 1 to 2 ft above water level near Island Rock. Coll. Dec. 5, 1963 and subm. by P. E. Damon and G. A. Cole, to check for CO_2 gradient between water level and rim of sink.

A-533. Grass

$$\delta C^{14} = +819 \pm 28\%$$

Grass growing on edge of Montezuma Well, 75 ft above water level. Coll. Dec. 5, 1963 and subm. by P. E. Damon and G. A. Cole. *Comment:* difference between A-533 and A-530 may represent greater increment of pond CO_2 in A-530.

A-538. Turtle

$$\delta C^{14} = -840 \pm 26\%$$

Sonoran mud turtle, *Kinosternon sonoriense* le Conte, died in early 1961. Coll. 1961 and subm. 1963 by G. A. Cole, Arizona State Univ., Tempe. Although possibly omnivorous, it was probably primarily a carnivore. Snails and insects which it ate at Montezuma Well are directly (as in the snail) or indirectly (some insects) dependent on the low- C^{14} aquatics for feed.

A-487. Tucson, Arizona

$$\delta C^{14} = +730 \pm 24\%$$

Bermuda grass rootlets from residence on outskirts of Tucson (32° 08' N Lat, 110° 58' W Long). Coll. and subm. Aug. 28, 1963 by C. V. Haynes.

II. GEOLOGIC-PALEOCLIMATIC SAMPLES

Las Vegas Valley series, Nevada

As a result of problems defined during 1962-1963 Tule Springs expedition of Nevada State Mus. (Shutler, 1965), C. V. Haynes and P. J. Mehringer are continuing investigations of ancient springs of Las Vegas Valley in order to learn more about past spring discharge in relation to climatic change, faulting, valley subsidence, and aquifer conditions. Buried organic mats associated with the ancient springs offer a unique opportunity for detailed analysis of fossil pollen and plants (Mehringer, 1965). In addition to chronological control, C^{14} analyses of plants compared to C^{14} analyses of contemporaneous tufa permit estimation of initial C^{14} deficiencies in ground water (Haynes, 1965, p. 97). Previous C^{14} analyses are reported by Fergusson and Libby (1964).

It was found that tufa associated with extinct springs in the Valley yielded 0.1 to 0.2% organic carbon upon pyrolysis, acid leaching and combustion. Both organic and carbonate fractions were analyzed for comparison.

4910 \pm 90

A-508. Large vertebrate bone, carbonate **2960 B.C.**

Fragment of bone from base of unit E₁ channel fill (elev 2292 ft) at Tule Springs Locality 4 (36° 19' N Lat, 115° 11' W Long) where associated carbonized wood dates 12,400 \pm 350 B.P. (UCLA-512). Coll. 1963 by K. Dove and subm. by C. V. Haynes.

5160 \pm 200

A-509. Large vertebrate bone, carbonate **3210 B.C.**

Fragment of bone from unit B₂ spring deposit (elev 2295 ft) at Tule Springs Locality 2 (36° 19' 06" N Lat, 115° 11' 38" W Long) where associated carbonized wood dated >40,000 B.P. (UCLA-517). Coll. 1963 by J. W. Mawby and subm. by C. V. Haynes. *Comment:* carbonate fractions of bone samples buried at similar elevations in strata of widely separate ages were dated for comparison with associated carbonized wood. The young and similar ages of the carbonates indicate secondary deposition presumably upon lowering of water table which left bone above zone of saturation. A lowering of the water table between 4000 and 6000 yr ago is compatible with geologic evidence.

14,100 \pm 100

A-459A. Tufa, carbonate fraction **12,150 B.C.**

13,680 \pm 160

A-459B. Tufa, organic fraction **11,730 B.C.**

Cylindrical tube of algal(?) tufa from the surface at Locality 68, Eglington scarp (36° 18' N Lat, 115° 8' W Long). Tufa encased tree branch that was subsequently destroyed by decay. Alignment of tufa outcrops suggest deposition at fault-controlled springs. Coll. 1963 and subm. by C. V. Haynes.

13,400 \pm 230

A-470. Tufa, organic fraction **11,450 B.C.**

Concretionary masses of algal(?) tufa from Locality 63 at foot of Eglington scarp (36° 16' 42" N Lat, 115° 9' 14" W Long). Coll. 1963 and subm. by C. V. Haynes. Carbonate fraction dated 15,000 \pm 300 B.P. (UCLA-641).

10,160 \pm 160

A-471. Tufa, organic fraction **8210 B.C.**

Cauliflower-like masses of algal(?) tufa at Locality 64 (36° 17' 22" N Lat, 115° 8' 16" W Long). Tufa forms a narrow sinusoidal ridge over 1 mi in length. Coll. 1963 and subm. by C. V. Haynes and R. Shutler. Carbonate fraction dated 11,800 \pm 250 B.P. (UCLA-642).

A-466. Tufa, organic fraction**>28,800
26,850 B.C.**

Tufa fragments from surface of spring-laid sediments at Tule Springs Locality 2 (36° 19' 6" N Lat, 115° 11' 38" W Long). Coll. 1963 and subm. by C. V. Haynes. A different specimen from same locality dated $15,920 \pm 220$ B.P. (UCLA-503). *Comment:* carbonate fractions are commonly older than organic fractions indicating some initial C¹⁴ deficiency in the spring water. Organic fractions probably yield more accurate dates than carbonates but could also be too old if derived from algae or aquatic plants (Arizona V, p. 93). Cross check by C¹⁴ dating of an associated organic mat indicates tufa dates to be less than 900 years too old (see comment on A-441 and A-442, this list). Tufa dates are assumed to be minimum for faulting which initiated artesian spring activity.

A-464. Plant matter**9870 ± 400
7920 B.C.**

Plant matter from buried spring mat exposed in an arroyo (36° 17' 20" N Lat, 115° 10' 5" W Long) cutting Eglington scarp. Truncated mat is buried by unit G alluvium of late prehistoric age. Coll. and subm. 1963 by C. V. Haynes. Recent vegetable matter was removed by repeated decantations after standard decalcification with HCl. *Comment:* minimum date for emergence of the spring.

A-462. Shell carbonate**31,300 ± 2500
29,350 B.C.**

Aquatic molluscs 2 ft above base of lacustrine mudstone (unit D) at Tule Springs Locality 13 (36° 19' 6" N Lat, 115° 11' 38" W Long). Shells removed from same sediment as pollen sample No. 51, Profile II (Mehring, 1965). Coll. and subm. 1963 by C. V. Haynes. *Comment:* check of contemporaneous charcoal and shell (UCLA-521 and 543, respectively) indicates shell carbonate is 1000 yr too old due to initial C¹⁴ deficiency. Large error is due to small size of sample which required dilution for counting.

A-465. Charcoal**4190 ± 170
2240 B.C.**

Charcoal from aboriginal fireplace on Eglington scarp (36° 16' 52" N Lat, 115° 9' 32" W Long). Charcoal, flint waste flakes, and chopper were exposed by deflation of unit F dunes. Coll. and subm. 1963 by C. V. Haynes and R. Shutler. *Comment:* date plus absence of pottery suggests a desert culture origin for fireplace.

A-463A. Charcoal**8540 ± 340
6590 B.C.**

Lens of disseminated charcoal at Tule Springs Locality 1 (36° 19' 6" N Lat, 115° 11' 38" W Long). Sample is from top of unit E_{2a} silt. Coll. 1962 by K. Dove; subm. by C. V. Haynes. *Comment:* sample immediately predates a minor erosional interval separating E_{2a} from E_{2b}.

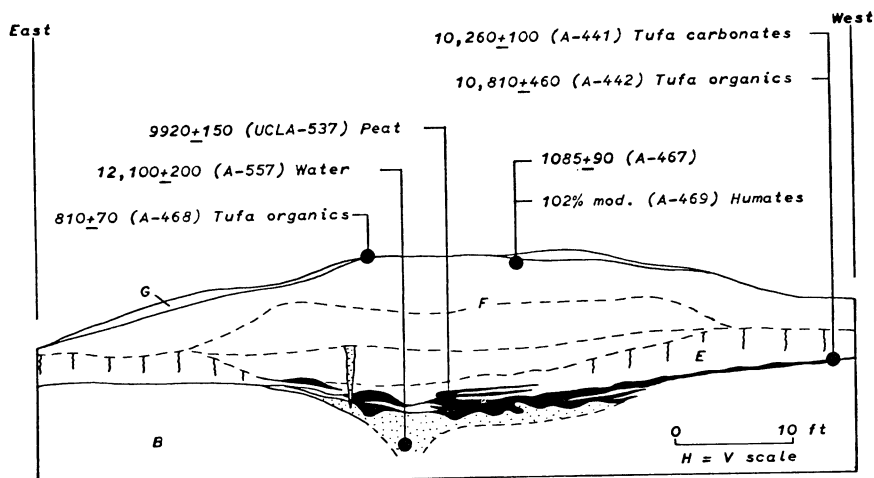


Fig. 1. Geologic cross section of the mound of spring No. 4, Gilcrease Ranch, Las Vegas Valley, Nevada, showing the stratigraphic location of C^{14} samples. Stratigraphic units are designated by the letters B, E, F, and G. Weathering is shown by vertical wavy lines. Stippling indicates sand-filled feeder conduits, and organic mat is shown in solid black. The rest of the sediments are sandy silts (E, F, and G) and mudstone (B).

Gilcrease Spring Mound series, Las Vegas Valley

Gilcrease Spring No. 4 ($36^{\circ} 17' 47''$ N Lat. $115^{\circ} 28''$ W Long) is a silt mound 12 ft high and 100 ft in diam that has been dry since early 1920s when it was damp. It was dissected by bulldozer trench in 1963 in order to investigate the stratigraphy shown in Figure 1. Analyses of fossil pollen (Mehring, 1964) augmented stratigraphic and geochronologic studies. Coll. 1963-1964 and subm. by C. V. Haynes.

A-469. Soil humates

$102.6 \pm 2.1\%$ modern

Adsorbed humates extracted from soil 1 ft below top of mound by 2% NaOH solution before decalcification. *Comment:* modern soil is enriched in nuclear-age C^{14} . Dated carbon was 0.45% of initial sample weight.

810 ± 70

A-468. Tufa-caliche, organic fraction

A.D. 1140

Porous tufa transitional to caliche formed partial cap on top of mound. Sample was pyrolysed and decalcified before combustion. *Comment:* dated carbon was 0.14% of initial sample weight. Date is approximate for end of eolian sand accumulation on mound.

1085 ± 90

A-467. Caliche, organic fraction

A.D. 865

Sandy caliche from 1 ft below top of mound (approx. same level as A-469) was pyrolysed and decalcified before combustion. *Comment:* the

0.1% organic carbon probably represents absorbed humates fixed by calcium. Date is approximate for final stage of mound accretion and is supported by A-468.

A-441. Tufa, carbonate fraction **10,260 ± 100**
8310 B.C.

A-442. Tufa, organic fraction **10,810 ± 460**
8860 B.C.

Buried masses of concretionary algal(?) tufa containing molds of sedge leaves indicating shallow-water deposition. Organic fraction (0.11%) was obtained by pyrolysis and combustion after decalcification. *Comment:* both fractions agree and indicate deposition in spring water with C^{14} content at least 90% that of the atmosphere when compared to date of 9920 ± 150 B.P. (UCLA-537) on contemporaneous organic mat. This suggests that 10,000 yr ago recharge required less than 800 yr to emerge at the spring.

A-557. Spring water **12,100 ± 200**
10,150 B.C.

Spring water that seeped from floor of bulldozer trench where it cut into sand-filled feeder conduit was coll. and dissolved CO_2 extracted by acidification and agitation. Coll. 1964 by C. V. Haynes, P. J. Mehlinger, George Wilson, and R. Shutler; subm. by C. V. Haynes. *Comment:* this date, when compared to analyses of A-441, A-442, and UCLA-537, strongly suggests that spring water emerging today is "fossil" water that fell as rain between 10,000 and 12,000 yr ago and is not a mixture of younger water with older water.

A-526. Glen Canyon Excavation, Utah **24,600 ± 1400**
22,650 B.C.

Horse dung from Oakleaf Alcove, Glen Canyon area excavations at Lake Canyon, $\frac{1}{4}$ mi upstream from Colorado River, San Juan County, Utah ($37^\circ 25'$ N Lat, $110^\circ 38'$ W Long), excavation coord. 42 SA 374, FS3/2. Coll. ca. 1960 by Univ. of Utah Glen Canyon salvage archaeologists and subm. by P. S. Martin, Geochronology Labs., Univ. of Arizona, Tucson. According to Professor Martin, a 200-grain pollen count contains 43% *Betula* and 39% *Artemisia*. Oakleaf Alcove is considered to be inaccessible to horses or other large herbivores. Sample may have been brought in by pack rats which often line their nests with animal dung.

A-474. China Lake, California **>31,200**

Organic matter in lacustrine silt at 21.5 ft below surface of China Lake playa, California ($35^\circ 43'$ N Lat, $117^\circ 38'$ W Long), same location as drill hole MD-1 of Smith and Pratt (1957). Coll. 1963 by Roland von Huene, Naval Ordnance Test Station, China Lake; subm. by P. S. Martin, Univ. of Arizona, Tucson. *Comment:* dates sedge and cattail pollen peak above a pine pollen maximum.

4100 ± 800**A-554. Owens Lake, California****2150 B.C.**

Organic matter in lacustrine clayey silt 875 to 900 cm below surface of Owens Lake playa, California (36° 25' N Lat, 118° 00' W Long), 50 yd E of Bartlett Salt Plant Well No. 2 Coll. 1963 and subm. by P. S. Martin and David Adams, Univ. of Arizona, Tucson. *Comment:* confirms postglacial estimate of age.

Osgood Swamp series, California

These samples were dated to provide geochronological control for pollen analyses of a 4.4 mi core from Osgood Swamp (38° 45' 45" N Lat, 120° 02' 47" W Long), Eldorado County, California. Coll. 1963 and subm. by David Adam.

2830 ± 200**A-544. 60-70 cm below surface****880 B.C.**

Comment: dates uppermost shift in the pollen record.

9900 ± 800**A-545. 300-310 cm below surface****7950 B.C.**

Comment: dates inception of vegetation similar to that of the present.

Lake Lahontan, Nevada**11,640 ± 100****A-460A. Tufa, carbonate****9690 B.C.****12,150 ± 400****A-460B. Tufa, organic fraction****10,200 B.C.**

Algal(?) tufa from lowest (4192 ± 2 ft) dendritic terrace of Lake Lahontan at Boot Hill (40° 8' N Lat, 118° 32' 20" W Long), Pershing County, Nevada. Organic fraction obtained by pyrolysis and decalcification. Coll. 1963 by M. Wheat; subm. by R. Shutler, Nevada State Mus., Carson City. *Comment:* the two dates are within statistical agreement. Because algae can metabolize CO₂ from water it cannot be assumed that organic fraction is unaffected by any initial C¹⁴ deficiency.

Rio Laja, Chile**17,000 ± 4000****A-636A. Base-soluble organic fraction****15,050 B.C.****15,000 ± 500****A-636B. Carbonized plants****13,050 B.C.**

Carbonaceous debris overlain by volcanic mud flow (lahar) deposit along S bank of Rio Laja, Chile (37° 21' S Lat, 71° 53' W Long). Coll. 1960 and subm. by Donald MacPhail, Univ. of Colorado, Boulder. *Comment:* the more precise of the two dates is probably maximum for the lahar.

Dahlak Archipelago series

Carbonate samples from raised fossil reef, Entedebir Island, Dahlak Archipelago, E of Massaua, Ethiopia in S Red Sea ($15^{\circ} 53' \text{ N Lat}$, $39^{\circ} 55' \text{ E Long}$). Coll. 1962 and subm. by Yaacov Nir, Geol. Survey of Israel, Jerusalem.

A-447. 7 m above mean sealevel **$28,000 \pm 600$**
26,050 B.C.

Coll. from base of highest ridge on Entedebir Island, Papenfuss Ridge, 7 m above mean sealevel.

A-448. 19 m above mean sealevel **$16,400 \pm 150$**
14,450 B.C.

Coll. from 12 m above A-447 at top of fossil reef on Papenfuss Ridge.
Comment: A-448 and A-359 ($17,200 \pm 330 \text{ B.P.}$, Arizona IV, p. 296) indicate that time of last uplift of Archipelago was between 16,000 and 17,000 B.P. Rate of reef-carbonate accumulation appears to be 1 m per 1000 yr. All samples were washed in dilute HCl before hydrolysis to remove possible recent contamination.

A-513. Potato Lake, Coconino County, Arizona **$14,400 \pm 300$**
12,450 B.C.

Organic material from sediment core, Potato Lake, Coconino County, Arizona ($34^{\circ} 26' \text{ N Lat}$, $111^{\circ} 20' \text{ W Long}$). 142 to 172 cm depth in core. Coll. 1963 by G. A. Cole and Mel Whiteside; subm. by Mel Whiteside, Arizona State Univ., Tempe. *Comment:* palynological studies indicate high *Picea* and *Abies* at level of this sample.

University of Arizona series, Tucson

A-692. Caliche **$34.8 \pm 2.0\%$ modern**

Uppermost portion of upper caliche bed, 3 ft below ground surface, Univ. of Arizona campus, Tucson ($32^{\circ} 20' \text{ N Lat}$, $111^{\circ} 00' \text{ W Long}$). Coll. 1965 by David Coatsworth, Melissa Lukow and D. C. Grey; subm. by D. C. Grey, Geochronology Labs., Univ. of Arizona.

A-693. Caliche **$7.8 \pm 2.0\%$ modern**

Lowest portion of upper caliche bed, 5 ft below ground surface.
Comment: samples A-692 and A-693 are part of a chemical and radiometric study of caliche formation.

III. EARLY MAN-ALLUVIAL STRATIGRAPHY

Lehner Ranch series, Arizona

Lehner site, San Pedro Valley ($31^{\circ} 25' 23'' \text{ N Lat}$, $110^{\circ} 06' 48'' \text{ W Long}$), Cochise County, Arizona, Ariz:EE:12:1, is an elephant-kill site in which Clovis fluted points were found in association with charcoal, bones of nine immature mammoths, and remains of horse, bison and tapir (Haury *et al.*, 1959; Lance, 1959; Antevs, 1959). Pollen investigations are being conducted by P. J. Mehringer, Jr. and geochronology and

geochemistry of the sediments are being investigated by C. V. Haynes, Jr. Coll. 1963-1965 and subm. by C. V. Haynes and P. J. Mehringer.

A-479A. Wood **1430 ± 160**
A.D. 520

A-479B. Humates **110 ± 20**
A.D. 1840

Wood from one of two buried pits exposed by Bulldozer Trench A and 3 ft below ground surface. *Comment:* dates upper part of unit G (undifferentiated) and unidentified aboriginal occupation. Humates show a modern component.

A-611. Charcoal **1460 ± 120**
A.D. 490

Charcoal from fireplace buried in alluvial fan near mouth of Lehner Ranch arroyo and exposed by Bulldozer Trench C. *Comment:* dates upper part of unit G (undifferentiated) and an unidentifiable aboriginal occupation.

A-633. Soil humates **2550 ± 500**
600 B.C.

Humates extracted from very dark brown soil in unit G (undifferentiated) ¼ mi upstream from Lehner site. *Comment:* soil is believed to have formed between 3000 and 4000 yr ago.

A-480. Charcoal **3950 ± 180**
2000 B.C.

Charcoal from fireplace buried 16 in. below surface and exposed by Bulldozer Trench B. *Comment:* dates lower part of unit G (undifferentiated) and an unidentified aboriginal occupation.

A-632A. Calcareous sinter **7900 ± 600**
5950 B.C.

Organic fraction of calcareous sinter obtained by pyrolyzing and decalcifying. Sample from Bulldozer Trench B. *Comment:* apparently dates secondary deposition of soil organic matter as the sample is stratigraphically below A-33 bis (10,410 ± 190 B.P.) (Arizona III, p. 243).

A-478B. Carbonized wood **11,600 ± 400**
9650 B.C.

Carbonized wood from unit E was dissolved in 2% NaOH after decalcification and was precipitated as humates. *Comment:* date is minimum for unit E because of possible younger humate contamination.

A-525A. Carbonized wood **10,550 ± 550**
8600 B.C.

A-525B. Base-soluble organic fraction **11,080 ± 300**
9130 B.C.

average: 10,815 ± 450
8865 B.C.

Carbonized wood (charcoal?) from buried concentration associated

with bones exposed in arroyo wall $\frac{1}{4}$ mi upstream from the Lehner site. *Comment:* excavations are planned at this locality.

A-576. Caliche**7000 \pm 300****5050 B.C.**

Buried caliche in unit F₃ on top of unit F₂ (Layer K, dated 10,410 \pm 190 B.P., A-33 bis) and exposed by Bulldozer Trench A. *Comment:* apparently dates secondary deposition of pedogenic (?) carbonate in unit F₃.

A-575. Caliche**10,250 \pm 550****8300 B.C.**

Secondary deposit of pedogenic (?) caliche in unit E (>11,600 B.P., A-478B) and overlain by unit F₂ (10,410 \pm 190 B.P., A-33 bis) in Bulldozer Trench A. *Comment:* carbonate was apparently deposited upon desiccation of wet-meadow soil of unit F₂ (Layer K).

A-573. Caliche**15,450 \pm 700****13,500 B.C.**

Caliche cementing gravel (unit C) which caps N rim of Lehner Ranch arroyo. Exposed by Bulldozer Trench A. *Comment:* maximum date for pedogenic deposition of calcium carbonate in gravel believed to be considerably older.

A-635. Caliche**17,760 \pm 700****15,810 B.C.**

Nodular caliche in paleosol exposed in arroyo wall $\frac{1}{4}$ mi upstream from Lehner site. Overlies A-525 (10,815 \pm 450 B.P.). *Comment:* maximum date for carbonate deposition in younger sediment. This suggests deposition from ground water.

A-574. Carbonates**>28,800**

Calcareous mudstone in unit D exposed in Trench A. *Comment:* the mudstone and carbonates may be lacustrine deposits.

A-572. Caliche**>30,000**

Caliche nodules in upper part of unit B and exposed by Bulldozer Trench A. *Comment:* date is in accord with pre-Wisconsin age estimate for unit B.

Blackwater No. 1 series, Clovis, New Mexico

The Blackwater No. 1 locality (34° 17' N Lat, 103° 19' W Long), Roosevelt County, New Mexico is a commercial gravel mine and early-man site described by Sellards (1952, p. 29-31). Recent exposures of springlaid sediments are described by Haynes and Agogino (in press). Coll. 1963 and subm. by C. V. Haynes unless indicated otherwise.

A-512. Burned bone**8470 \pm 350****6520 B.C.**

Burned bone fragments from aboriginal fireplace at eroded contact between "carbonaceous silt" (unit E) and "jointed sand" (unit F).

Archaic notched projectile point was found on same burial surface 10 ft away, and stem of a Scottsbluff point was found on same surface elsewhere. Sample decalcified and combusted. Coll. 1963 and subm. by G. A. Agogino, Eastern New Mexico Univ. *Comment:* it is not known whether fireplace was on buried eroded surface or exposed by erosion before deposition of unit F, but date is consistent with dating of similar projectile points elsewhere in U. S.

9890 ± 290**7940 B.C.****A-489. Plant remains**

Humates and soluble lignins extracted from "carbonaceous" silt," unit E₁, N wall. Rootlet contamination was removed by flotation and repeated decantations after decalcification. *Comment:* date is compatible with A-512 stratigraphically higher and A-488 and A-492 which are lower.

10,200 ± 250**8250 B.C.****A-488. Plant remains****10,490 ± 200****8540 B.C.****A-492. Plant remains**

Humates and soluble lignins extracted from plant remains in "diatomaceous earth," unit D₂ at two places along N wall. *Comment:* dates are stratigraphically equivalent and are above unit D_{1b} containing Agate Basin projectile points and which overlies unit D_{1a} containing Folsom points. Dates are comparable to A-386 (10,490 ± 900 B.P.) and A-379-380 (10,250 ± 320 B.P.) from deeper pond facies of "diatomaceous earth" (Arizona V, p. 101).

11,040 ± 500**9090 B.C.****A-490. Plant remains****11,630 ± 400****9680 B.C.****A-491. Plant remains**

Humates and soluble lignins extracted from plant remains at bottom and top, respectively, of unit C₁, N wall. Vertical separation is 2 ft. *Comment:* dates are stratigraphically inverted but within one sigma of each other and are comparable with A-481 (11,170 ± 360 B.P., Arizona V) in unit C₀, a coeval facies containing Clovis points and mammoth bones.

Blackwater Draw barrow pit series, Clovis, New Mexico

A barrow pit, Locality 7 (34° 15' 50" N Lat, 103° 18' 55" W Long), in Blackwater Draw, has exposed a stratigraphic section consisting of (from bottom to top) fluvial sand (B₁), lacustrine mudstone (B₂), and diatomaceous silt (D). Haynes (in press) correlates unit B₂ with top of Tahoka formation in Texas and unit D with "diatomaceous earth" at Clovis site (Blackwater No. 1). An erosional contact between units B₂ and D truncates a thick caliche in top of B₂.

A-493. Shell carbonate**10,600 \pm 200
8650 B.C.**

Anodonta shells from base of unit D at approximate level of Wendorf pollen samples 22 and 23. *Comment:* date supports correlation of "diatomite" in Blackwater Draw to that in gravel pit at Clovis site.

A-669B. Lacustrine carbonate**15,770 \pm 440
13,820 B.C.**

Mudstone of Wendorf pollen samples 27 to 29, 2 ft below zone of caliche and 1/2 ft above unit B₁ sand. Subm. by F. Wendorf. *Comment:* date supports correlation of unit B₂ with top of Tahoka and with shallow pond sediments at McCullom Ranch site dated 15,750 \pm 760 B.P. (A-375) (Arizona V, p. 101).

Hell Gap series, Wyoming

Since 1959 the late Quaternary alluvial stratigraphy associated with early man sites in Wyoming has been investigated by C. V. Haynes, Jr. in collaboration with archaeologists H. T. Irwin, Peabody Mus., Harvard Univ., Cynthia Irwin-Williams and George A. Agogino, Eastern New Mexico Univ. Attention is being focused upon the Hell Gap (42° 24' 35" N Lat, 104° 38' 25" W Long) and Pattern Creek (42° 26' 53" N Lat, 104° 43' 20" W Long) areas where archaeologists have demonstrated a remarkably complete record of human occupation from 11,000 B.P. to the present. Carbonaceous silt samples were extracted with 4% NaOH after decalcification and decantation. Coll. 1963 and subm. by C. V. Haynes except where otherwise indicated.

A-501. Hell Gap Site 1**8600 \pm 380
6650 B.C.**

Mixed charcoal and earth associated with burned area in Frederick level, lower part of unit F (S-13, 5 ft 4.5 in. to 5 ft 7.5 in. below datum). *Comment:* date is same as I-245 (8600 \pm 600 B.P., Isotopes IV) for Scotts-bluff level a few in. below and separated by a minor conformity.

A-498. Hell Gap Site 2**5740 \pm 230
3790 B.C.**

Charcoal from firepit on the contact between units F and G₁. Weathering in unit G₁ is believed to represent a late "Altithermal" soil. Unit F is pre-"Altithermal." *Comment:* date supports the interpretation.

Hell Gap Site 2, unit E:**A-500.****10,150 \pm 300
8200 B.C.**

Carbonaceous silt of Level II (1075-12E, 11 ft 5 in. below datum) believed to correspond to the Hell Gap and Alberta occupation level elsewhere.

A-499.

Carbonaceous silt of Level V (113-1145, 15-20E). Midland point occurred 2 in. above the 1/2-in. thick carbonaceous band.

10,000 ± 200
8050 B.C.

A-504.

Carbonaceous silt of Level V (100-1055, 5E). Unidentified projectile point occurred 1/2 in. above the 1/4 in. thick carbonaceous band.

10,600 ± 500
8650 B.C.

A-502.

Carbonaceous silt 2 ft below Level IV (46S-OE, 11 ft 4 in. to 11 ft 8 in. below datum). Middle and darkest of three bands and 8 to 10 in. above contact with unit B. May correlate with Level V (Midland level).

10,200 ± 500
8250 B.C.

A-503.

Carbonaceous silt at base of unit E (27S-OE, 11 ft below datum) and on the contact with gray silty clay of unit B.

Comment: considering that the sample material is subject to contamination by mobile humic acids, it is not surprising that one of the dates (A-499) is inconsistent with the sequence. It is, however, within 2σ of A-504 which should be the same age. The data, including A-501 (this list), indicate that unit E was deposited between 9000 and 11,000 yr ago. During this 2000-yr period, four different cultures camped at the site at various times.

10,840 ± 200
8890 B.C.

A-563. Adams' locality

Charcoal from buried fireplace 1.5 ft below top of a 7-ft terrace (42° 24' 27" N Lat, 104° 38' 02" W Long). Coll. 1962 and subm. by D. Adams. *Comment:* sample overlies a late "Altithermal" paleosol.

3340 ± 200
1390 B.C.

A-497. Patten Creek

Charcoal from aboriginal fireplace buried 1 ft below 7-ft terrace and 6 in. below unconformable contact (42° 26' 55" N Lat, 104° 43' 32" W Long). *Comment:* date is maximum for period of degradation separating the alluvial deposits.

1790 ± 180
A.D. 160

A-706. Patten Creek

Charcoal from aboriginal firepit buried 2.5 ft below terrace surface at test trench No. 1 (42° 26' 53" N Lat, 104° 43' 20" W Long). Level 8128 (PC65, I-99-100, 32 in. below datum). Coll. and subm. 1965 by Sally Keller. *Comment:* dates second occupational level with Patten Creek projectile points.

2900 ± 140
950 B.C.

IV. ARCHAEOLOGIC SAMPLES

Casa Brandes series, Mexico

Charred corn kernels, twigs, and charcoal from Casa Grandes archaeological site (30° 22' N Lat, 107° 58' W Long), NW Chihuahua, Mexico. Coll. 1957-1959 and subm. 1964 by C. C. DiPeso, Amerind Foundation, Inc., Dragoon, Arizona. *Comment:* a tree ring chronology has been established which covers a period of 486 yr from A.D. 851 to A.D. 1336 (Scott, 1963).

A-612. Charcoal, CG(P)233 **470 ± 90**
A.D. 1480

From fire hearth No. 2, Room 24-N, Buena or Diablo phase.

A-609. Charred twigs, CG(C)185 **740 ± 115**
A.D. 1210

From house No. 1, fill No. 2, 8th floor, CH1H:D:9:14, Reyas phase of medio period.

A-608. Charred corn kernels, CG(P)57 **320 ± 250**
A.D. 1630

From floor of House C, CH1H:D:9:2, Pelon phase of Viejo period.

A-610. Charred log, CG(D)319 **300 ± 90**
A.D. 1650

Tree fragment from central post hole, room No. 2, CH:G:2:3, Robles site.

Powder River Canyon series, Wyoming

Charcoal samples from a multi-component rock shelter site on rim of canyon of Middle Fork of Powder River, Wyoming (43° 35' N Lat, 107° 00' W Long). Field work of Wyoming Archaeol. Soc. Coll. 1959 and subm. by D. C. Grey. *Comment:* site appears to show habitation through the hiatus between Early period and Middle period.

A-483. **3450 ± 40**
1500 B.C.

Charcoal from hearth in upper Layer II, associated with McKean artifacts. Appears to postdate a dry, windy climatic period of possible "Altithermal" age. Date agrees well with other McKean dates. *Comment:* an aliquot of the field sample was dated by the collector in a private lab. at 1220 B.C. ± 180.

A-484. **7800 ± 110**
5850 B.C.

Charcoal from a hearth in middle Layer III, associated with beveled points indentified as Meserve-Dalton affiliates. Predates what appears to be "Altithermal" deposit. Postdates water-laid sand. *Comment:* an aliquot of this sample was previously dated at 8600 ± 250 in a private lab. by the collector.

A-485.**3980 ± 70****2030 B.C.**

Charcoal from hearth in upper Layer III, dating earliest appearance of McKean points in the site. Sample appears to date transition into a deposit interpreted as being "Altithermal." *Comment:* an aliquot of the sample was previously dated at 5600 ± 200 in a private lab. by the collector.

A-548. PK Ranch, Sheridan County, Wyoming, burial**900 ± 240****A.D. 1050**

Human bone from PK Ranch, Sheridan County, Wyoming ($44^{\circ} 30'$ N Lat, $107^{\circ} 30'$ W Long). Multiple burial 2 ft below surface on hilltop. Coll. 1958 by Glenn Sweem and D. C. Grey; subm. 1963 by D. C. Grey, Geochronology Labs., Univ. of Arizona, Tucson. *Comment:* multiple burial with Late Prehistoric cultural association (Grey, 1958; Bass and Lacy, 1963).

A-583. Big Horn Mountains, Wyoming, Turk burial**670 ± 160****A.D. 1280**

Human bone from Site 48WA301, Gray Mount, Big Horn Mountains, Wyoming ($43^{\circ} 38'$ N Lat, $107^{\circ} 09'$ W Long). Multiple burial in limestone fissure. Coll. 1960 by Glenn Sweem and D. C. Grey; subm. by D. C. Grey. *Comment:* multiple burial showing evidence of violent death (Birkby and Bass, 1963; Grey, 1963).

18,600 ± 1900**A-518. Arka, Northern Hungary****16,650 B.C.**

Charcoal in East-Gravettian level in secondary loess deposit and under a paleosol at Arka, Northern Hungary ($48^{\circ} 30'$ N Lat, $21^{\circ} 30'$ E Long). Coll. 1963 and subm. by Laslo Vertes, Hungarian Natl. Mus., Budapest. *Comment:* date is in statistical agreement with GrN-4038 ($17,050 \pm 350$ B.P., Vogel and Waterbolk, 1964, p. 354) on the alkali soluble fraction which could be somewhat younger because of humic acid contamination.

284 ± 90**A-522. Easter Island****A.D. 1670**

Charcoal sample from Easter Island ($27^{\circ} 08'$ S Lat, $109^{\circ} 25'$ W Long). Site E-5, $\frac{1}{2}$ mi E of Arizona Cove on N coast, 60 to 80 cm depth in refuse mound. Sample rested on sterile soil and represents remains of one of earliest fires in refuse pit. Should approximate date of thick-walled adjoining masonry dwelling. Coll. 1955 and subm. by Edwin Ferdon, Jr., Arizona State Mus., Tucson (Heyerdahl and Ferdon, 1961, p. 305-311).

20 ± 140**A-593. Nevado de Toluca, Mexico****A.D. 1930**

Copal (resin) from larger of two lakes in crater of Nevado de Toluca, Mexico ($19^{\circ} 06' 28''$ N Lat, $99^{\circ} 45' 44''$ W Long). Sample recovered

from bottom mud of lake and presumed to have been ceremoniously thrown into lake to appease rain god. *Comment*: date confirms the ritual is still practiced.

**A-595A. Pinacate, Sonora, Mexico, soluble
bone organic matter 110% modern**

**A-595B. Pinacate, Sonora, Mexico,
bone black carbon 117% modern**

Burned bones of deer, antelope, and sheep from surface concentration near Papago Tanks (31° 55' N Lat, 113° 35' W Long), Pinacate, Sonora, Mexico. Coll. and subm. 1964 by J. D. Hayden, Arizona State Mus., Tucson. *Comment*: data indicates animals lived during the atomic era. C¹⁴ content of the atmosphere was at this level between 1955-1956 (Broecker and Walton, 1959).

**A-615A. Hunter Wash, Arizona, charcoal 3440 ± 100
1490 B.C.**

**A-615B. Hunter Wash, Arizona, soluble
lignins and humates 3050 ± 250
1100 B.C.**

Charcoal from rock-lined fireplace exposed in N wall of Hunter Wash (31° 28' N Lat, 110° 9' W Long), Arizona. Hearth is in brown alluvial sand is 1 ft above basal contact with gray mudstone. *Comment*: alluvium is correlated with unit G at Lehner site, about 4 mi to the SE.

**A-549. Laguna Salada, Arizona 6400 ± 500
4450 B.C.**

Carbonaceous mud from pollen-sample core, 320 to 339 cm beneath surface of Laguna Salada playa (34° 21' N Lat, 110° 17' W Long). Coll. and subm. 1963 by R. H. Hevly and P. S. Martin, Geochronology Labs., Univ. of Arizona, Tucson (Hevly, 1962; Harrell and Eckel, 1939). *Comment*: samples diluted for counting.

**A-550. Carter Ranch, Snowflake, Arizona 1280 ± 120
A.D. 670**

Charcoal from pithouse hearth, site No. 186, (34° 30' N Lat, 110° 05' W Long), near Snowflake, Arizona. Coll. 1963 by R. H. Hevly; subm. by P. S. Martin, Chicago Natural History Mus. (Martin *et al.*, 1961).

**A-495. Glen Canyon, Arizona, charcoal 1510 ± 80
A.D. 440**

Charcoal from a hearth buried 120 cm beneath surface in sandy Quarternary detritus beneath cliff of Navajo sandstone in Glen Canyon (37° 07' 30" N Lat, 110° 56' 30" W Long). Coll. 1960 by A. J. Lindsay, Jr.; subm. by P. V. Long, Jr., Mus. of Northern Arizona, Flagstaff. *Comment*: site has no ceramic associations but appears to be important in local archaeology.

**A-581. Tiburon Island, Gulf of California, 1100 ± 300
burials A.D. 850**

Human bone from Tiburon Island 29° 10' N Lat. 112° 26' W Long). Interred beneath deep midden deposit into truncated alluvial fan. Coll. 1949 and subm. by W. N. Smith. *Comment*: date is average of two independent measurements on samples from different burials: 800 ± 500 and 1400 ± 300.

**A-109. Bisti site, San Juan County, New Mexico 2140 ± 90
190 B.C.**

Charcoal from pits 26-25, 27-27, and 28-26, in grey sand 24 to 36 in. below surface at Bisti site (36° 28' N Lat, 108° 08' W Long), 18 mi SW of Bloomfield, New Mexico. Coll. 1958 and subm. by Albert Mohr, Anthropol. Dept., Univ. of Wisconsin, Madison. *Comment*: dates the aboriginal occupation and stratigraphic unit.

**A-110. Cly site, San Juan County, New Mexico 2510 ± 110
560 B.C.**

Charcoal from aboriginal occupation Level O in sandy soil at Cly site (36° 16' N Lat, 107° 52' W Long), San Juan County, New Mexico. Coll. 1958 and subm. by Albert Mohr. *Comment*: dates the occupation and the stratigraphic unit.

**A-669. Williamson Farm, Dinwiddie County 1590 ± 150
Virginia A.D. 360**

Charcoal in yellowish-grey silt 18 to 30 in. below surface and in a buried depression containing chert flakes, Williamson Farm (37° 04' 30" N Lat, 77° 30' 40" W Long), Dinwiddie County, Virginia. Coll. and subm. 1965 by C. V. Haynes and Ben C. McCrary. *Comment*: the abundance of fluted projectile points from plowed fields on this farm (McCrary, 1951) made it advisable to date this sample. Date does not apply to either the fluted points or to historic charcoal-making activities.

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BERN RADIOCARBON DATES V

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This list includes about half of the samples measured during the last year. Many studies need further investigation and the results will be published later when additional information will make better interpretations possible.

The equipment and the technique is essentially the same as described earlier (Bern IV).

Reliable results on CO₂ samples extracted out of ice are obtained with the small counter mentioned in Bern IV.

Our laboratory is financed by the Schweizerischer Nationalfonds. The authors wish to thank H. Loosli and P. Horisberger for their assistance in the measurements of part of the samples. They also thank M. Welten and H.-G. Bandi for their help in selecting and discussing the samples.

USA CRREL, the University of Bern and the Swiss Glacier Commission conducted a joint research project during March-April 1964 in the Tuto Tunnel, North Greenland, which runs 350 m horizontally into the polar ice sheet (Langway *et al.*, 1965). Four samples were taken at each of two locations, approximately 300 m (Location 1) and 200 m (Location 2) from the tunnel portal. For the extraction two completely independent methods were used: precipitation in sodium hydroxide, and collection in molecular sieve (Oeschger *et al.*, 1965).

The samples from Location 1 measured so far give ages of 2500 to 3000 B.P., whereas for Location 2 dates of 5000 B.P. to 6000 B.P. are obtained. The final results will be published after the measurement of all samples and the evaluation of the other studies connected with this project.

Murifeld-Bern series, Switzerland

Gyttja and peat from lake and bog deposit, Murifeld, near Bern (46° 56' 22" Lat, 7° 28' 35" E Long). Coll. 1962 and subm. by M. Welten, Univ. of Bern. *Comment* (M.W.): deep excavations in connection with construction of a highway permitted taking of samples on open walls of sediments, already well-known by pollen-analyses. The clearly developed late-glacial sediments proved to contain sufficient organic material for sample C¹⁴ dating. Location was first in Switzerland where Alleröd was dated (B-38, Bern I). It is now the first to record the Bölling-zone: the pollen diagram is clear and the dates fix the warm time as beginning at ca. 11,400 B.C., and ending at ca. 10,500 B.C. in full correspondence with north and central European datings. The oldest date (B-684) fixes a definite stage in establishment of late-glacial vegetation

at this location. Another sample of Bölling age in Switzerland Lobsigen-see (B-398, Bern IV), though not proved to belong to the zone, is fully confirmed by this series. B-501 was measured twice; being more than one thousand years too old, it can only be supposed that stratification was disturbed, possibly when dead-ice melted off.

B-439. Murifeld, 281 cm depth	10,580 ± 120 8630 B.C.
B-440. Murifeld, 291 cm depth	10,580 ± 200 8630 B.C.
B-441. Murifeld, 429 cm depth	13,210 ± 400 11,260 B.C.
Samples from a pollen profile excavated a few years ago.	
B-501. Murifeld, 69 cm above horizon of reference	11,580 ± 200 9630 B.C.
B-500. Murifeld, 35 cm above horizon of reference	11,360 ± 200 9410 B.C.
B-499. Murifeld, 19.5 cm above horizon of reference	11,900 ± 200 9950 B.C.
B-497. Murifeld, 5.5 cm above horizon of reference	12,730 ± 200 10,780 B.C.
B-683. Murifeld, 15 cm below horizon of reference	13,340 ± 200 11,390 B.C.
B-684. Murifeld, 42 cm below horizon of reference	13,860 ± 200 11,910 B.C.

Mont Carré series, Switzerland

Peat and gyttja from Mont Carré, small bog in Val d'Héremence, Valais (46° 9' 11" N Lat, 7° 22' 12" E Long, alt 2290 m). Coll. Aug. 1964 and subm. by M. Welten. *Comment* (M.W.): the 3 samples give an approx. idea of the chief period of development of Hypnaceae-bog situated high above actual timberline. In this case organic matter originates from Atlantic and subboreal time. Within this period accumulation of moss-turf was ca. 0.33 mm/yr. Vegetational history is recorded palynologically.

B-627. Mont Carré, 63 cm depth	4800 ± 120 2850 B.C.
B-628. Mont Carré, 88 cm depth	5260 ± 120 3310 B.C.
B-629. Mont Carré, 140 cm depth	6740 ± 150 4790 B.C.

Gondo-Alpje series, Switzerland

Peat and gyttja from Gondo-Alpje, Valais (46° 12' 30" N Lat, 8° 6' 50" E Long, alt 1635 m). Coll. Sept. 1965 and subm. by M. Welten. *Comment* (M.W.): the 5 samples date vegetational history and different sand-layers, thought to be climatological indices on southern slope of Alps.

		1400 ± 100
B-699.	Gondo-Alpje, 77 cm depth	A.D. 550
		3060 ± 120
B-630.	Gondo-Alpje, 192 cm depth	1110 B.C.
		3740 ± 120
B-631.	Gondo-Alpje, 287 cm depth	1790 B.C.
		4670 ± 130
B-632.	Gondo-Alpje, 387 cm depth	2720 B.C.
		5310 ± 200
B-633.	Gondo-Alpje, 430 cm depth	3360 B.C.

Simplon-Hopschensee series, Switzerland

Samples of gyttja and clay-gyttja were taken by boring with Hiller-sampler at Simplon-Hopschensee, Valais (46° 15' 12" N Lat, 8° 1' 25" E Long, alt 2018 m). Coll. Oct. 1963 by M. Welten and K. Heeb; subm. by M. Welten. *Comment* (M.W.): investigations over two years with repeated sampling and remeasuring have convincingly confirmed existence of a layer of Alleröd-mud at the extremely high altitude of 2017 m above sealevel. Up to now the highest altitudes where Alleröd was clearly proved by pollen-analysis were not much above 1500 m, most higher localities having too little organic matter for C¹⁴-dating and yielding only clay and boulder material during late-glacial period. Result seems to fall in Bölling-period, but the pollen diagram is against this interpretation. Considering the standard deviation of B-608, an Alleröd date is not ruled out. Other results date stages of vegetational history to be discussed elsewhere. B-636 proved an early invasion-peak of spruce in the pollen diagram to be a mistake, resulting from pollen contamination during boring.

		660 ± 80
B-634.	Simplon-Hopschensee, 97 cm depth	A.D. 1290
		3230 ± 100
B-669.	Simplon-Hopschensee, 201 cm depth	1280 B.C.
		4500 ± 300
B-635.	Simplon-Hopschensee, 246 cm depth	2550 B.C.
		5040 ± 150
B-635E.	Simplon-Hopschensee, 277 cm depth	3090 B.C.

B-636. Simplon-Hopschensee, 328 cm depth	3970 ± 120
	2020 B.C.
B-610. Simplon-Hopschensee Gyttja, 22.5 cm above boulders and clay of Younger-Dryas-period.	7730 ± 180
	5780 B.C.
B-609. Simplon-Hopschensee Gyttja, 7.5 cm above the boulder-and-clay layer.	9000 ± 150
	7050 B.C.
B-530. Simplon-Hopschensee Gyttja, 5 m above the boulder-and-clay layer.	9530 ± 250
	7580 B.C.
B-608. Simplon-Hopschensee 15 cm of clay-gyttja under the 70-cm thick layer of boulders and clay supposed to originate from Younger-Dryas-period.	12,580 ± 200
	10,630 B.C.

Hellelen-Zeneggen series, Switzerland

Peat and gyttja from peat-basin at Hellelen-Zeneggen, Valais (46° 17' 3" N Lat, 7° 50' 40" E Long, alt 1510 m). Coll. April 1965 and subm. by M. Welten. *Comment* (M.W.): series dates a remarkable sequence of organic sediments covering the whole postglacial period. Rate of sedimentation for gyttja between 6000 and 2000 B.C. reached 0.33 mm/yr, whereas between 1000 B.C. and A.D. 1400 1.6 mm of sedge-peat was formed each year. Consequently period of culture from Bronze Age to late Middle Ages is very well developed in pollen diagram. Details will be published later.

B-637. Hellelen-Zeneggen, 113 cm depth	1200 ± 100
	A.D. 750
B-724. Hellelen-Zeneggen, 210 cm depth	1775 ± 100
	A.D. 175
B-638. Hellelen-Zeneggen, 270 cm depth	2320 ± 100
	370 B.C.
B-639. Hellelen-Zeneggen, 438 cm depth	3120 ± 120
	1170 B.C.
B-640. Hellelen-Zeneggen, 480 cm depth	3920 ± 100
	1970 B.C.
B-723. Hellelen-Zeneggen, 562 cm	5970 ± 120
	4020 B.C.
B-641. Hellelen-Zeneggen, 622 cm depth	8160 ± 130
	6210 B.C.

Krauchtal series, Glarus, Switzerland

Wood fragments found in deposits from a landslide during technical borings near Krauchtal (46° 58' 32" N Lat, 9° 13' 34" E Long, alt 1400 m). Coll. and subm. Nov. 1964 by Chr. Schaerer and Crettaz, ETH, Zürich.

B-660. Krauchtal **3560 ± 120**
1610 B.C.
From uppermost part of landslide deposit.

B-661. Krauchtal **6395 ± 150**
4445 B.C.
From an under part of landslide deposit.

Robiei series, Val Bavona, Switzerland

Fragments of trees found during excavation work in a peat deposit above present timberline at Robiei, Val Bavona, Ticino (46° 26' 40" N Lat, 8° 30' 56" E Long, alt 1880 m). Coll. 1964 and subm. by Maggia Kraftwerke, Locarno.

B-675a. Trunk (Larix decidua) **6200 ± 100**
4250 B.C.

B-675b. Bough (Pinus cembra) **4520 ± 100**
2570 B.C.

Basel series, Pfalz, Switzerland

Bones from tombs found on the Pfalz behind the minster of Basle (47° 34' N Lat, 7° 35' E Long). Coll. August 1965 and subm. by R. Moosbrugger, Basle. *Comment* (R.W.): C¹⁴ ages show that tombs are contemporary or a little older than adjacent Carolingian crypt from beginning of 9th century A.D.

B-681. Tomb 2 **1180 ± 120**
A.D. 770

B-682. Tomb 2, "Vorbestattung" **1310 ± 100**
A.D. 640

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BERLIN RADIOCARBON MEASUREMENTS II

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This date list covers age measurements carried out at the Radiocarbon Dating Laboratory of the German Academy of Sciences of Berlin (DAW) since 1963 and is a continuation of our first date list (Berlin I). Procedures and methods of preparing the samples are essentially the same. We completed our laboratory with a second electronic counting apparatus. Two further proportional counters with internal anticoincidence (Houtermann-Oeschger counters) are made from an old railway-car axle. The total volume of these counters is 4 L, the effective volume 2.2 L, the background 2.0 counts/min at 700 Torr (acetylene filling), and the contemporary standard value (0.95 NBS oxalic acid) is 20 counts/min. Each sample is measured twice, first for 48 hr and after 8 days for another 24 hr. Data have been calculated on the basis of a C^{14} half-life of 5570 yr (Godwin, 1962). Errors listed include the standard deviations (1σ) of the counting rates of the contemporary samples, the background and the unknown samples. Calculated errors less than 100 yr have been increased to that figure as a minimum.

Corrections have not been made for C^{13} content. Mass spectrometric C^{13} measurements of some samples indicate that errors resulting from fractionation are minimal.

I. ARCHAEOLOGIC SAMPLES

The dates published are part of a research program of the Institut für Vor- und Frühgeschichte of the German Academy of Sciences, covering mainly the Neolithic period in Central and South East Europa. In order to help clear up certain chronologic questions, stratigraphically reliable finds were given preference. Cooperation with the Inst. of Archaeol. of the Bulgarian Acad. of Sciences in Sofia for the first time made it possible to date several stages in the East Balkan Karanovo civilization by means of numerous samples from Tell Azmak and Tell Karanovo. It appeared that the vast majority of C^{14} data agree with those of the relative (stratigraphic) chronology. According to C^{14} analysis, 18 out of 20 datings of the early Karanovo I/II culture, for instance, are of the first half of the 5th millennium, while the same number of datings of the stratigraphically later Karanovo V and VI stages date back to between 4000 and 3500 B.C.

The first series of measurements of a European Tell settlement is of interest also from the point of view of method. The difference in measured values of samples of the same settlement stratum may be as great as 500 yr, so with only few datings there can be no clear temporal differentiation between two successive settlement phases. In a number of cases even greater differences may occur, due to possible contamination and the differing age of timber. Better results may be expected from

measuring cereals stored in vessels, the age of which usually coincides with the date of the destruction of the settlement.

Considering radiocarbon measurements as well as archaeological findings (Georgiev, 1961) the South Bulgarian Karanovo I/II culture appears to be a Neolithic civilization probably influenced directly from the Near East. The late Starčevo-Körös civilization, the Sesklo culture in Thessaly, and the Chalcolithic Hacilar I/II and Can Hasan stages in Anatolia developed almost simultaneously. According to C^{14} data, Karanovo V and especially VI turn out to be parallel to the beginning of the Vinča-Pločnik stage, the early Gumelnița, Cucuteni and Lengyel civilizations, as well as to the Central European Stroke-ornamented ware (Stichbandkeramik). Therefore the Karanovo III and IV stages, necessarily dating back to the latter half of the 5th millennium according to stratification, have been identified with the beginning Vinča and Theiss cultures, the Romanian Bojan culture and probably with the early Dimini stages as well. Thus the early dating of the Balkan Neolithic period so far apparent from a number of isolated C^{14} dates has been confirmed once more via the Karanovo chronology.

The resulting consequences for the absolute chronology of the Neolithic period in Central Europe can be given only in outline. As far as Linear pottery (Linienbandkeramik), the earliest Neolithic civilization in this area, is concerned we have nearly 40 C^{14} dates of the latter half of the 5th millennium. Although its initial stage is insufficiently dated due to the highly contradictory measurements of ceramic material (Berlin I), we must assume that the beginning of Linear pottery dates back to the time of the late Starčevo-Körös and Karanovo I/II civilizations (Quitta, 1964). By means of radiocarbon measurements the much-debated question of the origin of the spiral meander ornament should be settled too in favor of a Balkan-Anatolian origin. The end of Linear pottery phase and the transition to Stroke-ornamented ware has been fixed by several dates of the early 4th millennium. Some measurements of Berlin II are single dates, which should not be overrated in their bearing on chronology.

Dates are expressed as before A.D. 1950. Where the archaeological data are unpublished, we have quoted descriptions and cultural assignments kindly provided by the excavators or their sponsoring institutions. We wish to express our thanks for botanical determinations to Frau Dr. M. Hopf, Römisch-Germanisches Zentralmuseum, Mainz, and also to Herr Dr. K.-D. Jäger, Berlin.

SAMPLE DESCRIPTIONS

A. German Democratic Republic

Bln-163. Dessau-Mosigkau

1360 ± 100

A.D. 590

Charcoal (*Quercus robur* L.) from Slavic dwelling site at Dessau-Mosigkau (51° 48' N Lat, 12° 10' E Long), Kr. Dessau. Sample from

wooden rafter in eastern part of Pit-house No. 6, dug to 0.70 m depth in sand. Assigned to Early Slavic period of 7th to 8th century. Excavated 1962 and subm. by B. Krüger, Inst. f. Vor- u. Frühgesch. d. DAW, Berlin (Krüger, 1964). *Comment:* C¹⁴ date of the so-called "Prager Typus" agrees with expected age of immigration of Slavic tribes in Middle Germany.

Bln-353. Dessau-Mosigkau

1046 ± 150

A.D. 904

Charcoal (*Quercus robur* L.) from same site of Pit-house No. 16, 0.45 m depth. Coll. June 14, 1964. *Comment:* date is much younger than Bln-163; possibly sample was contaminated by recent organic matter.

Bln-251. Dresden-Prohlis

7047 ± 100

5097 B.C.

Extracted humic acid from black-brown filling material of a Neolithic building pit in Dresden-Prohlis (51° 2' N Lat, 13° 49' E Long). Soil sample taken from Pit No. 4, sunk to 0.70 m below old surface and covered in post-medieval time by slope loam, 1 m thick. Pit filling contained potsherds belongs to old phase of Stichbandkeramik (Baumann, Czerney, and Fiedler, 1964). Coll. and subm. by W. Baumann, Landesmus. f. Vorgesch., Dresden. *Comment:* in contradiction to another dates of Stichbandkeramik, Bln-251 shows relatively high age, possibly because of admixture of humic matter from an older soil. Extraction was made by Institut für Bodenkunde d. Technischen Univ., Dresden by HCl treatment followed by 1% NaOH. Sample contained 8.8% carbon.

Bln-248. Helmsdorf

3613 ± 160

1663 B.C.

Wood (*Quercus sessiliflora* Smith) from "prince-burial" at Helmsdorf, locality Heiligenthal (51° 36' N Lat, 11° 38' E Long), Kr. Hettstedt. Sample from wooden deathbed (Totenbett), situated ca. 5.50 m below tumulus surface, inside the wooden tomb. Belongs to late phase of Aunjetitz culture. Excavated 1906 by H. Grössler, Mus. Eisleben; subm. 1963 by H. Behrens, Landesmus. f. Vorgesch., Halle (Grössler, 1907). *Comment:* agrees with expected age.

Bln-231. Kmehlen

5360 ± 160

3410 B.C.

Grain (*Triticum dicoccum* Schübl, *Triticum compactum* Host) from Neolithic settlement at Kmehlen (51° 23' N Lat, 13° 44' E Long), Kr. Grossenhain. From cylindrical storage-pit (32.50 m E/2.0 m S), sunk to 0.80 m depth in yellow loess loam. Although pit is situated inside a Linear pottery house, sherds in pit belong to very early phase of Funnel-Beaker culture (Baalberg-Gatersleben group?); one sherd is stroke-ornamented and influenced from late Stichbandkeramik. Excavated Nov. 1963 (continued March 1966) and subm. by W. Baumann, Landesmus. f. Vor-u. Frühgesch., Dresden (Baumann, 1965). *Comment:* date is impor-

tant, because transition from early to middle Neolithic is dated for the first time in Central Germany.

6045 \pm 120

4095 B.C.

Blm-250. Köttichau

Extracted humic acid from A-horizon of chernozem soil below Neolithic barrow near Köttichau (51° 8' N Lat, 12° 8' E Long), Kr. Hohenmölsen. Soil sample was taken in center of the 3-m-high mound, 30 to 50 cm below upper boundary of old A-horizon (old Neolithic surface). Stratigraphic relations show chernozem is older than the burial belonging to the Salzmünder group of Funnel-Beaker culture. Coll. 1962 by G. Billig, Halle; subm. by W. Baumann (Billig, 1962). *Comment:* agrees with supposed age of fossil chernozem. Extraction was carried out as for Blm-251. Sample contained 11.4% carbon (Czerney, 1965).

2860 \pm 120

910 B.C.

Blm-398. Ichtershausen

Charcoal and grain (*Hordeum* sp., *Triticum monococcum* L., *Triticum dicoccum*) from Bronze-age settlement near Ichtershausen (50° 52' N Lat, 10° 58' E Long), Kr. Arnstadt. From lower part of Storage-pit No. 11, dug to 0.35 m in loess loam. Assigned to late "Urnenfelderkultur" (probably "Unstrutgruppe") on basis of other settlement finds. Coll. 1962 and subm. by R. Feustel, Mus. f. Ur- u. Frühgesch. Thüringens, Weimar (Feustel and Gall, 1965). *Comment:* date agrees with supposed age of settlement.

13,700 \pm 380

11,750 B.C.

Blm-220. Königsee-Garsitz

Soil sample with bone-charcoal from cave "Bärenkeller" near Königsee-Garsitz (50° 58' N Lat, 11° 5' E Long), Kr. Rudolstadt. Found in a fireplace, ca. 20 m from entrance of cave. Suggested assignment to Gravettian or early Magdelénian. Coll. and subm. by R. Feustel. *Comment:* on typological evidence Feustel considers Bärenkeller to be earlier (beginning of Würm III Stadial) than C¹⁴ date. Possibly sample was contaminated by organic matter of Neolithic and Bronze-age levels above fireplace.

3830 \pm 100

1880 B.C.

Blm-166. Forst Leina

Charcoal (*Quercus sessiliflora*) from Barrow III in Forst Leina, SE of Altenburg (50° 58' N Lat, 12° 31' E Long), Kr. Altenburg. Sample was taken 0.90 m below surface from burnt plankwall, bordering Burial E. Belongs to "Ostsaalische Gruppe" of younger central German Corded ware. Coll. 1962 and subm. by V. Weber, Landesmus. f. Vorgesch., Dresden (Weber, 1964). *Comment:* date agrees with numerous C¹⁴ measurements of Corded ware.

2063 \pm 100

113 B.C.

Blm-225. Radibor-Brohna

Charcoal (*Quercus sessiliflora*) from Slavic fortification at Radibor-Brohna (51° 15' N Lat, 14° 24' E Long), Kr. Bautzen. From burned

layer inside of wall (Point A III, Planum 8). Suggested assignment to Middle Slavic period (10th to 11th century). Coll. 1951 and subm. by W. Coblenz, Landesmus. f. Vorgesch., Dresden (Coblenz, 1951). *Comment*: date is much older than expected. As Slavic town wall was set up in a settlement of late Hallstatt period (Billendorfer group), it is possible that charcoal was re-buried.

Bln-176. Rehmsdorf**5932 \pm 100****3982 B.C.**

Wood (*Quercus* sp.) from stake construction of quadrangular timbered well at Rehmsdorf (51° 2' N Lat, 12° 7' W Long), Kr. Zeitz. Sample represents inmost part of round wooden stake of 18 cm diam. Well was sunk to 5 to 6 m depth in a browncoal seam and was filled with sandy loam. Dated by pottery on bottom of well to late phase of Linear pottery (Šarka Typ). Coll. 1921 by E. Amende; subm. by H. Höckner, Mus. Altenburg (Amende, 1928). *Comment*: agrees with measurements of same Linear pottery phase from Dresden-Nickern (Bln-73: 5955 \pm 100, Berlin I).

Bln-212. Reitzenhain**1024 \pm 160****A.D. 926**

Wood (*Betula* sp.) of a yoke from peatbog near Reitzenhain (50° 33' N Lat, 13° 14' E Long), Kr. Marienberg. Found 1896 in peat cutting, 1.75 m depth below surface. Dating unknown; suggested age on basis of pollen-analysis by Firbas was from Bronze age to modern. Yoke is kept in Mus. Marienberg/Erzgebirge. Subm. 1963 by W. Jacobeit, Inst. f. Volkskunde der DAW, Berlin (Tackenberg, 1939). *Comment*: medieval dating eliminates a supposed prehistoric age of the yoke.

Bln-342. Serrahn**4166 \pm 120****2216 B.C.**

Charcoal (*Quercus sessiliflora*) from Megalithic grave at Serrahn (53° 38' N Lat, 12° 22' E Long), Kr. Güstrow. Sample, dispersed between skeletal remains, was taken from a 20-cm-thick loamy layer on floor of enlarged dolmen, ca. 1.10 m below tumulus-surface. Burial was secondary and belonged to Globular Amphorae culture. Coll. 1964 and subm. by E. Schuldt, Mus. f. Vor- u. Frühgeschichte, Schwerin. *Comment*: date is acceptable compared to dates of late Funnel Beaker culture and Corded ware.

Bln-162. Tornow**1125 \pm 100****A.D. 825**

Grain (*Secale cereale* L.) from an early medieval fortification (Burg-wall) at Tornow (51° 31' N Lat, 13° 50' E Long), Kr. Calau. Taken from a wooden box at Granary 3 in second fortification (B), ca. 2.80 m below top of wall. Assigned to Old Slavic period (beginning of 9th century). Coll. 1962 and subm. by J. Herrmann, Inst. f. Vor- u. Frühgesch. d. DAW, Berlin (Herrmann, 1966). *Comment*: in agreement with archaeological dating of the Tornow group.

2138 ± 80**Bln-164. Wüste Kunersdorf****188 B.C.**

Charcoal (*Quercus sessiliflora*) from settlement of Younger Bronze age, Late Iron period and Roman Empire time at Wüste Kunersdorf (52° 24' N Lat, 14° 31' E Long), Kr. Seelow. Taken from culture layer in Sector E 102, 0.80 m below surface. Assigned to Late Iron age (Vor-römische Eisenzeit). Coll. 1962 and subm. by R. Laser, Inst. f. Ur- u. Frühgesch. d. Humboldt-Univ., Berlin (Seyer, 1962).

*B. Bulgaria***Tell Azmak series**

Tell of Azmak is 6 km E of Stara Zagora (42° 27' N Lat, 25° 46' E Long), in southern Bulgaria. Excavations of the whole prehistoric mound between 1960 and 1963 were directed by G. I. Georgiev of Archaeol. Inst. of Bulgarian Acad. of Sciences in Sofia. The mound, with diam of 80 m and height of 7.94 m above marsh level, gave stratigraphic succession from Neolithic to Early Bronze age. Cultural layers were accumulated up to thickness of 7.5 m, of which 3 m belonged to Neolithic and 4.5 m to Eneolithic and Bronze age. In Neolithic period five dwelling horizons of Karanovo I culture and a much destroyed sixth level of Karanovo III were observed. After a break, Eneolithic occupation accumulated ca. 3.80 m with eight dwelling horizons; lower four belong to Karanovo V and top four to Karanovo VI culture (Georgiev, 1965). Most charcoal samples were burned wooden posts or carbonized grain and seeds from ovens, storage vessels, and pits. Coll. and subm. by G. I. Georgiev, Sofia.

In the following list depths are stated in heights above level of Azmak Lake. All samples with exception of Bln-134 and 135 were coll. in eastern part of mound. Grid references are to areas of 5 x 5 m.

7158 ± 150**Bln-291. Karanovo I culture: I-1****5208 B.C.**

Charcoal sample 1/64 (*Quercus* sp.) from Area 84-b in Level I-1, 1.13 m high. Coll. July 10, 1962.

6878 ± 100**Bln-292. Karanovo I culture: I-1****4928 B.C.**

Grain sample 2/64 (*Triticum dicoccum*, *T. monococcum*) from Area 84-a in Level I-1, 0.96 m high. Coll. Aug. 22, 1962.

7303 ± 150**Bln-293. Karanovo I culture: I-1****5353 B.C.**

Charcoal sample 3/64 (*Quercus* sp.) from Area 85-w in Level I-1, 0.66 m high. Coll. Aug. 18, 1962.

6768 ± 100**Bln-294. Karanovo I culture: I-1****4818 B.C.**

Charcoal sample 4/64 (*Quercus* sp.) from Area 85-w in level I-1, 0.66 m high. Coll. Aug. 20, 1962.

- Bln-296. Karanovo I culture: I-2** **6779 \pm 100**
4829 B.C.
 Charcoal sample 6/64 (*Quercus* sp.) from Area 99-b in Level I-2,
 1.40 m high. Coll. July 30, 1962.
- Bln-295. Karanovo I culture: I-2** **6720 \pm 100**
4770 B.C.
 Grain sample 5/64 (*Triticum dicoccum*, *T. aestivum* L., sens. lat.)
 from Area 83-w in Level I-2, 1.11 m high. Coll. Oct. 9, 1962.
- Bln-299. Karanovo I culture: I-3** **6812 \pm 100**
4862 B.C.
 Charcoal sample 9/64 (*Fraxinus* cf. *ornus* L.) from Area 99-b in
 Level I-3, 1.69 m high. Coll. July 24, 1962.
- Bln-297. Karanovo I culture: I-3** **6675 \pm 100**
4725 B.C.
 Grain sample 7/64 (*Triticum dicoccum*, *T. aestivum* L., sens. lat.)
 from Area 100-a in Level I-3, 2.16 m high. Coll. Aug. 10, 1962.
- Bln-298. Karanovo I culture: I-3** **6540 \pm 100**
4590 B.C.
 Charcoal sample 8/64 (*Quercus* sp.) from Area 100-a in Level I-3,
 2.16 m high. Coll. Aug. 10, 1962.
- Bln-301. Karanovo I culture: I-4** **6483 \pm 100**
4533 B.C.
 Charcoal sample 11/64 (*Quercus* sp.) from Area 70-g in Level I-4,
 2.41 m high. Coll. July 11, 1962.
- Bln-300. Karanovo I culture: I-4** **6426 \pm 150**
4476 B.C.
 Charcoal sample 10/64 (*Quercus* sp.) from Area 132-b in Level I-4,
 2.14 m high. Coll. July 27, 1962.
- Bln-430. Karanovo I culture: I-5** **6279 \pm 120**
4329 B.C.
 Seed sample 10/65 (*Lathyrus* cf. *cicera* L., *Vicia* cf. *angustifolia* L.,
Pisum sp.) from Area 85-a in Level I-5, 2.24 m high. Coll. May 14, 1962.
- Bln-203. Karanovo I culture** **6880 \pm 100**
4930 B.C.
 Charcoal (*Quercus* cf. *pubescens* Willd.) from burned layer at east-
 ern side of central profile, 1.88 m high. Coll. June 13, 1963 and subm.
 by H. Quitta.
- Bln-267. Karanovo I culture** **6758 \pm 100**
4808 B.C.
 Powdered charcoal (unidentifiable) with same position as Bln-203.
- Bln-224. Karanovo I culture** **6652 \pm 150**
4702 B.C.
 Charcoal (*Quercus* sp.) from same profile, probably Level I-4, 2.18
 m high. Coll. June 13, 1963 and subm. by H. Quitta.

- Bln-136. Karanovo V culture: III-2** **5840 ± 100**
3890 B.C.
Charcoal sample 6/62 (*Quercus* sp.) from Area 84-a in Level III-2, 4.20 m high. Coll. Oct. 11, 1961.
- Bln-143. Karanovo V culture: III-2** **5737 ± 150**
3787 B.C.
Seed sample 13/62 (*Vicia* cf. *angustifolia*) from Area 70-w in Level III-2, 3.80 m high. Coll. Oct. 30, 1961.
- Bln-150. Karanovo V culture: III-2** **5630 ± 150**
3680 B.C.
Grain sample 20/62 (*Hordeum vulgare* L., subsp. *polystichum* var. *nudum*) from Area 83-g in Level III-2, 4.20 m high. Coll. Oct. 13, 1961.
- Bln-151. Karanovo V culture: III-3** **5829 ± 100**
3879 B.C.
Seed sample 21/62 (*Vicia* cf. *angustifolia*, *Hordeum vulgare*, *polystichum* var. *nudum*, *Lens* cf. *esculenta* Moench) from Area 69-g in Level III-3, 3.60 m high. Coll. Oct. 11, 1961.
- Bln-148. Karanovo V culture: III-3** **5760 ± 150**
3810 B.C.
Seed sample 18/62 with same species and same positions as Bln-151.
- Bln-142. Karanovo V culture: III-4** **5803 ± 150**
3853 B.C.
Grain sample 12/62 (*Hordeum vulgare polystichum* var. *nudum*, *Lens* cf. *esculenta*) from Area 84-a in Level III-4, 4.70 m high. Coll. Aug. 15, 1961.
- Bln-137. Karanovo V culture: III-4** **5697 ± 100**
3747 B.C.
Charcoal sample 7/62 (*Quercus* sp.) from Area 115-w in Level III-4, 5.30 m high. Coll. July 31, 1961.
- Bln-147. Karanovo V culture: III-4** **5219 ± 150**
3269 B.C.
Grain sample 17/62 (*Hordeum vulgare polystichum* var. *nudum*) from Area 97-w in Level III-4, 4.35 m high. Coll. Nov. 14, 1961.
- Bln-149. Karanovo VI culture: IV-1** **5888 ± 100**
3938 B.C.
Grain sample 19/62 (*Hordeum vulgare polystichum* var. *nudum*, *Triticum monococcum*, *Pisum* cf. *elatius* Stev) from Area 84-w in Level IV-1, 4.00 m high. Coll. Aug. 31, 1961.
- Bln-145. Karanovo VI culture: IV-1** **5390 ± 100**
3440 B.C.
Seed sample 15/62 (*Lens* cf. *esculenta*, *Vicia* cf. *angustifolia*, *Hordeum vulgare polystichum* var. *nudum*) from Area 116-b in Level VI-1, 5.70 m high. Coll. July 8, 1961.

- Bln-146. Karanovo VI culture: IV-1** **5035 \pm 150**
3085 B.C.
Grain sample 16/62 (*Hordeum vulgare polystichum* var. *nudum*) from Area 84-w in Level VI-1, 5.60 m high. Coll. July 11, 1961.
- Bln-131. Karanovo VI culture: IV-2** **5717 \pm 100**
3767 B.C.
Charcoal sample 1/62 (*Viburnum* sp., *Carpinus* sp., *Ulmus* sp.) from Area 99-b in Level IV-2, 6.21 m high. Coll. Aug. 11, 1960.
- Bln-139. Karanovo VI culture: IV-2** **5703 \pm 100**
3753 B.C.
Seed sample 9/62 (*Vicia* cf. *angustifolia*) from Area 83-g in Level IV-2, 6.04 m high. Coll. Aug. 11, 1960.
- Bln-144. Karanovo VI culture: IV-2** **5597 \pm 120**
3647 B.C.
Seed sample 14/62 with same species and same positions as Bln-139.
- Bln-135. Karanovo VI culture: IV-3** **5700 \pm 100**
3750 B.C.
Charcoal sample 5/62 (*Fraxinus* sp.) from Area 113-b (western part) in Level IV-3, 6.00 m high. Coll. Aug. 8, 1960.
- Bln-138. Karanovo VI culture: IV-3** **5621 \pm 200**
3671 B.C.
Charcoal sample 8/62 (*Ulmus* sp.) from Area 115-a in Level IV-3, 6.81 m high. Coll. July 11, 1960.
- Bln-141. Karanovo VI culture: IV-3** **5620 \pm 100**
3670 B.C.
Grain sample 11/62 (*Triticum monococcum*, *T. dicoccum*) from Area 84-b in Level IV-3, 5.90 m high. Coll. Aug. 10, 1960.
- Bln-134. Karanovo VI culture: IV-3** **5520 \pm 200**
3570 B.C.
Charcoal sample 4/62 (*Quercus* sp.) from Area 98-b (western part) in Level IV-3, 6.21 m high. Coll. Apr. 19, 1960.

General Comment: C¹⁴ measurements of Azmak levels for the most part agree with cultural sequence and archaeological interpretation (see table, fig. 1). Averages are best calculated from grand total of C¹⁴ counts of dwelling levels from Karanovo I culture, as follows: Level I-5, 4329 B.C.; Level I-4, 4522 B.C.; Level I-3, 4696 B.C.; Level I-2, 4794 B.C.; and Level I-1, 4932 B.C.

Dates for Bln-293 and Bln-291 appear to be too old, but may mean that oak timber used for house construction was sometimes much older than age of settlement. The proven break in continuity of occupation of Azmak mound after the Karanovo III layer coincides with the big time gap between Neolithic and Eneolithic dates. Average of all eight dates from Karanovo V culture is 3743 B.C., or 3810 B.C. without Bln-147, which seems to be too young. C¹⁴ dates of the Karanovo VI culture may seem

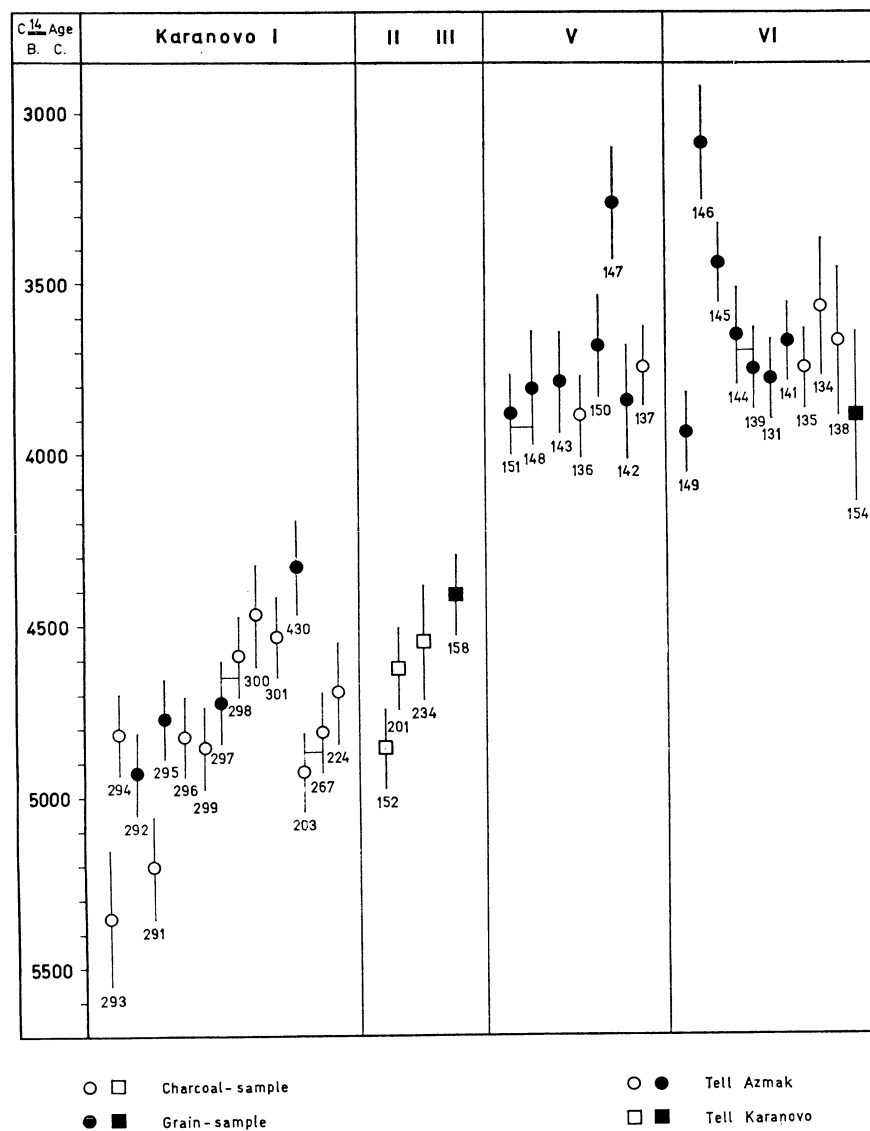


Fig. 1. C^{14} dates, arranged in stratigraphic order, at two early Neolithic sites in southern Bulgaria.

surprisingly high; average of second dwelling level is 3732 B.C. and of third level 3664 B.C. However, equivalent measurements of late Karanovo culture from Chotnica (see Bln-125, this list) and other samples dated at Groningen (Groningen IV and V) from a middle phase of Gumelnița culture (GrN-1987, GrN-3025, GrN-3028) and the related Salcuța group (GrN-1989, GrN-1990), as well as dates of Vinča-Pločnik (GrN-1974, GrN-1542), confirm the early C¹⁴ age of Balkan Eneolithic period. This is very complicated problem and we hope that new measurements of Early Bronze age (Karanovo VII) and similar cultures in the Danubian plain and in Anatolia will help to solve it. Some dates of the Azmak series do not fall in line with their stratigraphical position, but this may be caused by minor archaeological disagreement or by secondary contamination. No explanation can be given for great differences between three dates (Bln-145, 146, 149) of the first dwelling level from Karanovo VI culture.

Tell Karanovo series

Tell Karanovo is 9 km NW of Nova Zagora (42° 30' N Lat, 25° 56' E Long) in Southern Bulgaria. Excavations in four sectors between 1947 and 1957 were directed by V. Mikov and G. I. Georgiev of Archaeol. Inst. of the Bulgarian Acad. of Sciences in Sofia. The 12.40-m-high mound, 180 to 250 m in diam, is one of the largest in the Balkans. Profile indicates a complete cultural sequence from Neolithic (Karanovo I-IV) through Eneolithic (Karanovo V-VI) to Early Bronze age (Karanovo VII). A further distinction is possible on basis of building horizons, but is not elaborated here (Mikov, 1959; Georgiev, 1961).

Bln-152. Karanovo II culture

**6807 ± 100
4857 B.C.**

Charcoal sample 22/62 (*Quercus* sp.) from Sector III in SW side of mound, Level II. Coll. June 19, 1949 and subm. by V. Mikov/G. I. Georgiev, Sofia.

Bln-201. Karanovo II culture

**6573 ± 100
4623 B.C.**

Charcoal (*Quercus* sp.) from burned building horizon in northern profile of Sector III. Sample, associated with Karanovo II potsherds, was taken at 1.40 m above ground level. Coll. June 14, 1963 and subm. by H. Quitta.

Bln-234. Karanovo II culture

**6500 ± 150
4550 B.C.**

Charcoal (*Quercus* cf. *pubescens* Willd.) from same building horizon as Bln-201, but taken from eastern profile of Sector III. Coll. June 14, 1963 and subm. by H. Quitta.

Bln-158. Karanovo III culture

**6360 ± 100
4410 B.C.**

Grain sample 28/62 (*Triticum dicoccum*, *T. monococcum*, *Hordeum vulgare* var. *nudum*) from Sector IV in NE side of mound, Level

III, 8.90 m below surface. Coll. Nov. 1954 and subm. by V. Mikov/G. I. Georgiev.

Bln-154. Karanovo VI culture

5840 ± 250

3890 B.C.

Grain sample 24/62 (*Triticum dicoccum*, *Hordeum vulgare polystichum* var. *nudum*, *Vicia* cf. *angustifolia*) from Sector IV, taken from destroyed house in Level VI, 2.70 m below surface. Coll. Oct. 10, 1949 and subm. by V. Mikov/G. I. Georgiev.

General Comment: Bln-154 is older than expected age for end of Karanovo VI culture. Other dates of Karanovo II and III seem acceptable in comparison with Azmak dates.

Bln-125. Chotnica

5560 ± 100

3610 B.C.

Grain (*Triticum dicoccum*, *T. monococcum*) from upper dwelling horizon of Tell Chotnica (43° 8' N Lat, 25° 28' E Long), district Tarnovo. Taken in western part of mound, 5 m high, from burned layer of House 2, 0.90 m below surface. Belongs to late Eneolithic period (Karanovo VI). Coll. 1956 and subm. by N. Angelov, Arch. Mus. Tarnovo (Angelov, 1958). *Comment:* agrees with dates of same period in Bulgaria and also with dates of related Gumelnița culture in Romania.

Bln-202. Kapitan Dimitriev

4242 ± 100

2292 B.C.

Bln-405.

4075 ± 100

2125 B.C.

Grain (*Triticum dicoccum*, *T. monococcum*) from the Tell "Banjata," 1.5 km W of Kapitan Dimitriev (42° 5' N Lat, 24° 22' E Long), district Pasardžik in southern Bulgaria. Taken from destroyed dwelling horizon 6 m below surface; mound was 12 m high. Assigned on basis of Kapitan Dimitriev sequence to Eneolithic period (Karanovo V/VI). Excavated 1947 and subm. by P. Detev, Arch. Mus. Plovdiv (Detev, 1950; Georgiev, 1961). *Comment:* neither date agrees with C¹⁴ age of other Karanovo V and VI sites. As top level of Banjata mound represents remains of Early Bronze age, it seems possible that grain belonged to later period.

C. Czechoslovakia

Bln-239. Tušimice

4768 ± 100

2818 B.C.

Charcoal (*Pirus* sp.) from Neolithic flint mine at Tušimice (50° 23' N Lat, 13° 21' E Long), Kr. Teplice, from Fireplace No. 1 on bottom of vertical pit, cut to 3.50 m depth in sandstone. Archaeological assignment unknown; no sherds in association with object. Only a few hammerstones and artifacts of quartzite and bone were found in the fill. Surface finds of Bandkeramik and TRB culture (probable Řivnač group). Coll.

1962 and subm. by E. Neustupný, Archeol. ústav ČSAV—Expositur Most (Neustupný, 1963). *Comment:* evidently dates mining activity in the Eneolithic period.

Bln-240. Žalany

5881 ± 100

3931 B.C.

Charcoal (*Quercus* sp.) of Bandkeramik dwelling site at Žalany (50° 35' N Lat, 30° 54' E Long), Kr. Teplice; from Dwelling Pit No. 1, dug to 0.90 m depth below surface in loess loam and overlain by humus soil 40 cm thick. Assigned to early phase of Stichbandkeramik. Excavated 1958 by N. Mašek, Town Mus. Prag; subm. by E. Neustupný, Arch. ústav ČSAV—Expositur Most. *Comment:* Bln-240 agrees with dates of Zwenkau-Harth (Bln-66, 5900 ± 100; K-555, 5840 ± 120; H-224/223, 6000 ± 115; see Berlin I), belonging to same phase of Stichbandkeramik.

D. Hungary

Bln-404. Szamossályi

6136 ± 100

4186 B.C.

Charcoal (*Fraxinus* cf. *excelsior* L.) from dwelling pit of Neolithic site at Szamossályi (47° 53' N Lat, 22° 36' E Long), Kom. Szabolcs. Assigned to local group of Linear pottery of NE Hungary. Coll. 1963 and subm. by J. Korek, Hungar. Nat. Mus. Budapest. *Comment:* no significant difference from date of Tarnabod (Bln-123, 6280 ± 100, Berlin I), also belonging to Alföld group of Linear pottery.

II. GEOLOGIC SAMPLES

A. The Lusitanian ice-marginal valley

History of the Lusitanian ice-marginal valley (LIMV)—Breslau-Magdeburg—is shown by important sections in brown coal opencasts near Cottbus (51° 31.0' N Lat, 14° 7.2' E Long). The LIMV, containing layers of peat and limnic sediments, was assigned to end of Warthe (pre-last) glacial epoch by Firbas and Grahmann (1928). Geological facts (Cepek, 1965) and C¹⁴ dates now transfer it to early Weichsel (last) glacial epoch. Brörup and Paudorf interstadials are represented in limnic-fluviatile facies. As soon as Brandenburg stage had attained its maximum extension during last glaciation, Spree River finished its break through Lusitanian frontier wall and stopped sedimentation in the LIMV. Thus C¹⁴ dating permits an indirect age determination for maximum extent of last glaciation in Central Europe. Date, ca. 20,000 B.P., is in accord with ground moraines of Main Wisconsin, the maximum extent of last inland ice in North American region of glaciation, which was obtained by direct C¹⁴ dating. Table I summarizes the results (A.G.C.). All samples of LIMV are coll. and subm. by A. G. Cepek, Zentrales Geologisches Institut der VVB Feste Minerale, Berlin N 4, Invalidenstrasse 44.

TABLE 1
Arrangement of the Weichsel glaciation by Radiocarbon Dates

Found in the LIMV	C ¹⁴ age B.P.	NE German arrangement*
		younger Dryas
Niemtsch;	11,000	
	11,130	Alleröd
Marga	11,440	
		older Dryas
		Bölling
		Pommeranian
		Blankenburg
Klein-Koschen, Skado	20,270	
	21,160	Brandenburg
Marga D; Skado; Lohsa	{ 25,670 }	
	{ 26,440 }	Paudorf
Marga C	30,415	
Marga B; Skado	>40,000	Brörup
Marga A ?		Amersfort
		Eem

* Arranged by A. G. Cepek, 1958.

Skado series, Lusitian ice-marginal valley

Samples from brown-coal open cast Skado near Sorno/Hoyerswerda, Bez. Cottbus (51° 31' N Lat, 14° 7.2' E Long).

Bln-99. Skado, No. 8 (59) **9905 ± 200**
7955 B.C.

Moss-peat, depth 7 m at base of an 0.9 m thick peat layer under sand. Pollen date, Preboreal (v. Bülow, 1926). Coll. 1959.

Bln-100. Skado, No. 2 (59) **21,825 ± 600**
19,875 B.C.

Muddy silt with peat, depth 10 to 11 m. Assigned to late Würm-glacial by Firbas and Grahmann. Coll. 1959.

Bln-104. Skado, No. 3 (59) **30,415 ± 700**
28,465 B.C.

Peat, depth 8 m.

Bln-108. Skado, No. 7 (59) **>40,000**

Muddy peat, depth 4.6 to 4.7 m. Late Warthe glacial, according to Firbas and Grahmann.

Bln-109. Skado, No. 6 (59) **>40,000**

Muddy peat, depth 5.3 to 5.4 m. Late Warthe glacial, according to Firbas and Grahmann.

- Bln-110. Skado, No. 5 (59)** **25,670 ± 600**
23,720 B.C.
Organic silt, depth 3.0 to 3.2 m. Late Warthe glacial, according to Firbas and Grahmann. *Comment* (A.G.C.): late Paudorf interstadial.
- Bln-111. Skado, No. 4 (59)** **22,110 ± 400**
20,160 B.C.
Organic silt, depth 3.5 to 3.7 m. Late Warthe glacial, according to Firbas and Grahmann. *Comment* (A.G.C.): late Paudorf interstadial.
- Bln-222. Skado, No. 2 (64)** **>40,000**
Lower Tropfenboden (mud with coarse organic detritus), depth 7.1 to 7.3 m. *Comment* (A.G.C.): Brörup interstadial.
- Bln-362. Skado, No. 1 (64)** **15,900 ± 650**
13,950 B.C.
Upper Tropfenboden (fine-sandy, slightly organic silt), depth 1.5 to 1.6 m.
- Bln-363. Skado, No. 3 (64)** **20,475 ± 600**
18,525 B.C.
Fine-sandy silt with plant remains, depth 3.0 to 3.1 m, post-Paudorf (A.G.C.).
- Bln-364. Skado, No. 4 (64)** **19,310 ± 1000**
17,360 B.C.
Fine-sandy silt with plant remains, depth 2.10 to 2.15 m.

Lohsa series

Samples from brown-coal open cast "Glück auf III" near Lohsa/Hoyerswerda, Bez. Cottbus (51° 23.2' N Lat, 14° 26.0' E Long). The importance of the Lohsa profile is its position near the S end of L.I.M.V. The overlying sands were spread as a *sandr*, outward from the bank of the Spree. Samples from measured section, as follows:

- 0.2 m Fill (boulders)
- 0.9 m Fine, somewhat silty sand
- 0.3 m Mud; Bln-359
- 1.4 m Fine, somewhat silty sand
- 0.5 m Clayey mud; Bln-360
- 0.85 m Fine sand with silt lenses
- 2.2 m Clayey mud with peaty inclusions; Bln-221
- 5.05 m Fine to medium sand, somewhat silty
- 0.7 m Clayey mud; Bln-361, 400 and 401
- >1 m Sand (base not exposed).

- Bln-359. Lohsa III No. 1** **A.D. 1112 ± 120**
Mud (filled whirlpool, Kolkfüllung), depth 1.2 to 1.3 m. *Comment*: according to pollen analysis (K. Erd) sample corresponds roughly to late Slavic time (ca. A.D. 1000).

Bln-360. Lohsa III No. 2 **25,246 ± 1000**

Clayey mud, slightly organic, depth 3.0 to 3.2 m. *Comment:* cryoturbation has disturbed the layers of sand and silt within and under the *sandr* (1 to 2 m thick) of the Spree. Pollen is dominantly NAP (95%), mainly grass and sedge. Sampled layer of clayey mud shows diminishing AP (Pinus, some Betula), and is assigned to the Paudorf interstadial (A.G.C.).

Bln-221. Lohsa III No. 3 **26,440 ± 800**

Peat lens in clayey mud, depth 5.8 to 5.9 m.

Bln-361. Lohsa III No. 4 **>40,000****Bln-400.** **33,105 ± 5000****Bln-401.** **>40,000**

Clayey mud, depth 11.7 to 11.8 m. Samples Bln-361 and 400 had HCl pretreatment only; Bln-401 had HCl and NaOH treatment, to remove humic acid. *Comment* (A.G.C.): horizon corresponds to Brörup interstadial of Skado. Clayey mud has only 20 to 30% NAP and is dominated by Pinus and Betula. All thermophiles (Abies, Picea, Carpinus and Corylus) are below 1%.

Niemtsch series

Samples from brown-coal open cast Niemtsch (51° 30.7' N Lat, 14° 3.4' E Long), Kreis Senftenberg, Bez. Cottbus. Sampled 1964 from measured section, as follows:

0.7 m Mud of "Schwarze Elster" river

0.7 m Sand

0.1 m Peat (Holocene?); Bln-375

4.9 m Sand, gravelly

0.4 m Mud, frost-contorted; Bln-376, "Tropfenboden"

8.0 m Sand, gravelly.

Bln-375. Niemtsch, 1964 **12,000 ± 640**
10,050 B.C.
 Peat.

Bln-376. Niemtsch, 1964 **>36,000**
 Tropfenboden, depth 6.5 to 6.7 m.

Bln-127a. Niemtsch, 1962 **11,130 ± 200**
9180 B.C.

Peat, from middle of layer, AP ca. 70 to 80% (85% Pinus, 10% Betula, 1 to 2% Picea).

Bln-127. Niemtsch, 1962 **11,440 ± 200**
9490 B.C.
 Wood, near basal peat.

Bln-128. Niemtsch, 1962**11,090 ± 200****9140 B.C.**

Muddy peat, ca. 80% AP (Pinus equals Betula, some Salix; K. Erd).
1962 section was as follows:

- 0.9 m Mud of "Schwarze Elster"
- 1.6 m Sand
- 0.15 m Muddy peat
- 1.35 m Fine sand with mud layers
- 0.4 m Peat; Bln-127, 127a and 128.

Comment: this series of Alleröd dates corresponds well to the pollen analysis (made by K. Erd).

Bln-101. Kerkwitz No. 1**27,200 ± 600****25,250 B.C.****Bln-101a.****27,800 ± 600****25,850 B.C.**

Fine detritus gyttja from Kerkwitz clay pit, Kr. Guben, Bez. Cottbus (53° 54.9' N Lat, 14° 37.5' E Long). Depth: 2.0 to 2.2 m. Section: 1 m, medium sand; 1 m, clay, sandy; 0.2 m, fine-detritus gyttja (Bln-101, 101a); 0.2 m, diatom mud and gyttja; 1.7 m, clay. Coll. 1959 and subm. by A. G. Cepek (Cepek, 1960). *Comment:* assigned to the late Eem interglacial on the basis of pollen analysis by K. Erd (1961), the layer now seems to belong to the Paudorf interstadial.

Bln-126. Klein-Koschen**21,160 ± 800**

Silt with some wood, carbonate-free, from brown-coal open cast Klein-Koschen, Kr. Senftenberg, Bez. Cottbus (50° 30.9' N Lat, 14° 5' E Long). Section, beginning 2.3 to 2.4 m below ground level: 1.5 to 2 m, fine sand; ca. 1 m, silt (sampled layer); 10 m, sand. *Comment:* late Warthe glacial, according to Firbas and Grahmann; see Skado series, this date list.

*B. Other samples***Bln-368. Stubbenkammer I****39,700 ± 3000****Bln-369.****>40,000**

Fine-sandy humic silt, carbonate-free, from layer 0.2 m thick, overlain by 0.3 to 0.4 m of chalk, underlain by fine sand, 3.2 m thick, then by boulder clay; exposed in Baltic Sea cliff Stubbenkammer, N of Sassnitz, Kr. Rügen, Bez. Rostock (54° 32.2' N Lat, 13° 40.9' E Long). Pollen analysis (K. Erd) indicates a very cool climate; silt layer assigned to Holstein or Eem interglacial.

Bln-365. Bansin No. 1**11,267 ± 400****9317 B.C.****Bln-367. Bansin No. 3****11,244 > 640****9294 B.C.**

Peat, frost-contorted and mixed with fine sand, from inactive cliff 0.75 km N of Bansin, Kr. Wolgast/Rostock (53° 58.9' N Lat, 14° 8.2' E

Long); from layer 0.7 m thick, overlain by 6 m of sand containing boulders, in part containing roots of grass and beech; underlain by fine sand 1 m thick, then by moraine 4 m thick. Coll. and subm. 1964 by A. G. Cepek. *Comment*: assigned by Keilhack (1917) to the last interglacial, but pollen analysis by Hallik (Hallik and Ludwig, 1959) indicates Alleröd age, confirmed here. Date is important for genesis of the Baltic, for the locality was reached by active ice during Younger Dryas time, when the ice-margin is supposed (De Geer, 1954) to have stood at a line from Stockholm to Helsinki.

1265 ± 100

Bln-214. Hiddensee, Salzwiese**A.D. 685**

Wood (beech), overlain by gray marine sand, 1.4 m thick, and by rush (*Juncus*) peat, 0.25 to 0.4 m thick at marsh surface; part of layer containing wood and amber in small pieces, presumably driftwood; on island of Hiddensee, Kr. Bergen/Rügen, Bez. Rostock. Coll. and subm. 1963 by E. Fröde, Forschungsanst. Hiddensee, Kloster auf Hiddensee. *Comment*: modern island of Hiddensee was formed by fusion of two islands, Hiddensee and Gellen; sample dates the fusion.

9467 ± 250

Bln-242. Alperstedt II**7517 B.C.**

Organic sandy clay, 2.2 to 2.4 m depth, overlain by chalky Flachmoor peat, underlain by sandy clay, at Alperstedt, Bez. Erfurt. Pollen analysis, by E. Lange, shows, at bottom of layer, *Pinus* 45%, *Betula* 54%, *Salix* 1% (of tree pollen) NAP + spores 29%, with trace of *Ephedra*; at top of layer, NAP + spores = 38%, but *Pinus* rises to make 98% of AP, with *Betula* 1% and *Salix* 1%. Coll. and subm. 1963 by E. Lange, Inst. f. Spezielle Botanik, Friedr.-Schiller Univ., Jena. *Comment*: dates beginning of Holocene in Thuringia.

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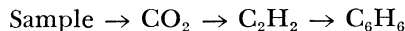
FLORIDA STATE UNIVERSITY RADIOCARBON DATES I

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Laboratory construction was begun in December 1964 and routine dating was in progress by late February 1965. The primary purpose of this facility is to assist in marine geological studies and the archaeological chronologies of the region. Dating is carried out by utilizing the techniques of liquid scintillation described by Noakes *et al.* (1965), wherein the carbon of the sample to be dated is converted to benzene and the natural radioactivity detected in a liquid scintillation spectrometer.

After sample pretreatment to remove non-contemporaneous carbon, the sample is chemically converted as follows:



Conversion to CO_2 is a fairly standard procedure in all laboratories and therefore will not be discussed. Conversion of $\text{CO}_2 \rightarrow \text{C}_2\text{H}_2$ via Li_2C_2 is an adaption of the technique used by Barker (1953), which gives consistent chemical yields of 95-98%. Conversion of acetylene to benzene is carried out through the action of a vanadium-alumina catalyst which gives yields of 85-92% of very pure benzene.

Noakes, Kim and Stipp (1965) undertook mass spectrometric studies at the Oak Ridge National Laboratories on the possible isotopic fractionation in the conversion of acetylene to benzene prepared both by the original diborane-activated silica-alumina catalyst described by Noakes *et al.* (1963) and with the new high-valence metal oxide catalysts described by Noakes, Kim and Akers (1965). In this study he found that even over a large range of induced experimental yields (30-98%) there was no isotopic fractionation. This had previously been indicated through reproducibility studies (Stipp *et al.*, 1962; Noakes *et al.*, 1964; Tamers *et al.*, 1964; McDowell and Ryan, 1965), and through statistical comparison techniques (Tamers and Pearson, 1965).

Barker's (pers. comm., 1962) acetylene purification method, using columns filled with glass beads coated with concentrated phosphoric acid and 50% KOH, has insured against quenching by removing nitrogen-hydrogen and sulphur products.

Radon, if initially present, should be removed during the high temperature evacuation carried out on the hot lithium carbide. Apparently this step is quite effective as no radon has ever been seen to contaminate any of the counting solutions.

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Detection is carried out in an ANS, Inc. automatic two-channel Liquid Scintillation Spectrometer. It has been shown previously by McDowell (pers. commun., 1964) and Pietig and Scharpenseel (1964) that supplemental shielding with mercury in liquid counting has a significant effect in reducing background levels. Therefore, in cooperation with ANS, Inc., an experiment at Florida State University using a two-in. shield of triple-distilled mercury in place of the standard lead shield was carried out with the result that backgrounds were lowered by approx. 20%. The standard vial size chosen is 5cc which gives a background of 7.41 counts/min and a modern standard rate (age-corrected 1860 wood) of 34.87 counts/min yielding an age range of 44,000 yr for a two-sigma deviation and 48 hour counting period. For older samples a 15 cc vial is used with a background rate of 12.82 counts/min and a modern rate of 111.16 counts/min, with an extension of age range to 51,800 yr on the same criterion.

The possibility of sample quenching is closely monitored both by the channels ratio and the automatic external standardization method employing a Cs^{137} gamma source ($5_{\mu\text{C}}$). Both methods are sensitive in detecting any sample or electronic discrepancies to less than one percent.

The modern standard, once accurately determined, is checked daily thereafter with a "hot" reference standard (Pearson, pers. commun., 1964; Noakes *et al.* 1965). This technique has allowed nearly continuous monitoring of the modern rate while at the same time eliminating the necessity for frequent and time-consuming preparation of modern samples.

Data calculation is done by a Fortran II program which also analyzes continuous instrument performance from the frequent-interval data print-out. Arrangements are now being made to print the raw data onto a coded punch tape to further facilitate handling.

Dates contained in the following partial list were calculated using the Libby half-life of 5570 yr and reported with their counting error uncertainty of 1 standard deviation. Because of the lack of suitable mass-spectrometric facilities no corrections are made for natural $\text{C}^{13}/\text{C}^{12}$ ratio fluctuations. All collectors and submitters of samples from Florida State University, Tallahassee, Florida, unless stated otherwise.

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We are particularly grateful to Mr. Dennis Cassidy for his invaluable technical assistance during the laboratory's construction.

SAMPLE DESCRIPTIONS

I. CHECK SAMPLES

Florida number	Florida date	Other number	Other date	Reference
FSU-1a	2320 \pm 100	ML-86	2025 \pm 55	Miami I-III
FSU-1b	2360 \pm 80			
FSU-1c	2380 \pm 80			
FSU-2	9880 \pm 230	ML-153B	9900 \pm 105	Miami I-III
FSU-3	11,245 \pm 450	{ C -800	10,856 \pm 410	Chicago IV
		{ TX-44	10,700 \pm 210	Texas II
		{ L -6980	11,840 \pm 100	Broecker and Farrand (1963)

II. GEOLOGIC SAMPLES

*A. South-East U. S.***Tampa Bay series, Florida**

Oyster shell and meat from various localities within Tampa Bay. Oysters were living at time of collection and were measured to provide indication of any significant difference in natural fractionation between shell and flesh fractions of modern oysters. Results were correlated with pH, salinity and temperature data. Coll. May 1965 by C. H. Solomon, U. S. Dept. of Interior; subm. by H. S. Rydell.

Number	Name	Material	N Lat	W Long	C ¹⁴ % > Mdn
FSU-12.	Big Bend	Meat	27° 46' 18"	82° 26' 0"	21.3 \pm 0.23
FSU-16.	Big Bend	Shell	27° 46' 18"	82° 26' 0"	22.7 \pm 0.30
FSU-13.	Piney Pt.	Meat	27° 38' 36"	82° 33' 40"	20.3 \pm 0.37
FSU-17.	Piney Pt.	Shell	27° 38' 36"	82° 33' 40"	23.6 \pm 0.32
FSU-14.	Rocky Pt.	Meat	27° 57' 42"	82° 54' 36"	22.5 \pm 0.54
FSU-18.	Rocky Pt.	Shell	27° 57' 42"	82° 54' 36"	25.5 \pm 0.35
FSU-15.	Skyway	Shell	27° 40' 18"	82° 41' 0"	24.4 \pm 0.30

Appalachicola Bay series, Florida

Samples are of recent and Pleistocene surface and subsurface wood and shell material collected between Cape San Blas and Alligator Harbor, Florida. Dates represent part of study of coastal evolution of Appalachicola delta region of NW Florida with respect to late Pleistocene-Holocene sealevel fluctuations. Coll. 1964 and early 1965. Subm. 1965 by J. Schnable.

- FSU-23. St. George—1** **560 ± 100**
A.D. 1390
Wood from taproot stump of pine tree in growth position and now awash (intertidal) on present beach. Coll. ½ mi SW of New Pass, St. George Island, Florida (29° 36' 30" N Lat, 84° 58' 20" W Long).
- FSU-24. Royal Bluff** **4610 ± 625**
2660 B.C.
Sandy fresh-water peat from intertidal zone coll. W of Carrabelle on mainland shore approx. 1 mi E of Royal Bluff, Florida (29° 48' 6" N Lat, 84° 44' 18" W Long).
- FSU-25. Alligator Harbor** **1390 ± 175**
A.D. 560
Wood chips from peat layer ca. 1 ft above MSL from E shore of Alligator Harbor, Florida (29° 54' 0" N Lat, 84° 22' 0" W Long).
- FSU-26. Alligator Harbor** **350 ± 120**
A.D. 1600
Wood from taproot stump of pine tree in growth position and now awash (intertidal) on present beach. Coll. from SW Cape on Alligator Spit (29° 53' 30" N Lat, 84° 22' 30" W Long).
- FSU-28. St. George—3** **40,340⁺ 1630**
— 1350
38,390 B.C.
Log, probably driftwood, at 41 ft below MSL in continuously cored section of Pleistocene sediments. Boring site in old dune area on St. George Island, Florida (29° 39' 42" N Lat, 84° 51' 12" W Long).
- FSU-29. St. George—4** **>30,000**
Wood fragments, probably driftwood, at 36 ft below MSL in continuous cored section of Pleistocene sediments. Boring site on present beach, St. George Island, Florida (29° 39' 36" N Lat, 84° 51' 12" W Long).
- FSU-30. St. George—5** **>27,620**
Wood fragments, probably driftwood, at 38 ft below MSL from a boring site in old dune area on St. George Island, Florida (29° 39' 42" N Lat, 84° 52' 24" W Long).
- FSU-31. St. George—6** **30,700⁺ 2760**
— 3050
28,750 B.C.
Wood fragments, probably driftwood, at 37.5 ft below MSL in a continuously cored section of Pleistocene sediments. Boring site on present beach, St. George Island, Florida (29° 39' 36" N Lat, 84° 51' 12" W Long).

FSU-32. Lanark Village**3780 ± 330****1830 B.C.**

Wood fragments in a subsurface sandy peat from ca. 5 ft below MSL. Boring site on bayshore, Lanark, Florida (29° 52' 51" N Lat, 84° 35' 48" W Long).

FSU-33. St. George—7**4100 ± 110****2150 B.C.**

Oyster shells (*Crassostrea virginica*), from bay deposit 18 ft below MSL. Boring site on bayside of St. George Island ca. 1 mi W of ferry landing (20° 39' 48" N Lat, 84° 52' 0" W Long).

FSU-34. St. George—8**4370 ± 420****2420 B.C.**

Reworked oyster shells (*Crassostrea virginica*), from barrier island sand deposit 12.5 ft below MSL. Boring site on bay side of St. George Island ca. 1 mi W of ferry landing (same location as FSU-33). *Comment:* although FSU-33 and FSU-34 appear to be reversed, they are statistically indistinguishable.

Comment (J.S.): dates in the 30,000 to 40,000 yr B.P. range indicate possibility of a relatively high stand of sea during mid-Wisconsin. Dates are on wood believed to be driftwood occurring in subsurface Pleistocene sediments. Dates less than 5000 yr B.P. on wood fragments and oyster shells give some indication of Holocene sealevel rise. More dates concerning this study will be published in the future.

Alligator-Horseshoe Creek series

Fossil wood buried at various depths in recent soils from the drainage area of Alligator and Horseshoe Creeks, in Gulf Co., Florida. These samples, plus others to be dated, should indicate rate of soil formation in the respective areas. Coll. 1965 by B. Williamson of Gulfland Timber Co., Florida; subm. 1965 by W. F. Tanner.

FSU-59. Gulf Co.—1**1520 ± 80****A.D. 430**

From hillside in Gulf Co., Florida (30° 6' 54" N Lat, 85° 15' 16" W Long), at 29 in. depth.

FSU-60. Gulf Co.—2**520 ± 140****A.D. 1430**

From hillside in Gulf Co., Florida (30° 3' 34" N Lat, 85° 15' 17" W Long), at 10 in. depth.

FSU-61. Gulf Co.—3**480 ± 145****A.D. 1470**

From hilltop in Gulf Co., Florida (30° 3' 22" N Lat, 85° 15' 9" W Long), at 11 in. depth.

FSU-62. Gulf Co.—4**2630 ± 135****680 B.C.**

From flood plain in Gulf Co., Florida (30° 2' 5" N Lat, 85° 15' 2" W Long), at 25 in. depth.

Comment (W.F.T.): FSU-61, only hilltop sample of the four, yielded fastest rate of soil formation (1 in./43 yr). FSU-62, the only floodplain sample, yielded slowest rate (1 in./106 yr). The other two (hillside samples) taken ca. 4 mi apart, produced essentially identical rates of soil formation (1 in./52 yr). This was unexpected, as hilltop soils normally develop less rapidly than floodplain material. Several explanations are being considered pending further dates.

B. Antarctic

Eltanin series

Core samples of foraminiferal ooze (*Globigerina parhyderma*) taken during U.S.N.S. Eltanin Cruise 10. These were used to compare $\text{Th}^{230}/\text{Th}^{232}$ age method with C^{14} method. Coll. Nov. 1964 by I. Zemel; subm. Mar. 1965 by C. Holmes.

18,240 \pm 1050
16,290 B.C.

FSU-46. Pacific Basin

From E edge of SE Pacific Basin ($64^{\circ} 5' 30''$ S Lat, $75^{\circ} 19' 42''$ W Long). Sample taken from Core No. 10-15, 0 to 10 cm from top of core.

22,460 \pm 925
20,510 B.C.

FSU-47. Pacific Rise

From E edge of SE Pacific Rise ($64^{\circ} 10' 30''$ S Lat, $75^{\circ} 18' 0''$ W Long). Sample taken from Core No. 10-14, 5 to 15 cm from top of core.

23,940 \pm 925
21,940 B.C.

FSU-48. Pacific Basin

From E edge of SE Pacific Basin ($64^{\circ} 5' 30''$ S Lat, $75^{\circ} 19' 32''$ W Long). Sample taken from Core No. 10-15, 20 to 30 cm from top of core.

>23,600

FSU-49. Drake Passage

From middle of Drake Passage ($60^{\circ} 2' 0''$ S Lat, $64^{\circ} 54' 0''$ W Long). Sample taken from Core No. 4-14, 85 to 95 cm from top of core. *Comment*: dates from the two methods (Holmes, 1962) were found to differ by a factor of 2, C^{14} ages being younger.

11,960 \pm 265
10,010 B.C.

FSU-57. Pacific Ridge

Sample of *Globigerina pachyderma*, *Globigerina bulloides*, and *Globigerina inflata*, off Pacific Antarctic Ridge ($54^{\circ} 25' 0''$ S Lat, $129^{\circ} 37' 36''$ W Long), at 1890 fm depth. Taken from trigger core No. 24, 0 to 19 cm from top of core on U.S.N.S. Eltanin, Cruise 13. Coll. 1964 by M. Boeuf; subm. 1965 by H. Goodell.

9730 \pm 255
7780 B.C.

FSU-50. Scotia Ridge

Unidentified coral dredged from a seamount ($59^{\circ} 56' 8''$ S Lat, $34^{\circ} 41' 1''$ to $34^{\circ} 32' 7''$ W Long), at 620 fm depth. Coll. 1964 by S. Koster; subm. 1965 by H. Goodell. *Comment*: gives date B.P. that coral lived and

since no living coral has been found on Sars Bank in this locality at present time it gives a max time for sealevel rise.

III. ARCHAEOLOGIC SAMPLES

FSU-63. Basin Bayon West, Florida **1150 ± 150** **A.D. 800**

Charcoal from ramp fill of primary mound at Site WL 13, Walton Co., Florida (30° 29' 59" N Lat, 86° 14' 30" W Long). Site excavated by Moore (1901) and assigned to Weeden Island I Phase by Willey (1949). Coll. 1958 and subm. 1964 by W. Lazarus, Fort Walton Beach, Florida. *Comment:* date closely approximates midrange of Weeden Island phase.

FSU-65. Butcherpen Mound, Florida **945 ± 140** **A.D. 1005**

Charcoal lumps in Pit 1, Level 2, of Site Sa29 in association with E side sherd deposit of mound (30° 23' 30" N Lat, 87° 7' 15" W Long). *Comment:* may date Weeden Island II Phase on this part of Gulf coast. Coll. 1961 and subm. 1964 by W. Lazarus.

FSU-64. Alligator Lake, Florida **3085 ± 130** **1135 B.C.**

Charcoal from pit in Area A of Site W1 29, Walton Co., Florida. Site is reported by Lazarus (1965) (30° 20' 10" N Lat, 86° 12' 10" W Long). Coll. and subm. by W. Lazarus. *Comment:* sample was in association with a vessel of Alexanders type.

FSU-68. Buck Site, Alabama **210 ± 85** **A.D. 1740**

Charred wood from a feature containing oyster shells and cultural material of Fort Walton Phase at Site 1 Ba 56, Baldwin Co., Alabama (30° 17' N Lat, 87° 43' W Long). Coll. 1965 by D. White; subm. 1965 by D. Phelps. *Comment:* date seems late for Fort Walton Phase, but duration of phase is little known at present in this area.

Tucker Site series, Florida

Charred material from surfaces and interiors of vessel fragments obtained from eroding beach component of Tucker Site (Fr 4), Florida (29° 55' 15" N Lat, 84° 22' 31" W Long). Burial mounds on site were excavated by Moore (1902). Willey (1949) records the site, and Sears (1963) did stratigraphic testing in a few undisturbed areas. The beach component was not sampled by previous studies because it was covered by salt marsh. Coll. and subm. 1965 by D. Phelps.

FSU-67. Tucker, Norwood **2962 ± 120** **1012 B.C.**

Charred fiber from sherd interiors of the types Norwood Plain and Norwood Simple Stamped recently described by Phelps (1965). *Comment:* date fits into the reported range of fiber-tempered ceramics in SE U.S. (Bullen, 1961).

1605 ± 325**FSU-66. Tucker, Gulf Check Stamped****A.D. 345**

Charred organic residue from exterior of vessel of the type Gulf Check Stamped (Willey, 1949). *Comment:* no absolute dates have been previously reported for this type.

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Chicago IV	Libby 1954
Miami I-III	Östlund <i>et al.</i> , 1965
Texas I	Stipp <i>et al.</i> , 1962
Texas II	Tamers <i>et al.</i> , 1964
Texas A&M I	Noakes <i>et al.</i> , 1964

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GAKUSHUIN NATURAL RADIOCARBON MEASUREMENTS V

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This list includes many of the datings done from September 1964 to October 1965. The instruments and techniques used for this work are essentially the same as those used previously (Gakushuin III). Bone samples were dated on the organic materials obtained by the following procedure. After washing with distilled water the powdered bone samples were boiled with 10% H_2SO_4 solution 10 to 40 hours. The extract, a clear solution, was exaporated to almost dryness, and, after concentrated H_2SO_4 was added, heating was continued until most of the organic compounds became insoluble carbonized or polymerized material. The black residue was washed in water and treated as the usual charcoal sample for dating.

Age calculations are based on the Libby half life of C^{14} , 5570 ± 30 yr, and the modern activity given by $0.95A_{\text{ox}}$, i.e., 95% of the activity of NBS oxalic-acid standard. Except for tree ring samples, the errors quoted are the standard deviation obtained from the number of counts only. When observed activities are less than 2σ above background, infinite dates are given with a limit corresponding to the activity of 3σ , and when they are greater than $0.95A_{\text{ox}} - 2\sigma$, modern dates are given with the limit equal to $0.95A_{\text{ox}} - 3\sigma$.

We wish to acknowledge the help of Tamako Morinaga in preparing chemical samples. The description and comments are essentially those of persons submitting the samples.

SAMPLE DESCRIPTIONS

I. TREE RING SAMPLES

Tree ring dated samples were taken from a tree trunk of *Cryptomeria japonica* from Yalu Island, Kyushu ($30^\circ 40'$ N Lat, $130^\circ 30'$ E Long). Each annual tree ring was separated and the tree rings of 20- or 10-year sequences were mixed to make a sample for the assay of C^{14} .

Activity measurements were made on ca. 7 L of acetylene under 1 atm pressure. The results of assay are shown in Table 1 together with the values of δC^{13} which were measured by H. Sakai of Okayama Univ. on seven randomly selected samples. The calculation of Δ° for all samples except these seven was made under the assumption that δC^{13} is equal to a mean value indicated in Table 1. The errors of Δ° listed are standard deviations including statistical errors calculated from counting number, errors derived from applied high voltage, and errors derived from the estimation of δC^{13} .

The secular variation of the atmospheric C^{14} concentration suggested by these measurements was discussed by Kigoshi and Hasegawa

TABLE 1
Radiocarbon Concentration in Yaku Sugi Tree Rings

Code no.	Age span A.D.	$\delta^{14}\text{C}/\text{‰}$ Decay was corrected by half life of C^{14} , 5570 yr.	$\delta^{13}\text{C}/\text{‰}$ $\delta^{13}\text{C}$ of NBS oxalic acid standard was assumed to be -18.6 ‰ .	$\Delta \text{‰}$
GaK-270:27.	137 to 156	-14.9 ± 2.9		-17.7 ± 3.1
GaK-270:9.	167 to 186	-13.0 ± 3.0		-15.8 ± 3.2
GaK-270:26.	167 to 186	-14.4 ± 3.3		-17.2 ± 3.4
GaK-270:28.	187 to 196	-11.6 ± 3.1	-23.6 ± 0.2	-14.4 ± 3.1
GaK-270:29.	227 to 236	-18.6 ± 2.9		-21.4 ± 2.9
GaK-270:30.	317 to 326	-9.3 ± 3.1		-12.2 ± 3.2
GaK-270:12.	387 to 406	-5.9 ± 3.0		-8.7 ± 3.2
GaK-270:13.	467 to 486	-8.9 ± 3.4		-11.7 ± 3.5
GaK-270:22.	467 to 486	-6.6 ± 3.4		-9.4 ± 3.5
GaK-270:14.	587 to 606	-11.2 ± 3.2		-14.0 ± 3.3
GaK-270:15.	667 to 686	-17.4 ± 3.3	-23.1 ± 0.2	-21.2 ± 3.3
GaK-270:21.	667 to 686	-14.4 ± 3.0		-17.2 ± 3.2
GaK-270:1.	707 to 726	$+2.5 \pm 3.5$		-0.2 ± 3.6
GaK-270:20.	787 to 806	-7.4 ± 2.9	-22.9 ± 0.2	-11.6 ± 2.9
GaK-270:2.	807 to 826	-9.1 ± 2.9		-11.9 ± 3.1
GaK-270:19.	887 to 906	-10.5 ± 2.9	-24.3 ± 0.2	-11.9 ± 2.9
GaK-270:8.	927 to 946	-6.4 ± 2.9		-9.2 ± 3.1
GaK-270:16.	947 to 966	-11.1 ± 2.9		-13.9 ± 3.1
GaK-270:3.	1047 to 1066	-6.5 ± 3.7		-9.3 ± 3.8
GaK-270:4.	1127 to 1146	-5.4 ± 3.5		-8.2 ± 3.6
GaK-270:5.	1207 to 1226	-5.2 ± 3.1		-8.0 ± 3.2
GaK-270:6.	1327 to 1346	-6.2 ± 3.2		-9.0 ± 3.3
GaK-270:25.	1347 to 1366	-4.6 ± 2.9		-7.4 ± 3.1
GaK-270:7.	1447 to 1466	-1.8 ± 3.2		-4.6 ± 3.3
GaK-270:23.	1507 to 1526	-2.9 ± 2.8	-24.1 ± 0.2	-4.7 ± 2.8
GaK-270:24.	1587 to 1606	$+10.5 \pm 2.9$	-24.3 ± 0.2	$+9.1 \pm 2.9$
GaK-270:10.	1647 to 1666	$+7.3 \pm 3.6$		$+4.5 \pm 3.7$
GaK-270:17.	1667 to 1686	$+4.4 \pm 2.7$		$+1.6 \pm 2.9$
GaK-270:18.	1687 to 1706	-4.5 ± 2.7	-22.8 ± 0.2	-7.3 ± 2.9
GaK-270:11.	1847 to 1866	-7.1 ± 2.8		-9.9 ± 3.0
Mean value of $\delta^{13}\text{C} = -23.6 \pm 0.5$				

(1966) in relation to paleomagnetic data. The curves shown in Figure 1 are the computed variation in the atmospheric C^{14} concentration under an assumed variation of the magnitude of geomagnetic dipole moment which was given by Nagata (private commun.) as an average of observed magnitude of equatorial geomagnetic force in ancient time. Curves 1 and 2 give the limits of probable variation of computed values which are also affected by an unknown factor, i.e., the variation in geomagnetic dipole moment more than several thousand years ago. *Comment:* part of results of this series was published in Gakushuin III (1964). Those results were recalculated and listed in Table 1.

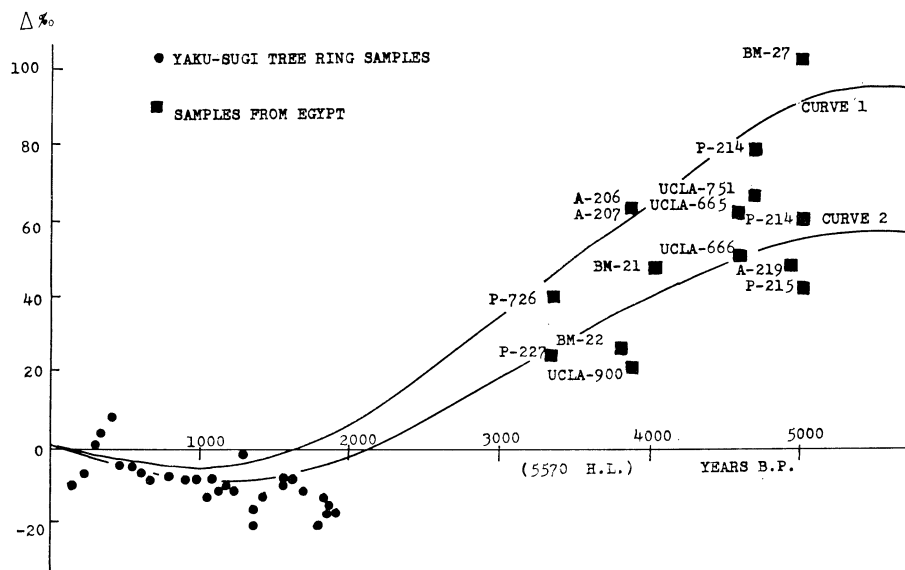


Fig. 1. Computed variations in atmospheric C^{14} concentration based on the variation in geomagnetic dipole moment and observed C^{14} content in Yaku-sugi tree ring samples (Table I) and in wood samples from Egypt measured by Ralph (Pennsylvania III), Stuckenrath and Ralph (Pennsylvania VIII), Fergusson and Libby (UCLA I), Berger, Fergusson, and Libby (UCLA IV), Barker and Mackey (British Museum I), Damon and Long (Arizona III), and Damon, Long, and Sigalove (Arizona IV).

II. GEOLOGIC SAMPLES

A. Japan

Ata and Aira pyroclastic flow deposits series, Kyushu

Samples from pyroclastic flow deposits in southern part of Kyushu Island related to volcanic eruptions of large-scale pyroclastic flows which resulted in formation of Ata and Aira calderas.

GaK-472. Kukino, Kagoshima

24,500 ± 900

22,550 B.C.

Carbonized wood from road cut ca. 1 km S of Kukino, Kaseda City, Kagoshima Prefecture ($31^{\circ} 19' 21''$ N Lat, $130^{\circ} 16' 38''$ E Long), alt 70 m, in lower part of Ata pyroclastic flow deposit, 10 cm above basement of deposit. Coll. and subm. 1964 by Tadahide Ui and Shigeo Aramaki, Univ. of Tokyo. *Comment* (S.A.): dates formation of Ata Caldera and confirms known stratigraphic order of Osumi pumice fall deposit dated as $22,000 \pm 850$ B.P. (GaK-211 Gakushuin II) and Ito pyroclastic flow deposit. For tephrochronology of this area, see Gohara (1963).

GaK-469. Nojiri, Miyazaki

27,700 ± 1500

25,750 B.C.

Charcoal from boring at Kakenbifu, Nojiri-machi, Miyazaki Prefecture ($31^{\circ} 56' 45''$ N Lat, $131^{\circ} 9' 0''$ E Long), 70.5 m from surface, im-

bedded in clay just below thick pyroclastic flow deposit. Coll. and subm. 1964 by Hisashi Asada, Chuō Kaihatsu. *Comment*: dates maximum age of Shinkawa (?) pyroclastic flow deposit.

16,350 ± 350
14,400 B.C.

GaK-473. Ichihino, Kagoshima

Carbonized wood from campus of Ichihino Junior High School, Hiwaki-machi, Kagoshima Prefecture (31° 47' 21" N Lat, 130° 24' 18" E Long), in Ito pyroclastic flow deposit. Coll. and subm. by Aramaki. *Comment* (S.A.): dates formation of Aira Caldera which is probably just after the deposition of Ito pyroclastic flow. See GaK-211 (Gakushuin II).

23,400 ± 800
21,450 B.C.

GaK-558. Ushikubi, Kagoshima

Carbonized wood trunk from Ushikubi, Aoyama-machi, Sendai City, Kagoshima Prefecture (31° 46' N Lat, 130° 17' E Long), in pumice flow deposit of several meters. Coll. and subm. 1964 by R. Ōta, Geol. Survey of Japan. *Comment*: pumice flow is supposed to be Ito but date conflicts with this view.

Itami series, Osaka

Wood from terrace and alluvial deposits at Itami City. Series provides information on development of topography in Itami area and on date of thick marine clay bed which is widespread in Osaka and Amagasaki areas, overlain by alluvial deposits. Coll. and subm. 1964 by Kazuo Huzita, Osaka City Univ.

29,800 ± 1200
27,850 B.C.

GaK-489. Kamikushiro, Kawanishi City

Charred wood from Kamikushiro, Kawanishi City (34° 48' N Lat, 135° 24' E Long), imbedded in Itami Terrace gravel layer. *Comment* (K.H.): dates Lower Terrace in Osaka Basin.

2700 ± 90
750 B.C.

GaK-490. Mokawa 1, Itami

Wood from under bottom of Kokawa River, Noda, Itami City (34° 46' 30" N Lat, 135° 24' E Long), imbedded in lower part of upper gravel layer.

5960 ± 90
4010 B.C.

GaK-491. Mokawa 2, Itami

Wood from same site as GaK-490, imbedded in blue sand layer below sample GaK-490.

Toyama series

Samples are related to development of alluvial deposits and change of shore line of Toyama Bay. Subm. 1964 by S. Fujii, Toyama Univ.

610 ± 100
A.D. 1340

GaK-538. Shibakusa

Wood from river cliff at Shibakusa, Mizuhashi-machi, Toyama Prefecture (36° 44' N Lat, 137° 17' E Long), just beneath pebble layer, 275 cm below surface of ground. Coll. 1964 by S. Fujii. *Comment* (S.F.): dates deposition of pebble layer which is supposed to have been caused by an earthquake in A.D. 1858.

2730 ± 90
780 B.C.

GaK-539. Uchiide

Wood from sea shore of Uchiide, Yokata-machi, Toyama City (36° 45' N Lat, 137° 13' 28" E Long), ca. 5 m below sealevel. Coll. by T. Takase.

1560 ± 110
A.D. 390

GaK-540. Higashikusano

Wood from buried forest at Higashikusano, Asahi-machi, Toyama Prefecture (36° 58' N Lat, 137° 34' E Long). Coll. 1962 by S. Fujii. Buried surface of woody layer is 2 m above present sealevel. *Comment*: see GaK-541 and GaK-563 of this series.

1750 ± 90
A.D. 200

GaK-563. Uozu

Humic soil from Uozu, Toyama Prefecture (36° 49' N Lat, 137° 23' E Long), 2.0 to 2.4 m below surface. Coll. 1964 by S. Fujii. *Comment*: dates buried ground surface of submerged forest. A tree of the same forest was dated by GaK-246 as 1960 ± 70 B.P. (Gakushuin II).

1950 ± 90
A.D. 0

GaK-541. Jinzugawa

Wood from river mouth of Jinzugawa, Kusazima, Toyama Prefecture (36° 44' N Lat, 137° 15' E Long), ca. 4 m below sealevel. Coll. 1963 by S. Fujii. *Comment*: see Fujii (1965).

3780 ± 100
1830 B.C.

GaK-560. Hakko

Peat from Hakko, Shimomura, Toyama Prefecture (36° 44' N Lat, 137° 7.5' E Long), 1.5 m below surface. Coll. 1964 by T. Takase and N. Fujii, Kanazawa Univ. *Comment*: dates alluvial peat deposit and submerged forests in Shimomura area.

1400 ± 90
A.D. 550

GaK-562. Hamabiraki, Shinminato

Peat from Hamabiraki, Shinminato City, Toyama Prefecture (36° 46' N Lat, 137° 9' E Long), overlain by new sand dune at present sealevel. Coll. 1963 by N. Fujii.

Niigata Plain series

Samples are taken from exploratory borings in Niigata Plain, S or SW of Niigata City. Subsurface information from borings in Niigata

Plain permits partial reconstruction of late-Quaternary sedimentary basin, now filled. Samples are coll. from beds of peat or peaty clay interbedded with sand, silt or sandy gravel which are interpreted as dunes, deltaic gravel, and natural levees. Coll. and subm. 1963 by Kunio Suyama, Satoru Ōya and Yuichiro Takahashi, Fukada Geol. Inst.

GaK-430. Sone, -15 m **>31,000**

Peaty clay from boring B-21 at Sone, Nishikambara-gun, Niigata Prefecture (37° 47' N Lat, 138° 55' E Long), just below the gravel layer, 165 m below surface.

GaK-431. Sone, -145 m **20,900 ± 600**
18,950 B.C.

Peat from boring B-21, just above gravel layer and overlain by sand, 145 m below surface.

GaK-432. Yotsugo, -148 m **25,500 ± 1100**
23,550 B.C.

Peat from boring B-11, ca. 4 km E of B-21, Yotsugo, Nishikambara-gun, Niigata Prefecture (37° 47' 30" N Lat, 138° 58' E Long), from peaty layer underlain by gravel layer, overlain by sand.

GaK-433. Yotsugo, -143 m **20,300 ± 600**
18,350 B.C.

Peat from boring B-11, 143 m below surface.

GaK-434. Yotsugo, -136 m **10,900 ± 250**
8950 B.C.

Peat from boring B-11, 136 m below surface.

GaK-435. Akatsuka, -127 m **18,300 ± 500**
16,350 B.C.

Peat from boring B-20, ca. 4 km N of B-21, Akatsuka, Nishikambara-gun, Niigata Prefecture (37° 49' N Lat, 138° 54' E Long), underlain by gravel layer, 127 m below surface.

GaK-436. Kamikiyama, -94 m **26,200 ± 1000**
24,250 B.C.

Peat from boring B-7, ca. 11 km SE of B-21, Kamikiyama, Niigata Prefecture (37° 44' 30" N Lat, 139° 2' E Long), underlain by gravel layer, 94 m below surface.

GaK-437. Kamikiyaka, -90 m **23,000 ± 1000**
21,050 B.C.

Peat from boring B-7, 85 m below surface.

GaK-439. Uchikoshi, -18 m **4150 ± 120**
2200 B.C.

Peat from boring B-22, 5 km S of B-21, Uchikoshi, Nishikambara-gun, Niigata Prefecture (37° 43' N Lat, 138° 57' E Long), underlain by sand, 18 m below surface.

- 1920 \pm 90**
- GaK-467. Kameda-go, -6 m** **A.D. 30**
 Peat from boring No. 5 at Kameda-go Nakakambara-gun, Niigata Prefecture (37° 53' N Lat, 139° 4' E Long), 6 m below surface.

- 11,700 \pm 280**
- GaK-468. Washimaki, -132 m** **9750 B.C.**
 Peat from boring B-12 at Kameda-go, Nakakambara-gun, Niigata Prefecture (37° 49' N Lat, 139° 3' E Long), 132 m below surface.

Mt. Fuji series

Natural charcoal taken from basaltic ejecta from Mt. Fuji. Coll. and subm. 1964 by Hiromichi Tsuya, Tokyo Univ. *Comment* (H.T.): dates the eruption which produced the charcoals.

- 890 \pm 90**
- GaK-633. Komitake** **A.D. 1060**
 Charcoal from Komitake, N flank of Volcano Fuji (35° 50' N Lat, 138° 44' E Long), alt 2320 m, imbedded in volcanic ash and scoria, 50 cm below surface.

- 1230 \pm 90**
- GaK-634. Inno-Tainai** **A.D. 720**
 Charcoal from inside of a lava-tree mould formed by the Inno-Tainai lava flow, SE foot of Volcano Fuji, Inno-mura, Shizuoka Prefecture (35° 17' N Lat, 138° 51' E Long).

- 470 \pm 80**
- GaK-635. Fujimiya** **A.D. 1480**
 Charcoal from volcanic ash bed lying just below bottom of a basaltic lava flow, SW flank of Volcano Fuji (35° 20' N Lat, 138° 44' E Long), alt 2300 m.

- 630 \pm 80**
- GaK-636. Oniwa** **A.D. 1320**
 Charcoal from volcanic ash bed lying just below bottom of a basaltic lava flow, Oniwa, NW flank of Volcano Fuji (35° 23' N Lat, 138° 42' E Long), alt 2200 m.

B. Australia

Robe beach deposit series

Marine shells (*Katelsia rhytophora* is prominent) from marine beach deposits near Robe, South Australia. Coll. and subm. by G. Blackburn, Div. of Soil, CSIRO. *Comment* (G.B.): dates latest time when marine conditions were present at the localities, and gives maximal ages of overlying soils. Deposits referred to by Sprigg (1952).

- 4330 \pm 110**
- GaK-607. Robe** **2380 B.C.**
 Taken from 5 mi ESE from Robe, South Australia (37° 12' S Lat, 139° 50' E Long), 6 ft above sealevel, overlain by juvenile soil. Coll. 1961.

GaK-608. Konetta **>45,000**

Taken from 19 mi ESE from Robe, South Australia ($37^{\circ} 16' \text{ S Lat}$, $140^{\circ} 5' \text{ E Long}$), 34 ft above sealevel. Occurred in drain exposure at ca. 2 ft below soil surface. Coll. 1961.

GaK-656. Woakwine Range **24,950 \pm 300**
23,000 B.C.

Katelysia rhytiphora, *Anadara trapezia*, *Fulvia racketti* and *Ostrea* from beach deposits ca. 40 ft above sealevel on inland fringe of Woakwine Range, 6.5 mi E from Robe, South Australia ($37^{\circ} 10' \text{ S Lat}$, $139^{\circ} 52' \text{ E Long}$), 21 to 24 in. below surface. Coll. 1965.

GaK-655. Salt Creek, Coorong **30,600 \pm 450**
28,650 B.C.

Shells of *Macra australis* from Salt Creek, Coorong, South Australia ($36^{\circ} 8' \text{ S Lat}$, $139^{\circ} 38' \text{ E Long}$), ca. 70 mi N of Robe, imbedded in beach deposit ca. 12 ft above water level in Coorong (coastal lagoon open to sea). Coll. and subm. 1965 by G. Blackburn. *Comment* (G.B.): dates marine conditions at this point and adjacent soil.

GaK-609. Mt. Gambier **1410 \pm 90**
A.D. 540

Charcoal apparently of tree root burnt during deposition of volcanic ash from Mt. Gambier, ca. 70 mi SE of Robe, imbedded in siliceous sand covered with 12 in. ash layer, 3 mi SSE of Mt. Gambier, South Australia ($37^{\circ} 53' \text{ S Lat}$, $140^{\circ} 46' \text{ E Long}$). Coll. 1956 and subm. by G. Blackburn. *Comment* (G.B.): appears to date ash deposit, but similar charcoal under volcanic ash 5 mi N from this site was dated as 4830 B.P. by NZ-33 (Fergusson and Rafter, 1957).

GaK-486. Frerentin Valley, Tasmania **14,200 \pm 700**
12,250 B.C.

Charcoal from Frerentin Valley, Tasmania ($42^{\circ} 37' \text{ S Lat}$, $146^{\circ} 27' \text{ E Long}$), in a soil profile buried beneath solifluction material thought to be periglacial in origin. Coll. 1963 by J. L. Davies and G. M. Dimmock; subm. by J. L. Davies, Univ. of Tasmania. *Comment* (J.L.D.): gives a maximum age for period of solifluction.

Barilla Valley series, Tasmania

Charcoal from Barilla Valley near Cambridge, Tasmania ($42^{\circ} 30' \text{ S Lat}$, $147^{\circ} 26' \text{ E Long}$). Subm. by J. L. Davies. *Comment* (J.L.D.): dates of gravel and silt deposits give a chronology of denudation and aggradation in this area; it is hoped the gravels may be linked to the fossil raised beaches on the coast.

GaK-487. Barilla Valley, 1 **7900 \pm 460**
5950 B.C.

Charcoal from near base of valley gravels which conceal rock floor of the valley. Coll. 1964 by J. L. Davies.

GaK-488. Barilla Valley, 2**4650 ± 120****2700 B.C.**

Charcoal from near base of valley gravels. Coll. 1964 by J. L. Davies.

GaK-651. Barilla Valley, 7**1160 ± 100****A.D. 790**

Charcoal from sandy silt layer lying in younger gravels, 1 m below ground surface. Coll. 1965 by N. Stephens and J. L. Davies.

Low raised beach series, Tasmania

Samples from beach sands assigned to the postglacial "Milford Level," Tasmania. Coll. 1964 and subm. by J. L. Davies. *Comment* (J.L.D.): suggest two periods of slightly higher sealevel in postglacial time.

GaK-647. Marion Bay, Tasmania**390 ± 90****A.D. 1560**

Carbonized drift wood contained in shell bed below sand forming a part of raised beach, 0.2 m above H.W.M.S.T., at inner side of spit between Marion Bay and Blackman Bay, Tasmania (42° 50' S Lat, 147° 52' E Long). Coll. by N. Stephens and G. Van de Geer.

GaK-648. Tinderbox, Tasmania**260 ± 70****A.D. 1690**

Shells from raised beach, 0.5 to 2 m above H.W.M.S.T., between NW Bay and Derwent estuary, Tasmania (43° 3' S Lat, 147° 19' E Long). Coll. by N. Stephens.

GaK-649. Snug, Tasmania**2760 ± 120****810 B.C.**

Shells from raised beach sands, 1.7 m below H.W.M.S.T. at Snug, Tasmania (43° 4' S Lat, 147° 16' E Long). Coll. by N. Stephens and G. Van de Geer.

GaK-650. Cremorne, Tasmania**3620 ± 80****1670 B.C.**

Carbonized drift wood from shell bed 1.2 m below surface of ground part of a raised beach 1.3 m above H.W.M.S.T. at NE side of Pipe Clay Lagoon. Cremorne, Tasmania (42° 57' S Lat, 147° 31' E Long). Coll. by N. Stephens and G. Van de Geer.

GaK-652. Smithton, Tasmania**22,700 ± 1100****20,750 B.C.**

Shells from shell deposit below tidal channel between Perkins Island and mainland, near Smithton (40° 37' 39" S Lat, 145° 2' E Long), ca. 3 m below H.W.M.S.T., sealed by 2 m of sands deposited as part of a beach or dune ridge. Coll. 1965 by Davies and G. Van de Geer; subm. by J. L. Davies.

*C. Pacific***Managalase series, Papua**

Charcoal from dacitic ash layers of the Managalase, Northern District, Papua (9° S Lat, 148° 20' E Long). Coll. and subm. 1964 by B. P. Ruxton, Div. of Land Res. CSIRO. *Comment* (B.P.R.): dates the upper ash layers around Mount Lamington (see Ruxton, 1965).

GaK-542. Managalase, S78 a **6800 ± 250**
4850 B.C.

Top charcoal layer, 25 to 28 in. from surface.

GaK-543. Managalase, S78 b **15,600 ± 500**
13,650 B.C.

Second charcoal layer, 60 to 67 in. from surface.

GaK-544. Managalase, S78 c **20,100 ± 500**
18,150 B.C.

Third charcoal layer, 90 in. from surface.

GaK-545. Managalase, T1 **7930 ± 370**
5980 B.C.

Top charcoal layer, 3 ft from surface.

Buka Island series

Shell and coral from raised reef on Buka Island, Bougainville (5° S Lat, 154° 30' E Long). Coll. and subm. 1964 by J. G. Speight, Div. of Land Res. CSIRO. *Comment* (J.G.S.): uplift is certainly pre-Holocene.

GaK-546. Buka Island, S136 **>33,500**

Shell of giant clam from upper surface of tectonically raised coral reef at Tohatsi, 300 ft above sealevel.

GaK-547. Buka Island, S157 **>33,000**

Coral from cave at Melasang in base of same raised reef as GaK-546.

*D. Antarctica***Macquarie Island series**

Fossil bird bone from Macquarie Island (54° 30' S Lat, 159° E Long). Subm. by J. McNally, Nat. Mus. of Victoria. *Comment*: dated based on organic carbon extracted by method described in the introduction. Ages are calculated without consideration of any anomaly of C¹⁴ concentration in Antarctic region.

GaK-643. Macquarie Island, No. 14 **6100 ± 120**
4150 B.C.

Fossil bone of Royal Penguin from strata in bank of Finch Creek, Macquarie Island, 20 ft above sealevel. Coll. 1957 by A. R. McEvey and Whitten. *Comment*: see notes by Blake in a paper by D. Mawson (1943).

3980 ± 140**GaK-644. Macquarie Island, No. 17****2030 B.C.**

Fossil bone of King Penguin from W coast of Bauer Bay, Macquarie Island, under present Royal Penguin rookery, 24 ft under present surface. Coll. 1962 by W. J. M. Vestjens, Div. Wildlife Res. CSIRO.

III. ARCHAEOLOGIC SAMPLES

A. North America

3210 ± 90**GaK-504. Cooper County, Missouri****1260 B.C.**

Charcoal from site 23CP40, Cooper County, Missouri (38° 44' N Lat, 93° W Long), 152 cm deep. Sample occurred in general fill of cultural deposit within bluff shelter on Lamine River in central Missouri. Coll. 1959 by H. Collins and subm. by J. M. Shippee, Kansas City Archaeol. Soc. *Comment* (J.M.S.): cultural material exists in this deposit to depth of 3 m. Lanceolate projectile points (Sedalia complex) occur in deeper levels.

870 ± 80**GaK-590. Platte County, Missouri****A.D. 1080**

Charcoal from site of Steed-Kisker, 23PL13, Platte County, Missouri (39° 17' 15" N Lat, 94° 49' 30" W Long). Taken from large pit 155 cm deep. Coll. 1964 by R. B. Aker and subm. by J. M. Shippee. *Comment* (J.M.S.): dates refuse of Indians of Middle Mississippian culture in Kansas City area.

470 ± 80**GaK-591. Barton County, 14BT420, Kansas****A.D. 1480**

Charcoal from Site 14BT420, an earth-lodge village site identified as belonging to Smoky Hill aspect, Central Plains phase, Barton County, Kansas (38° 24' 20" N Lat, 98° 44' 44" W Long), taken from burned timber found on floor of House 1. Coll. 1963 and subm. by T. A. Witty, Kansas State Hist. Soc. *Comment* (T.A.W.): dates construction of House 1 and Smoky Hill occupation. See Graves and Button (1964).

1570 ± 230**GaK-592. Greenwood County, 14GR301, Kansas****A.D. 380**

Charcoal from Curry site, 14GR301, a village site belonging to Middle Woodland period, Greenwood County, Kansas (38° 10' 9" N Lat, 96° 12' 58" W Long), associated with an adult burial. Coll. and subm. 1964 by T. A. Witty. *Comment* (T.A.W.): dates the burial and Woodland occupation. See Curry and Witty (1964).

1040 ± 100**GaK-593. Jewell County, 14JW301, Kansas****A.D. 910**

Charcoal from Site 14JW301, a small earth-lodge village site belonging to Upper Republican focus of Central Plane phase, Jewell County,

Kansas (39° 45' 15" N Lat, 98° 10' 40" W Long), taken from pit in floor of House 1. Coll. and subm. by T. A. Witty.

GaK-594. Lyon County, 14LY301, Kansas **3780 ± 140**
1830 B.C.

Charcoal from Site 14LY301, probably preceramic site marked by deeply buried rock-filled hearths, Lyon County, Kansas (38° 12' 20" N Lat, 96° 17' 39" W Long), taken from large pile of burned sandstone fragments in occupation level. Coll. 1964 by D. Featherstone; subm. by T. A. Witty. *Comment* (T.A.W.): dates possible preceramic occupation of this site, but no diagnostic artifacts are associated with this level.

William Young site series, Morris County

Samples from William Young site, 14MO304, an Archaic campsite assigned to Munkers Creek focus, Morris County, Kansas (38° 44' 50" N Lat, 96° 30' 28" W Long), taken from a rock-filled hearth of the Munkers Creek occupation. Coll. and subm. 1964 by T. A. Witty. *Comment* (T.A.W.): see Witty (1962a) and GaK-297 (Gakushuin III).

GaK-595. Morris County, 14MO304, 1 **3100 ± 400**
1150 B.C.
Taken from lower level of occupation.

GaK-596. Morris County, 14MO304, 2 **3400 ± 500**
1450 B.C.
Taken from upper level of occupation.

GaK-597. Morris County, 14MO308, Kansas **460 ± 100**
A.D. 1490

Charcoal from Slough Creek site, 14MO308, Morris County, Kansas (38° 42' N Lat, 96° 32' 20" W Long), taken from storage pit in floor of House 1. Coll. and subm. 1964 by T. A. Witty. *Comment* (T.A.W.): site appears to be late Middle Woodland village. Previous dating GaK-298, 390 ± 120 (Gakushuin III) was too recent but confirmed. See Witty (1962a).

GaK-598. Montgomery County, 14MY309, Kansas **3680 ± 180**
1730 B.C.

Charcoal from site 14MY309, Montgomery County, Kansas (37° 15' 45" N Lat, 95° 50' 19" W Long), a deeply buried occupation level which probably represents a preceramic Archaic campsite, taken from an exposed hearth buried 24 ft below surface. Coll. 1964 by W. Frantz; subm. by T. A. Witty.

GaK-599. Montgomery County, 14MY316, Kansas **1050 ± 100**
A.D. 900

Charcoal from site 14MY316, Montgomery County, Kansas (37° 15' 30" N Lat, 95° 51' 11" W Long), taken from a post hole in a Middle Woodland lodge. Hopewell potsherds were present in the associated mid-

den. Coll. 1964 by W. F. Weakly; subm. by T. A. Witty. *Comment* (T.A.W.): see Witty (1962b).

**GaK-600. Montgomery County, 14MY355, 760 ± 90
Kansas A.D. 1190**

Charcoal from Site 14MY355, a late Middle Woodland village, Montgomery County, Kansas (37° 16' 54" N Lat, 95° 46' 45" W Long), taken from trash-filled storage pit. Coll. 1964 by K. R. McWilliams; subm. by T. A. Witty.

**GaK-637. Mitchell County, 14ML8, Kansas 455 ± 90
A.D. 1495**

Charcoal from roof beam at Site 14ML8, Mitchell County, Kansas (39° 29' 18" N Lat, 98° 19' 58" W Long), 1.6 to 1.8 ft below surface. Coll. 1964 and subm. 1965 by J. O. Marshall and P. Holder, Univ. of Nebraska. *Comment* (P.H.): the archaeological situation at 14ML8 is unclear, but there seem to be 2 components, one possibly affiliated with Keith focus Woodland manifestations and the other with the Aksarben aspect. The cultural debris associated with the carbon sample indicates an affiliation with the Aksarben aspect, and the date, while possible, is unlikely; too recent.

**GaK-638. Mitchell County, 14ML16, Kansas 760 ± 90
A.D. 1190**

Charcoal from pit in burial complex at Site 14ML16, Mitchell County, Kansas (39° 27' 0" N Lat, 98° 27' 14" W Long). Coll. 1964 by D. R. Yancey and subm. 1965 by J. O. Marshall. *Comment* (P.H.): cultural debris indicated an association with the Aksarben aspect and burial practices suggest influence from Mississippian cultures to the East. An early date but entirely possible.

Mitchell County, 14ML5 series

Charcoal from Site 14ML5, Mitchell County, Kansas (39° 29' 40" N Lat, 98° 27' 30" W Long). Coll. 1964 and subm. by J. O. Marshall.

**GaK-639. Mitchell County, 14ML5, 1 610 ± 100
A.D. 1340**

From a midden area 1.4 ft deep. Coll. by A. Ahrendts. *Comment* (P.H.): cultural debris indicates an association with the Aksarben aspect and date falls within the estimated range for Aksarben sites.

**GaK-640. Mitchell County, 14ML5, 2 230 ± 90
A.D. 1720**

From a postmould presumed to lie on periphery of a house of Aksarben affiliation. Coll. by J. O. Marshall. *Comment* (P.H.): cultural debris associated with carbon sample suggests an Aksarben affiliation but date is far too recent. Debris of historic European derivation was found above house floor and the postmould may represent an intrusive late feature.

B. Japan

GaK-536. Kotake Shell Mound **4800 ± 200**
2850 B.C.

Shells from Kotake Shell Mound, Kureha-machi, Toyama Prefecture (36° 43' N Lat, 137° 13' 25" E Long), 180 cm below surface. Site is 4 km distant from present shore line. Coll. and subm. 1964 by S. Fujii, Toyama Univ. *Comment* (S.F.): dates Early Jomon in Hokuriku, Honshu Island, and change of shore line.

GaK-561. Taikoyama **1600 ± 90**
A.D. 350

Charcoal from Nakayama Minami remains, House 2, Taikoyama, Kosugi-machi, Toyama Prefecture (36° 42' N Lat, 137° 6' E Long), 100 cm below surface, associated with Hajiki potsherds. Coll. 1963 by N. Fuji, Kanazawa Univ.

Bibi shell mound series, Hokkaido

Charcoal from Bibi shell mound, Chitose City, Hokkaido (43° 10' 30" N Lat, 141° 40' E Long), alt 20 m. Site is 17 km from present shore line. Coll. and subm. 1964 by Wataru Matsushita, Chitose City. *Comment*: dates the associated remains, advance of shore line, and Tarumae volcanic ash Layer Td (Yamada *et al.*, 1963). Dating by hydration layer of obsidian gave 4600 B.P. (Katsui *et al.*, 1964).

GaK-484. Bibi shell mound, -30 cm **3800 ± 140**
1850 B.C.

Charcoal from 30 cm below surface of shell deposit.

GaK-485. Bibi shell mound, -80 cm **4500 ± 140**
2550 B.C.

Charcoal from 80 cm below surface of shell deposit, just above thin humus layer underlain by Tarumae pumice Td.

C. Australia

Malangangerr series, N.T.

Site is shelter in a large weathered block of sandstone ca. 0.5 mi from East Alligator River and ca. 23 mi from sea, Malangangerr, Arnhem Land, Northern Territory (12° 27' S Lat, 132° 57' E Long), alt ca. 25 ft. Coll. and subm. 1964 by Carmel White, Australian Nat. Univ. *Comment* (C.W.): more samples were collected from these sites and it is hoped that further tests will be made later.

GaK-626. Malangangerr, 1 **370 ± 80**
A.D. 1580

Wood charcoal from M sq. 6C, a hearth in a shell midden 8 to 10 cm from surface, associated with bifacial point industry.

GaK-627. Malangangerr, 2**5980 ± 140****4030 B.C.**

Charcoal from M sq. 6D, a hearth 85 to 90 cm from surface which rests on a shelf of rock with several grinding hollows. *Comment* (C.W.): date should provide a terminus ante quem for the making and use of the grinding hollow.

GaK-628. Malangangerr, 3**19,600 ± 550****17,650 B.C.**

Charcoal near 2 polished grooved axes, from sq. 2A in sand 150 to 154 cm below surface. *Comment* (C.W.): dates of GaK-628 and GaK-629 are surprisingly high and further confirmation is required before these can be accepted.

GaK-629. Malangangerr, 4**22,700 ± 700****20,750 B.C.**

Charcoal from M sq. 5B in sandy loam 138 cm below surface, associated with several retouched flakes.

Tyimedee 1 series, N.T.

Wood charcoal from site Tyimedee 1, a small shelter at base of cliff of Kombolgie sandstone, Arnhem Land, Northern Territory (12° 25' S Lat, 133° 15' E Long). The basal deposit, ca. 100 cm deep, is heavily iron-stained sandstone overlain by yellow-brown sand which grades into the upper level of gray-brown sand. Coll. and subm. 1964 by Carmel White.

GaK-630. Tyimedee 1, 1**Modern <230**

Grey-brown sand, 0 to 5 cm below surface. From top 5 cm associated with stone spear points.

GaK-631. Tyimedee 1, 2**1900 ± 90****A.D. 50**

From yellow sand layer, 61 cm below surface, associated with bifacial points.

GaK-632. Tyimedee 1, 3**10,790 ± 200****8840 B.C.**

From yellow sand layer, 61 cm below surface, associated with bifacial points. *Comment* (C.W.): date is surprisingly high since sample is associated with same cultural material as GaK-631; it requires further confirmation before it can be accepted.

Kenniff cave series, Queensland

Charcoal from Kenniff cave, Queensland (24° 52' S Lat, 148° 2' E Long). Earlier excavations and datings (NPL-32 and NPL-33: National Physical Lab. I; NPL-65, NPL-66, NPL-67 and NPL-68: National Physical Lab. II) showed stratified floor of human occupation to a depth of 11 ft. Coll. and subm. 1964 by D. J. Mulvaney, Australian Nat. Univ. Mulvaney and Joyce (1965) provided detailed comments.

- GaK-522. Kenniff cave, No. 3** **1600 ± 100**
A.D. 350
Tr.B, Sq.1, Spit 6, 15 in. to 17 in. from surface. *Comment* (D.J.M.): post-dates the latest appearance of backed-blade implement types, including geometric microliths. Consistent with NPL-32, 65.
- GaK-523. Kenniff cave, No. 14** **4130 ± 90**
2180 B.C.
Tr.B, Sq:4, Spit b, 3 ft 9 in. from surface. *Comment* (D.J.M.): pre-dates earliest appearance of backed-blade implement types; period of Pirri point use. Consistent with NPL-65, 66.
- GaK-524. Kenniff cave, No. 15** **5370 ± 140**
3420 B.C.
Tr.B, Sq.4, Spit e, 4 ft 4 in. to 4 ft 6 in. from surface. *Comment* (D.J.M.): is stratigraphically older than GaK-525. Consistent with NPL-66.
- GaK-525. Kenniff cave, No. 24** **4650 ± 100**
2700 B.C.
Tr.A, Sq.1, Spit 18, 4 ft 6 in. to 4 ft 9 in. from surface. *Comment* (D.J.M.): collected from the infilling of an eroded hollow. Stratigraphically younger than GaK-524; consistent with NPL-66.
- GaK-526. Kenniff cave, No. 21** **13,200 ± 300**
11,250 B.C.
Tr.C, Sq.5, Spit w, 8 ft 11 in. to 9 ft 3 in. from surface. *Comment* (D.J.M.): NPL-67, 33, 68, all collected between 5 ft 7 in. and 7 ft 8 in., are chronologically older than this sample; no source of contamination evident.
- GaK-527. Kenniff cave, No. 23** **9300 ± 200**
7350 B.C.
Tr.C, Sq.4-5, Spit y, 10 ft 6 in. to 10 ft 9 in. from surface. *Comment* (D.J.M.): this, and GaK-645, cannot be reconciled with the stratigraphically more recent GaK dates above, or with all the NPL dates. Source of possible error is unknown. Further samples will be submitted in hope of clarification.
- GaK-645. Kenniff cave, No. 22** **9650 ± 100**
7700 B.C.
Tr.B, Sq.24, Spit y, closest in depth to GaK-527 but coll. from wider area than GaK-527. 10 ft 3 in. to 10 ft 6 in. from surface. *Comment* (D.J.M.): see above, GaK-527.
- GaK-646. Kenniff cave, No. 16** **10,280 ± 180**
8330 B.C.
Tr.B, Sq:4, Spit h, 5 ft 2 in. to 5 ft 4 in. from surface. *Comment* (D.J.M.): consistent with NPL-67.

Wombah midden series

Samples coll. during excavation in 1964 at Wombah middens, Site 1, one of a series of middens at Wombah, near Iluka, on N bank of Clarence River, Northern New South Wales, 8 mi W of its mouth (29° 22' S Lat, 153° 17' E Long). Coll. and subm. 1964 by I. McBryde, Univ. of New England.

General Comment (I.M.): samples were taken from a grid of squares excavated ca. 50 yd to E of those excavated in 1963 from which samples have already been dated (GaK-374, 375, 376, Gakushuin IV). Also see McBryde (1965). Dates given here supplement those already received for the site. Cultural material from this site included uniface pebble artifacts, and some backed blades, but site as a whole not rich in artifacts.

2960 ± 120
1010 B.C.

GaK-564. Wombah Site 1, 1

Charcoal from Sq. f, Level IIA, Spit 2, section of main shell layer in the midden, at depth of 13 to 14 in. below surface.

2930 ± 100
980 B.C.

GaK-565. Wombah Site 1, 2

Charcoal from Sq. f, Level IIA, Spit 3, lowest part of main shell layer, 25 to 27 in. below surface. *Comment* (I.M.): stratified below GaK-564 so that the more recent result here is surprising, though the two dates are very close. Associated cultural material included blade tools, with some Bondi points.

1530 ± 90
A.D. 420

GaK-566. Wombah Site 1, 3

Charcoal from Sq. g, Level IIA, Spit 1, upper part of main shell layer, 17 to 18 in. below surface, *Comment* (I.M.): as expected from stratigraphic position, date is more recent than GaK-564 and 565.

3040 ± 120
1090 B.C.

GaK-567. Wombah Site 1, 4

Charcoal from Sq. k, Level IIA, Spit 3, a heavy concentration of shells in lower part of main shell layer of deposit, 18 in. below surface. *Comment* (I.M.): from its stratigraphic position date was expected to be in accord with GaK-565. Sample was associated with part of a broken ground-edged implement, giving interesting evidence on the antiquity of this type of artifact in northern New South Wales.

3230 ± 100
1280 B.C.

GaK-568. Wombah Site 1, 5

Charcoal from Sq. h, Level VIII, earliest stratigraphic level showing signs of human occupation on the site, at depth of 22 to 26 in. below surface. Associated artifacts included blade and uniface pebble tools. *Comment* (I.M.): date should be in accord with GaK-376, 2870 ± 130 B.P. (Gakushuin IV).

Bendemeer rock shelter series

Site is situated in Moonbi Range, near Hall's Creek, ca. 10 mi W of Bendemeer in northern New South Wales (30° 53' S Lat, 151° 2' E Long). Occupation deposit excavated was protected by the overhang of a large granite boulder which bears paintings in red ocher. Samples whose dates are given here were collected from upper two levels of deposit, and are stratified above levels which were richest in cultural material, yielding backed blades (Bondi points and geometric microliths), some burins, and two ground-edged axes.

General Comment (I.M.): dates will give an indication of chronology of this blade tool industry which is similar to that of "Bondaian" sites in eastern NSW to the South; will also date the blade tools found in the upper levels directly associated with the samples.

410 ± 40

GaK-569. Bendemeer Site 1, 1 **A.D. 1540**

Charcoal from Tr. 1, Zone a, Level 1, upper level of deposit, 4 to 5 in. below surface.

740 ± 40

GaK-570. Bendemeer Site 1, 2 **A.D. 1210**

Charcoal from Tr. 1, Zone b, Level 1, upper level of deposit, concentrated in a depression in this level, 7 in. below surface. *Comment* (I.M.): as the deposit here covers part of the red ocher art on the rock surface, date will be a useful indication of date of the art, which must be older than the deposit covering it.

535 ± 40

GaK-571. Bendemeer Site 1, 3

Charcoal from Tr. 1, Zone c, Level 1, upper level of deposit in Zone c, on W side of trench, 2.5 to 3 in. below surface of deposit. *Comment* (I.M.): should be in accord with GaK-569 and 570.

630 ± 40

GaK-572. Bendemeer Site 1, 4 **A.D. 1320**

Charcoal from Tr. 1, Zone c, Level II, a concentration of this material in second stratigraphic level distinguished in deposit, on S side of Zone c, 9 in. below surface. *Comment* (I.M.): sample was stratified below GaK-571 and expected to be older than GaK-569.

*D. Pacific***Aibura cave series, New Guinea**

Samples are taken from a limestone cave, Aibura cave, Tairora Census Division, Kainantu Sub-District, Eastern Highlands District, New Guinea (6° 20' S Lat, 145° 50' E Long). White ashy hearths visible to ca. 70 cm below surface; artifacts continue to ca. 130 cm below surface of ground. Coll. and subm. 1964 by J. P. White, Australian Nat. Univ. *Comment* (J.P.W.): see White (1965) for interim report on site. More

samples were collected from this site and it is hoped that further tests may be made.

GaK-622. Aibura cave, -50 cm **770 ± 100**
A.D. 1180

Charcoal in white ashy lens, Level 4, 50 cm below surface. Associated with ground stone axes and flaked artifacts. Pottery traded from Markham Valley is found down to Level 3 and shells (down to Level 5) were traded in from coast ca. 120 mi distant. *Comment* (J.P.W.): dates approximately the beginning of trade with the lowlands and coast.

GaK-623. Aibura cave, -122 cm **3800 ± 110**
1850 B.C.

Charcoal in soil matrix, 122 cm below surface. *Comment* (J.P.W.): probably dates earliest remains of occupation at site.

Kosipe series, Papua

Samples are taken from ridge-top site, Kosipe, 11 mi NNW of Wotape Government Station, Vetapu Census Div., Goilala Sub-District, Central District, Papua (8° 30' S Lat, 147° 20' E Long). Samples occur as loose carbon in buried soil layer. Coll. and subm. 1964 by J. P. White. *General Comment* (J.P.W.): samples should date period of use of waisted blades and, especially, mortars found in the buried soil layer, but dates of GaK-624 and GaK-625 are surprisingly high and further confirmation is required before these dates can be accepted. See White (1965). More samples have been collected.

GaK-624. Kosipe, Papua, -74 cm **16,300 ± 1200**
14,350 B.C.

Charcoal from buried soil, ca. 30 cm below top of buried soil.

GaK-625. Kosipe, Papua, -75 cm **19,350 ± 600**
17,400 B.C.

Carbonaceous soil from ca. 10 cm below top of buried soil.

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NPL II	Callow Baker, and Pritchard, 1963
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GIF NATURAL RADIOCARBON MEASUREMENTS II

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The C^{14} dating laboratories of Saclay (Saclay I, 1964 and Saclay II, 1965) and Gif (Gif-sur-Yvette, 1966) have joined together under the name of Gif C^{14} Dating Laboratory. The first series of dating results appears here with code designation Gif, Sa now being obsolete.

Gif laboratory comprises 3 complete routine sets, each equipped with a 1.2 L proportional counter, filled with pure CO_2 at 74 cm Hg pressure, having backgrounds of 3.40, 2.90 and 1.60 cpm. The first two are of stainless steel and the third is of OFHC copper.

In accordance with the decision of the Fifth Radiocarbon Dating Conference, NBS oxalic acid is adopted as modern carbon reference, and the half-life 5570 yr is used for age calculation.

Data listed here are part of those obtained from 1963, the date at which the first counter was calibrated, to October 1965.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Western France

Gif-166. Saint-Jude, Bourbriac, Côtes du Nord **3430 \pm 160**
1480 B.C.

Charcoal from an old burnt soil inside a tumulus at Saint-Jude, Bourbriac (48° 28' N Lat, 3° 18' W Long). Coll. 1962 and subm. by J. Briard and P. R. Giot, Lab. d'Anthropologie Préhistorique, Faculté des Sciences, Rennes, Ille et Vilaine. *Comment:* dates tumulus to Middle Bronze period.

Gif-167. La Belle-Etoile, Saint-Connan, Côtes du Nord **2350 \pm 140**
400 B.C.

Charcoal from habitat with heart at La Belle-Etoile, Saint-Connan (48° 25' N Lat, 3° 04' W Long). Coll. 1960 and subm. 1962 by Mazeas and P. R. Giot. A stock of about 50 iron ingots has been found, hidden in ground. The hotsherds found can be ascribed to La Tène I (Giot, 1964). *Comment:* confirms the supposed period: La Tène I of the second Iron period.

Gif-168. Plélauff, Côtes du Nord **1200 \pm 120**
A.D. 750

Fragments of wood from gallery of ancient mine found at 36 m depth during mining prospection at Plélauff (48° 22' N Lat, 3° 13' W Long). Subm. by P. R. Giot. *Comment:* dates this ancient lead mine to the First-Middle-ages period.

Créac'h-Kiliet series, Saint-Quay-Perros, Côtes du Nord

Charcoal from filling of Megalithic monument of Créac'h (48° 47' N Lat, 3° 23' W Long). Coll. and subm. 1963 by J. L'Helgouach, Lab. d'Anthropologie Préhistorique, Faculté des Sciences, Rennes, Ille et Vilaine.

Gif-197A. Créac'h-Kiliet A **2850 ± 170**
900 B.C.
E extremity, Squares I-II, bottom.

Gif-197B. Créac'h-Kiliet B **2790 ± 150**
840 B.C.
W extremity, Center 5, bottom.

Gif-197C. Créac'h-Kiliet C **3470 ± 200**
1520 B.C.
Lateral entrance.

Comment: possible partial contamination by infiltration of more recent coals, particularly during forest clearings of the Late Bronze period.

Tossen-Keler series, Penvenan, Côtes du Nord

Charcoal from tumulus of Tossen-Keler (48° 48' N Lat, 3° 33' W Long). Coll. and subm. by J. Briard and P. R. Giot.

Gif-237A. Tossen-Keler, Penvenan **500 ± 120**
A.D. 1450
Outer S hearth. Coll. and subm. 1963.

Gif-237B. Tossen-Keler, Penvenan **2700 ± 200**
750 B.C.
Central hearth. Coll. and subm. 1963.

Gif-280. Tossen-Keler, Penvenan **4500 ± 250**
2550 B.C.
E trench. Coll. and subm. 1964.

General Comment: Gif-280 is first dating of this Neolithic tumulus. Gif-237A might be a filling with superficial ground containing charcoal; during Middle-age, hearth had been built at foot of some of the menhirs erected around tumulus.

Gif-283. Le Champ-Grosset, Quessoy, Côtes du Nord **3820 ± 200**
1870 B.C.

Charcoal from Megalithic monument of the type "lateral entrance grave" found at Le-Champ-Grosset, Quessoy (28° 25' 20" N Lat, 2° 4' 30" W Long). Coll. and subm. 1964 by J. L'Helgouach. *Comment:* agreement with archaeological date (L'Helgouach and Le Roux, 1965).

Gif-158. Cleidern, Melgven, Finistère **2170 ± 140**
220 B.C.

Charcoal from filling of chest by 6 big flags, making a sepulture at Cleidern, Melgven (47° 54' N Lat, 3° 51' W Long). An intact three-

handled vase has been identified as being of Middle Bronze period. Coll. by J. Briard and subm. 1962 by P. R. Giot. *Comment*: charcoal much too young for Bronze period.

Ile de Geignog series, Landela, Finistère

Charcoal from excavations of Megalithic monuments in island of Geignog, 2 km off continent coast ($48^{\circ} 35' \text{ N Lat}$, $4^{\circ} 35' \text{ W Long}$). Coll. by L'Helgouach; subm. 1962 by P. R. Giot. Neolithic potsheerds have been discovered in these monuments which were re-used at late Bronze period. Traces of Late Bronze period still exist elsewhere in island. Monuments again occupied during Iron period (Giot, 1965).

Gif-161. Ile de Geignog	2750 ± 150
Room of Grave I A.	800 B.C.

Gif-162. Ile de Geignog	2840 ± 150
Room of Grave II B.	890 B.C.

Gif-163. Ile de Geignog	1150 ± 120
Room of Grave III A.	A.D. 800

Gif-164A. Ile de Geignog	2620 ± 150
Bottom of room in Grave III B.	670 B.C.

Gif-164B. Ile de Geignog	4350 ± 200
Bottom of room in Grave III B, around and in incineration of a skeleton.	2400 B.C.

Gif-165. Ile de Geignog	5800 ± 300
Bottom of room in Grave III C.	3850 B.C.

Gif-281. Ile de Geignog	2350 ± 200
Under the paving.	400 B.C.

General Comment: coherent series of dates which confirms an important reutilization of these graves at Late Bronze period. Reutilizations explain connection of island with the continent at that period. Existence of a farm (findings of Mediaeval ceramics) in central part of island confirmed by Gif-163. Gif-165 is somehow ancient for Neolithic period but has already been found for other graves, Kercado (5840 ± 300 , Sa-95, Saclay I). Gif-164B, somewhat too recent, may have been polluted by coals of Gif-164A origin.

Lezommy series, Cléder, Finistère

Charcoal from sepultures of Bronze period found at Lezommy, Cléder ($48^{\circ} 37' \text{ N Lat}$, $4^{\circ} 09' \text{ W Long}$). Without any apparent tumulus,

graves were only covered with a big lump of stone. Classic industry of Middle Bronze period. Coll. and subm. 1963 by J. Briard and P. R. Giot.

Gif-188. Lezommy **3600 ± 200**
1650 B.C.
W grave.

Gif-189. Lezommy **3150 ± 200**
1200 B.C.
SE grave.

General Comment: C¹⁴ date corresponds to archaeological date.

Pembrat-Vihan series, Lannilis, Finistère

Charcoal from hearths near urns surrounding a quadrangular Gallic stele in a cemetery with cremation urns at Pembrat-Vihan (48° 26' N Lat, 4° 30' W Long). With implement from post-Hallstatt-La-Tène I. Coll. and subm. 1963 by C. T. Le Roux, Direction des Antiquités Pré-historiques, Rennes, Ille et Vilaine.

Gif-220A. Pembrat-Vihan A **1570 ± 150**
A.D. 400
Sample from mixture of all charcoal found.

Gif-220B. Pembrat-Vihan B **1820 ± 150**
A.D. 130
Hearth floor of Urn 3.

General Comment: ages too recent, not yet explained.

Gif-238. Pointe de la Torche, Plomeur, Finistère **580 ± 120**
A.D. 1370

Marine shells of subfossil coastal line corresponding to highest present sealevel, Isthme de la Pointe de la Torche, Plomeur (44° 31' N Lat, 4° 22' W Long). Coll. and subm. 1963 by P. R. Giot and A. Guilcher, Institut de Géographie, Paris.

Le Curnic series, Guissény, Finistère

On beach of Curnic, Guissény, Finistère (48° 35' N Lat, 4° 25' W Long), charcoal found from hearths in pits, 0.50 m to 1 m-depth with Bronze age salt-pan industry. Just under middle-level of sea. Coll. and subm. 1962 by P. R. Giot.

Gif-159. Le Curnic **3175 ± 160**
1225 B.C.
E pit; charcoal.

Gif-160. Le Curnic **2750 ± 150**
800 B.C.
W pit; charcoal.

Gif-278. Le Curnic **3310 ± 200**
1360 B.C.

Sub-fossil wood from peat-bog in vicinity of site. *Comment:* peat-bog, whose base is placed on loess, is a sediment of fresh water; pollen

analysis (Van Zeist, 1963) shows presence of *Nymphaea*, *Alba*, *Alisma*, *Sparganium*, *Typha*, *Augustifolia*, indicating that sealevel was much lower than now (peat-bog is now immersed).

General Comment: Gif-159 and 160 complete first measurements for site, 3220 ± 110 B.P. (Gif-47C, Gif I). Gif-160 is probably contemporary of salt-pan industry; 159 and 47C show that sub-fossil wood from peat-bog may have been used as fuel in hearths.

4250 \pm 250
Gif-282. Le Correjou, Plouguerneau, Finistère 2300 B.C.

Charcoal found in a level of charcoal, 15 m thick, of a coastal peat-bog at Plouguerneau, on beach of Correjou ($48^{\circ} 37'$ N Lat, $4^{\circ} 31'$ W Long). Level is at present "mean" highest tide level. Coll. by C. T. Le Roux; subm. 1964 by P. R. Giot.

5000 \pm 300
Gif-249. Bois du Rocher, La Vicomté sur Rance, Côtes du Nord 3050 B.C.

Fragments of charcoal found in red clay 1 m thick, under 0.70 m sand-layer at a point in midst of Mousterian surface-workshop at Bois du Rocher ($48^{\circ} 30'$ N Lat, $1^{\circ} 58'$ W Long). Coll. and subm. by M. Gruet, 78 bis, rue de Frémur, Angers. *Comment:* on same site is a Megalithic tomb; date shows that place was also a Neolithic settlement.

1970 \pm 120
Gif-195. Mané-er-Hloch, Locoal-Mendon, Morbihan 20 B.C.

Charcoal from angled passage grave at Mané-er-Hloch, Locoal-Mendon ($47^{\circ} 43'$ N Lat, $3^{\circ} 07'$ W Long). Coll. 1924 by Le Rouzic; subm. by l'Hergouach. *Comment:* re-utilization of grave during Iron period.

2230 \pm 150
Gif-196. Ile de Téviec, Saint-Pieere, Quiberon, Morbihan 280 B.C.

Ashy ground from excavations of Mesolithic site of Ile de Téviec at Saint-Pierre Quiberon ($47^{\circ} 33'$ N Lat, $3^{\circ} 18'$ W Long). Coll. and subm. 1963 by P. R. Giot. *Comment:* Late Mesolithic age expected archaeologically out evident contamination probably due to "Guano" of sea-birds.

Le Castelleic series, Carnac, Morbihan

Coal of oak from low Neolithic long barrow at Le Castelleic ($47^{\circ} 34'$ N Lat, $3^{\circ} 25'$ W Long). Coll. 1922 by Z. Le Rouzic and S. J. Péquart; subm. by J. l'Helgouach.

3930 \pm 250
Gif-198A. Le Castelleic, A 1980 B.C.
Large hearth No. 13, E Zone.

5025 \pm 300
Gif-198B. Le Castelleic, B 3075 B.C.
Chest No. 3, W Zone.

Comment: indicates that W zone with chests is of Early Middle Neolithic period while E zone, which is composed of only 3 hearths, seems to have been added at end of Neolithic period.

6575 \pm 350

Gif-227. Ile de Hoëdic, Morbihan

4625 B.C.

Well-known Mesolithic layer in island of Hoëdic (47° 20' 35" N Lat, 2° 53' 04" W Long) (Péquart, 1954). Archaeological layer where coal has been found lies closely on rocky base and is covered with marine sand eolian deposit, maximum height 2 m. Also found in this layer: many fragments of shells, necropolis, and set of goods of Mesolithic period. Coll. 1962 and subm. 1963 by Y. Rollando, Conservateur du Musée Archéologique de la Société Polymathique du Morbihan, Vannes, Morbihan. *Comment:* dates Mesolithic period in Bretagne, showing that it is younger in Bretagne than at other Mesolithic stations in W Europe.

725 \pm 120

Gif-228. Ile de Boëde-en-Séné, Morbihan

A.D. 1225

Charcoal from salt-pan kiln of S coast of island of Boëde-en-Séné (47° 36' 15" N Lat, 2° 45' W Long). Coll. and subm. 1963 by J. Lejards, Société Polymathique du Morbihan, Vannes, Morbihan.

1495 \pm 150

Gif-229. Moustérien-en-Séné, Morbihan

A.D. 445

Charcoal from kiln of salt-pan of station of Moustérien-en-Séné (47° 36' 10" N Lat, 2° 44' 30" W Long), situated at coast of Gulf of Morbihan; kilns are covered with vegetable ground layer, 25 to 30 cm thick. Coll. and subm. 1963 by J. Lejards. *Comment:* age seems rather young for such stations, usually known as Gallic or Roman-Gallic. Near kiln, fragments of common vases of "La Tène" period were found.

3270 \pm 200

Gif-235. Tuchenn Cruguel, Guidel, Morbihan

1320 B.C.

Charcoal from ground of tumulus of Old Bronze period at Tuchenn Cruguel (47° 46' N Lat, 3° 13' W Long); 4 daggers, 1 hatchet, 14 arrows found in chamber of tumulus during excavations in 1890. Coll. by C. T. Le Roux and P. R. Giot; subm. 1963 by P. R. Giot. *Comment:* rather young.

Saint-Brévin-L'Océan series, Loire Atlantique

Bronze period coastal sites at Saint-Brévin-l'Océan (47° 12' N Lat, 2° 07' W Long). Flint splinters, many fragments of pottery, and statuette of baked clay found in the habitats (along the present beach), are supposed to be of Middle or Late Bronze period (Tessier, 1965). Coll. 1960 to 1962 and subm. 1963 by M. Tessier, Tharon, Loire Atlantique.

**Gif-193A. Saint-Brévin-l'Océan, l'Hermitage,
S 1960.**

**3175 \pm 200
1225 B.C.**

Charcoal.

Gif-193B. Saint-Brévin-l'Océan, l'Hermitage, 2775 ± 200
S 1961. 825 B.C.

Charcoal.

Gif-193C. Saint-Brévin-l'Océan, l'Hermitage, 2465 ± 200
N 1962. 515 B.C.

Charcoal.

Gif-194. Saint-Brévin-l'Océan, La Roussellerie 2720 ± 200
770 B.C.

Carbonized corn.

General Comment: possible dates for a Late Bronze age. Variations between ages show a rather long occupation of these sites.

Gif-236. Ancenis, Loire Atlantique 1820 ± 200
A.D. 130

Oak wood of a dug-out canoe found buried in bed of Basse-Loire River during re-building of bridge of Ancenis (47° 22' N Lat, 1° 02' W Long). Coll. 1950 by M. Liot; subm. 1963 by P. R. Giot. At same level, fragments of a brain-pan of *Bos primigenius*.

Mont-Saint-Michel series, Manche

Mortars from walls of Notre-Dame-sous-Terre church, so-called Carolingian church. Church, on which was erected in IIth century the Romanic basilica of Mont-Saint-Michel, built on the rock itself (48° 38' N Lat, 10° 30' W Long). Coll. and subm. 1964 by M. Traverse, Direction des Monuments Historiques de la Manche, J. Labeyrie and G. Delibrias.

Gif-314. Mont-Saint-Michel, E 1150 ± 120
A.D. 800

Front N wall separating the 2 chapels, "chapelle de la Vierge" and "chapelle de la Trinité."

Gif-315. Mont-Saint-Michel, C 1300 ± 120
A.D. 650

Arcade N of "chapelle de la Trinité."

Gif-316. Mont-Saint-Michel, D 1910 ± 150
A.D. 40

Wall W of "chapelle de la Vierge," mortar between bricks, at lowest part of wall.

General Comment: Gif-314 and Gif-315 clearly confirm that this now underground sanctuary is Carolingian and younger than the erection of the Roman basilica; they date it to the 8th and 9th centuries. Old date given by Gif-316 might indicate another much more ancient construction, unknown till now and partially re-used for foundation of the Carolingian church. These examples show that dating of old mortars made out of granitic sand may be very useful for archaeological determination (Froidevaux, 1961).

1160 \pm 150

Gif-190. Eglise Saint-Martin, Caen, Calvados **A.D. 790**

Charcoal found under skeleton in cemetery surrounding old church of Saint-Martin at Caen (49° 11' N Lat, 0° 20' W Long). Coll. and subm. 1963 by M. de Boüard, Laboratoire d'Archéologie Médiévale, Faculté des Lettres, Caen, Calvados. *Comment:* these graves of sarcophagus type were surrounded by a set of goods dated archaeologically to 7th century.

Le Pontpiau-Champtocé series, Maine et Loire

Charcoal found during excavation in grave of Pontpiau, Champtocé (47° 21' N Lat, 0° 52' W Long). Coll. 1961 and 1962, and subm. 1963 by M. Gruet, Musée de Paléonthologie, Angers, Maine et Loire.

Gif-234A.	2755 \pm 150 805 B.C.
Gif-234B.	2425 \pm 150 475 B.C.
Gif-234C.	2620 \pm 150 670 B.C.
Gif-234D.	2870 \pm 200 920 B.C.
Gif-234E.	3160 \pm 200 1210 B.C.

General Comment: monument appears to have been re-occupied in Bronze period.

B. Central and Eastern France

3480 \pm 200

Gif-209. Lac de Chalain, Doucier, Jura **1530 B.C.**

Wood from pile-dwelling in Lac de Chalain at Doucier (46° 40' N Lat, 1° 06' E Long). Coll. 1934, 10 m from present shore, during a 2.50 m temporary lowering of the waters. Subm. 1961 by F. Tanazacq, Laboratoire de Géophysique de la Sorbonne, Paris. *Comment:* no archaeological contradiction.

Forêt des Potées series, Maubert-Fontaine, Ardennes

Charcoal from tumuli of Celtic necropolis at Forêt des Potées (49° 52' N Lat, 0° 12' E Long). Coll. 1939 by J. Hégly; subm. 1962 by F. Tanazacq, Maubert-Fontaine, Ardennes.

Gif-210. Forêt des Potées, I-39-C	2020 \pm 150 70 B.C.
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Hearse and incineration tumulus.

Gif-211. Forêt des Potées, 5-39**2530 ± 150****580 B.C.**

Total incineration tumulus.

General Comment: shows that site has been used as necropolis during at least half a millenium.

Gif-186. Lezoux, Puy de Dôme**800 ± 120****A.D. 1150**

Charcoal found in the most recent soil, 1 m depth, of habitat erected upon remains of Roman-Gallic kiln of 2nd century A.D. at Lezoux (46° 52' N Lat, 3° 33' E Long). Coll. 1964 by G. Fournier and subm. 1964 by E. Thellier, Institut de Physique du Globe, Paris. *Comment:* found with ceramics of Mediaeval type; date marks evolution of Roman-Gallic pottery to Mediaeval pottery.

Gif-207. Ligugé, Vienne**1375 ± 120****A.D. 575**

Charcoal from mortar of Pre-Roman crypt of abbey of Ligugé (46° 31' N Lat, 0° 05' E Long). Coll. and subm. 1963 by Dom J. Coquet, Abbaye Saint-Martin, Ligugé, Vienne. *Comment:* agreement with archaeological age estimate.

Coincy-en-Tardenois series, Aisne

Samples from different layers of bed of Coincy, near Fère-en-Tardenois (49° 38' N Lat, 3° 23' E Long). place where the Tardenoisien defined (Alimen and others, 1964). Coll. and subm. 1961 by Hinout et H. Alimen, Laboratoire de Géologie, C.N.R.S., Bellevue, Seine-et-Oise.

**Gif-131. Coincy-en-Tardenois, so-called place
"Le Géant"****3260 ± 200****1310 B.C.**

Grave from base of peaty level overlying Tardenoisian industry.

Gif-132. Coincy-en-Tardenois**4740 ± 350****Hearth No. 2 "La Chambre aux Fées" 2790 B.C.**

Charcoal, found at 60 to 80 cm depth, mixed with Tardenoisian industry.

Gif-133-134. Coincy-en-Tardenois**5040 ± 500****Hearths No. 3 and 4 "La Chambre
aux Fées" 3090 B.C.**

Charcoal from two different hearths, No. 3 and 4, at 60 to 70 cm depth with a distance of 1.50 m between them, mixed with Tardenoisian industry, at horizontal distance of 15 m from Gif-131 and Gif-123. *Comment:* these two scarce samples have been added together. Besides, filling of the counter has been completed with inert CO₂; thus this measurement is more imprecise.

General Comment: Gif-132 and 133-134 are the first absolute datings of this layer eponymous of the Tardenoisian.

2440 ± 150
490 B.C.

Gif-272. Combe Barre T3, Darcey, Côte d'Or

Charcoal from hearth at base of tumulus of Iron period at Combe Barre T3, Darcey (47° 34' N Lat, 4° 34' E Long). Coll. 1962 and subm. 1965 by Abbé Joly, Antiquités Préhistoriques de Dijon.

950 ± 150
A.D. 1000

Gif-247. Sublaines, Indre et Loire

Bone in a crushed urn found at 1.70 m depth in Merovigian cemetery of Sublaines (47° 16' N Lat, 0° 59' E Long) (Cordier and Eygun, 1963). Coll. 1962 and subm. by G. Gordier, Beaulieu-lès-Loches, Indre et Loire. *Comment:* measurement has not been done on the collagene, but on the whole bone. Initially thought to be of Iron age but in reality dated from 7th century A.D.

Beaussement series, Chauzon, Ardèche

Charcoal from station surrounded by dry stones and big blocks of stones stretched over many thousands of m². Ferrières' characteristic ceramics (44° 32' N Lat, 4° 21' E Long). Coll. 1963 and subm. 1964 by R. Montjardin, Lycée Technique d'Arles, Bouches-du-Rhône.

4100
2150 B.C.

Gif-245. Beaussement S-3 — C4/6
Boring 3, Layer 4/6.

4170
2220 B.C.

Gif-246. Beaussement S-4 — C4
Boring 4, Layer 4.

Comment: Southern Late Neolithic of Early Ferrières group (Montjardin, 1962).

C. Southern and South-Eastern France

2450 ± 170
500 B.C.

Gif-72. La Bonne Mère, Bouches-du-Rhône

Human bones discovered at base of rocky spur on skirts of Etang de Berre, at La Bonne Mère, Marignane, Bouches-du-Rhône (43° 25' N Lat, 5° 10' E Long). Coll. 1959 and subm. by O. Sicard, Les Plaines, Marignane. *Comment:* no clue about date of these bones.

3880 ± 250
1930 B.C.

Gif-156. Lebous, Saint-Mathieu de Treviers, Hérault

Charcoal from surface layer, under Tower 1 of monument of Lebous, Saint-Mathieu de Treviers (43° 36' N Lat, 3° 51' E Long) (Arnal and others, 1964). Coll. and subm. 1962 by J. Arnal. *Comment:* industries of old Bronze period: daggers, needles, and pottery with fragments of a skeleton enable us to date site to end of Chalcolithic period. Monument, being really a fortification, shows an architecture which is, presently, the only one found at this period. Good agreement between C¹⁴ and archaeological dates for this Chalcolithic monument.

Saint-Etienne de Gourgas series, Hérault

Charcoal from prehistoric hearth found under rocky shelter close to an oppidum at Saint-Etienne de Gourgas (43° 46' N Lat, 3° 23' E Long) (Escalon de Tonkan, 1963). Coll. and subm. 1962 by G. Arnal, Lodève, Hérault.

Gif-154a. Saint-Etienne de Gourgas F.14 **3880 ± 250**
1930 B.C.

Gif-154f. Saint-Etienne de Gourgas F.18 **3780 ± 250**
1780 B.C.

Gif-154i. Saint-Etienne de Gourgas F.22 **4570 ± 300**
2620 B.C.

General Comment: 154i dates Hearth F.22 which corresponds to Chassean level of site while 154a is clearly marked by recent Neolithic and material contemporary with the monument of Lebous, Gif-156: 3880 ± 250.

Gif-96. Lasalle, Gard **150 ± 100**
A.D. 1800

Wood from vaulted cistern between l'Estréchure and Col de Marcou, at Lasalle (44° 05' N Lat, 3° 45' E Long). Coll. 1960 and subm. by P. Monnet, Eaux et Forêts, Gap, Hautes Alpes. *Comment:* building of unknown age, and technically interesting.

Gif-191. Grotte de Prével, Montclus, Gard **3880 ± 180**
1930 B.C.

Carbonized fruits found in clayey layer at 1 m depth in cave of Prével, commune de Montclus 44° 16' N Lat, 4° 25' E Long). An important industry has been found in this layer, including polished stone axes, foliated arrows, and copper needles; dated in Eneolithic age (Roudil, 1963). Coll. and subm. 1962 by J. L. Roudil, C.N.R.S. Montpellier, Hérault.

Aiguebelette series, Lac d'Aiguebelette, Savoie

Wood of pile-foundation at coastal station presently under ca. 2 m water in lake of Aiguebelette (45° 32' N Lat, 5° 43' E Long). Coll. and subm. 1962 by R. Laurent, Centre de Recherches Archéologiques Lacustres de Dauphiné-Savoie, Tresserve, Savoie.

Gif-222. Aiguebelette I, 601-D **2480 ± 150**
530 B.C.
South part of station.

Gif-223. Aiguebelette Ibis, 605B **contemporary**

On hillock at 350 m from Aiguebelette I. *Comment:* supposed age similar to Gif-222. Probably recent pile fixed up into hillock by fishermen.

General Comment: this Chalcolithic station is contemporary with other lake dwellings of area, particularly at Thonon, lake of Geneva (Sa-228: 2440 ± 180 , Saclay II). None of the lithic implements of this station have been found up to now.

1615 \pm 120

Gif-202. La Thuile, Beaumont, Haute-Savoie A.D. 335

Charcoal, 0.60 to 0.70 m depth, found under an accumulation of scoria and debris of kiln at La Thuile ($46^{\circ} 05' N$ Lat, $1^{\circ} 27' E$ Long), Beaumont, alt 1.260 m in the Alps. Coll. 1959 and subm. 1963 by H. Armand, Annecy, Haute-Savoie. *Comment:* this is an old working iron-mine and date found corresponds to most recent of the supposed dates for this type of exploitation.

Gif-217. La Condamine, Ladern-sur-Lauquet, Aude 1680 \pm 150 A.D. 270

Charcoal from Chalcolithic open-air station at La Condamine ($46^{\circ} 6' 5'' N$ Lat, $2^{\circ} 21' 50'' E$ Long). Coll. 1962 and subm. 1963 by J. Guilaïne, C.N.R.S. Carcassonne. *Comment:* it seems clear that there has been a contamination of the station by more recent charcoal.

6500 \pm 300

Gif-218. Shelter Jean Cros, Labastide-en-Val, Aude 4550 B.C.

Charcoal from rock shelter Jean Cros, Labastide-en-Val ($43^{\circ} 05' N$ Lat, $2^{\circ} 28' E$ Long). Coll. and subm. 1963 by J. Guilaïne. *Comment:* the layer from which charcoal was extracted has yielded an industry of Mesolithic tradition.

2580 \pm 150

Gif-258. La Valette, Veraza, Aude 630 B.C.

Charcoal of Cave III at La Valette, Veraza ($47^{\circ} 47' N$ Lat, $0^{\circ} 5' E$ Long). Coll. 1963 and subm. 1964 by J. Guilaïne. *Comment:* site contains Chalcolithic remains, but was probably re-occupied later.

D. Corsica and Sardinia

Filitosa series, Sollacaro, Corsica

Charcoal from circular monuments with outbuilding "Torri" at Filitosa, Vallée du Tavaro ($41^{\circ} 43' N$ Lat, $8^{\circ} 51' E$ Long). Ca. 10 of these monuments found in the valley. They certainly had a funerary purpose, as debris of bones have been collected at Filitosa and Cucuruzzu with goods of Bronze period (Grosjean, 1961, 1964). Coll. and subm. 1962 by R. Grosjean, C.N.R.S., Paris.

2550 \pm 170

Gif-150. Filitosa CB 600 B.C.

Bottom of Hut B, Torrean habitat of site. *Comment:* re-utilization of site has already been dated: 3220 B.P. (Gsy-58, Gif I).

Gif-151. Musolo, Sollacaro**1540 \pm 150****A.D. 410**

Charcoal from site of Musolo, Valley of Tavaro (41° 40' N Lat, 8° 50' E Long), Sollacaro; with a statue menhir. *Comment:* evident contamination.

Nuraghes series, Sardinia

Charcoal from *nuraghes*, which are fortresses with corridors in Sardinia. In these monuments, similar to Corsican *torri*, have been found a set of goods like those found at Cucuruzzu. Subm. by R. Grosjean.

Gif-242. Nuraghe Albucciu, Sassari, Sardinia**3170 \pm 250****1220 B.C.**

From 40° 43' N Lat, 8° 34' E Long, lower layer 6. Coll. 1961-1962 by Rerranese Ceruti.

Gif-243. Nuraghe Brunku Mādili 1 and 2, Gesturi, Cagliari**3770 \pm 250****1820 B.C.**

Layer e. Coll. 1962-1963 by Pr. Lilliu.

General Comment: dates earliest *nuraghes* of Sardinia, at least 600 yr before *torri* of Corsica (Gif-150, 239 and 241).

Cucuruzzu series, Lévie, Sartène, Corsica

Charcoal from *torri* citadel of Middle Bronze period at Cucuruzzu, Lévie, between Porto-Vecchio group and S. O. part of Corsica. Goods of Bronze period. Coll. and subm. 1963 by R. Grosjean.

Gif-239. Cucuruzzu 1**2610 \pm 150****600 B.C.**

Corridor C. 1 inferior.

Gif-241. Cucuruzzu 3**2830 \pm 150****880 B.C.**

Aeria B. C. II, inferior, part Ba.

Comment: consistent with Filitosa dating (Gif-150).

*E. Africa***Gif-83. Tibesti, Saraha****6300 \pm 320****4350 B.C.**

Human brain-pan found in recent depression dug in post-Tassilien and filled by faded brownish clay at E of Tibesti, S of Bassin of Koufra, at frontier of Libya-Tchad (22° 30' N Lat, 14° E Long); with Lamelli-branches, fresh water shells. Coll. and subm. 1960 by S. Arnould-Saget, Service Géologique, Compagnie Française des Pétroles, Paris. *Comment:* dates last Saharian pluvial.

Tassili-n-Ajjer series, Sahara

Samples coll. in Tassili in 1962 by the mission of H. Lhote and subm. by H. Lhote, 1964. Many marks of this Neolithic highly-cultured

central part of the Sahara, such as implements and potsherds found in natural cliff shelters. Beautiful paintings representing bulls, cows, etc. covered walls of these shelters. All charcoal from local hearths in archaeological layer which is found between 2 layers of sterile silt, 10 to 20 cm thick, covered with another layer of goat and cow manure and topped by sand of Eolian origin. Palynologic study of archaeological layers is in progress; betula has already been found.

Gif-286. Station of Initinen No. 1 **4860 ± 250**
2910 B.C.

From 24° 41' N Lat, 9° 41' E Long. Charcoal from Hearth No. 1.

Gif-287. Station of Initinen No. 2 **4630 ± 250**
2680 B.C.
Charcoal from Hearth No. 2.

Gif-288. Station of Titerast-n-Elias, No. 3 **4560 ± 250**
2610 B.C.

From 24° 39' N Lat, 9° 41' E Long. Charcoal from hearth bordered by a stone circle, inside a shelter with painted walls. *Comment:* pottery and cow bones found in vicinity of hearth. The paintings of cows are probably of same period as hearth.

Gif-289. Station of Initinen, No. 8 **2250 ± 200**
300 B.C.

Whitish paint of animal origin covering wall-pictures of one shelter. *Comment:* this date gives minimum age of this paint which is, in fact, probably much older, even "pre-Bovidian" according to archaeological inference.

Gif-290. Station de Titerast-n-Elias, No. 5 **7400 ± 300**
5450 B.C.

Charcoal from another hearth of same type. *Comment:* date is oldest ever found for Tassili human occupation. Oldest dates previously published were 4270 and 5470 (Sa-65, Sa-66, Saclay I).

Gif-291. Station of the Titerast-n-Elias, No. 6 **2500 ± 200**
500 B.C.

Charcoal from upper-level. *Comment:* this hearth, by its level, seems to correspond to a second period of occupation of the site.

Gif-292. Station of Ekaham-ouan-Tartaït, No. 7 **4470 ± 250**
2520 B.C.

From 24° 42' N Lat, 9° 39' E Long. Charcoal in archaeological layer of a huge shelter with wall paintings.

Gif-155. Ferkane, Tebessa, Algeria **1950 ± 150**
A.D. 1

Charcoal from tumulus at Ferkane, Tebessa (34° 33' N Lat, 7° 25' Long). Coll. 1961 by Grébénart; subm. 1961 by G. Camps, Centre de Recherches Anthropologiques Préhistoriques et Ethnographiques, Le

Bardo, Alger. *Comment*: one of the 201 protohistoric sepultures under tumulus found up to now in region of Ferkane. Skeleton was surrounded by big blocks of stones forming a chest and placed in centre of tumulus. The dated charcoals were mixed with filling sand of chest.

Tegdaoust series, Mauritanie

Mixed coals, bones, and straw found at Tegdaoust (17° N Lat, 12° W Long). Site supposed to be that of ancient big African town called Aoudaghost. Coll. and subm. 1964 by J. Devisse, Université de Dakar, Fann, Dakar.

Gif-265. Tegdaoust, No. 339 **650 \pm 120**
A.D. 1300

Mixed coal with bones from a fireplace at 3 m depth, House II.

Gif-266. Tegdaoust, No. 504K **Modern**
2.75 m depth.

General Comment: a pit, 1.50 m depth was dated 150 ± 100 (Sa-219, Saclay I).

Gif-304. Abri du Sous-Marin, Tamanrasset, Hoggar **4720 \pm 300**
2770 B.C.

Coal from hearth of archaeological layer at shelter "du Sous-Marin," Tamanrasset ($23^{\circ} 10'$ N Lat, $5^{\circ} 35'$ E Long). Coll. and subm. 1964 by G. Camps. *Comment*: confirms dates already known archaeologically as Neolithic.

Gif-305. Tombeau de la Chrétienne, Bérard, Algiers **1660 \pm 120**
A.D. 290

Wooden cramp joining together calcareous blocks of a Berber pre-roman mausoleum, Le Tombeau de la Chrétienne, Bérard, Algiers ($36^{\circ} 34'$ N Lat, $2^{\circ} 33'$ E Long). Coll. 1940 by M. Christoffe; subm. 1963 by G. Camps. *Comment*: construction supposed to be of the 1st century B.C.; result is unexplained.

F. Other countries

Gif-130. Caverne de Santimamiñe, Cortézubi, Spain **9470 \pm 400**
7520 B.C.

Bones of different animals from hearths found in archaeological layer No. 7 of Santimamiñe cave, Cortézubi, Biscaye ($43^{\circ} 17'$ N Lat, $3^{\circ} 01'$ W Long). Coll. 1960 by J. M. de Barandaran; subm. 1961 by P. Marquer, Laboratoire d'Anthropologie, Musée de l'Homme, Paris. *Comment*: would correspond better to supposed age of Layer 6 (Magdalenian) of this cave.

Tumulus de la Païta series, Nouvelle Calédonie

Many tumuli, similar to those already discovered in Island of the Pines, 70 km from Nouvelle, Calédonie, have been found lately at Païta

(22° 08' S Lat, 166° 28' E Long), Nouvelle Calédonie. These tumuli, max. height 2.50 m with a base 10 to 12 m in diam, have been built of small regular gravel of iron oxide in the Ile des Pins and with siliceous sand near Païta. In the central part stands a cylinder, 1 to 2 m in diam and 1 to 2.50 m high, made homogeneously of a hard lime mortar in which have been found shells. Neither implements, bones, or charcoal found there up to now. Up to 1964, 400 tumuli have been recorded on the Ile des Pins and 17 on the Nouvelle Calédonie Island; only four have been excavated: three contain single mortar-libre cylinders and the other two. Origin and significance of these tumuli are completely unknown. Monuments testify to an important human activity completely extinct today in Nouvelle Calédonie and in Ile des Pins (Chevalier, 1964). Coll. and subm. 1963 by L. Chevalier, Musée Néo-Calédonien de Nouméa, Nouvelle Calédonie.

12,900 ± 450
10,950 B.C.

Gif-298. Tumulus of Païta, I

Placostylus shells tied to mortar on surface of central cylinder in tumulus.

7070 ± 350
5120 B.C.

Gif-299. Tumulus of Païta, II

Mortar from surface of cylinder, tied to placostylus shells.

9600 ± 400
7650 B.C.

Gif-300. Tumulus of Païta, III

Mortar from interior of cylinder.

General Comment: although results are not very homogeneous, if cylinders are really man-made mortars, they are by far the most ancient mortars known. They are believed to be mortars and not transported stones cut out of limestone or local natural formation because external parts of cylinders contain many bits of silica gravel (Païta) or of iron oxide gravel (Ile des Pins), as if liquid mortar had been poured in hole previously dug in tumulus of gravel and then allowed to solidify "in situ." On the other hand, the fact that mortar had not been dissolved during long exposition to tropical climate, is probably explained by siliceous sand or iron oxide sand, of which the tumuli are made, being very arid soil. Incidentally, present people of islands know lime and mortar fabrication only from missionaries' arrival in 18th century.

II. GEOLOGIC SAMPLES

A. France

9440 ± 350
7490 B.C.

Gif-341. Couternon, Côte d'Or, 2

Fragment of *Pinus sylvestris* from clayey level covered with 2.50 m rough gravels and 0.50 m arable ground in forest "Les Sablières" at Couternon (47° 19' N Lat, 5° 09' E Long). At same level, *Elephas primi-*

genius. Coll. 1962 and subm. 1965 by Abbé Jolly. *Comment*: supposedly dates period before deglaciation, but date makes this unlikely.

Gif-342. Mammoth tooth, Manche **8720 ± 300**
6770 B.C.

Mammoth tooth found by fishermen trawling at 60 m depth in La Manche (50° 27' N Lat, 0° 25' W Long) in site where many remains of mammoths have been found. Subm. by C. Larssonneur, Institut de Géologie et de Paléontologie, Caen, Calvados. *Comment*: supposedly dates maximum limit of seashore before post-Würmian marine transgression, but anomalous young age suggests contamination. Organic fraction was too small to be dated so total carbonate was used.

Gif-340. Forêt de Fontainebleau, Seine et Marne **2075 ± 150**
125 B.C.

Debris of carbonized tree-branches from burnt level of podzol under dune, 2 m thick, and topped with present Fontainebleau forest (48° 26' N Lat, 2° 40' E Long). Level corresponds to horizon Ao-1 of podzol dune. Coll. and subm. 1964 by C. Allier, Ecole Normale Supérieure de Saint-Cloud, Seine. *Comment*: gives maximum age for emplacement of dune.

Prémery series, Nièvre

Sphagnum peat in small depression topping a hill in forest of Prémery (47° 12' N Lat, 3° 18' E Long), S of Basin of Paris. Coll. 1962 and subm. 1963 by R. Braque, Nevers, Nièvre.

Gif-199. Prémery No. 1 **7540 ± 350**
5590 B.C.

Pine-wood, 1.30 m depth, in silt-layer under peaty level.

Gif-200. Prémery No. 2 **4680 ± 300**
2730 B.C.

Wood, 0.85 cm depth, at the base of peaty level; in contact with silt deposit.

Gif-201. Prémery No. 3 **3500 ± 250**
1550 B.C.

Grey silt, peaty at 0.90 cm depth.

Comment: age of Gif-199 is identical with Sa-247 (7550 ± 350, Saclay II) for grey silt at 1.20 m depth. Pollen analysis of this silt has indicated Boreal period. Rather young age of Gif-201 could be explained by penetration of roots, sampling being at 5 cm under base of peaty level. Gif-200 could date end of silt sedimentation.

Coastal peat of Normandy series

Organic deposits of fresh or brackish water along coast sheltered from sea by line of drowned sandhills reaching to -1 to -2.50 m depth

below spring tide level. Pollen analysis: H. Elhai (Elhai, 1963). Coll. and subm. 1963 by H. Elhai, Institut de Géographie, Paris.

Gif-169. Appeville 1, Manche **2100 ± 140**
150 B.C.

Layer at Appeville (49° 19' N Lat, 1° 19' W Long), Alnus and Quercus predominating.

Gif-171. Le Becquet, Manche **2130 ± 150**
180 B.C.

Layer at Le Becquet (49° 39' N Lat, 1° 34' W Long), Quercus and Betula predominating.

Gif-172. Nacqueville, Manche **2130 ± 150**
180 B.C.

Layer at Nacqueville (49° 40' N Lat, 1° 44' W Long), in which have been found a Gallic coin and Roman millstones. Quercus and Betula largely predominating.

Gif-173. Saint-Pair 5 **3060 ± 160**
1110 B.C.

Deposit at 30 cm depth, alt 85 m above sealevel in present sand-hill at Saint-Pair (48° 48' N Lat, 1° 34' W Long). Quercus and Betula predominating with abundant Titium.

General Comment: confirmation of conclusions made after pollen analysis: formation of near-tidal deposits at end of Sub-Boreal or at beginning of Sub-Atlantic. For Saint-Pair, age corresponds to a different and older forest marked by absence of beech.

B. Spitsbergen

La Baie du Roi series, Spitsbergen

Shells from marine terrace raised by isostatic post-glacial movements in Barents sea, Baie du Roi (78° 55' N Lat, 12° 05' W Long), Spitsbergen. Coll. and subm. J. Corbel, Recherches Interdisciplines sur les Hautes Latitudes, C.N.R.S., Paris.

Gif-317. La Baie du Roi, I **9260 ± 350**
7310 B.C.
W terrace of French base, alt 11 m.

Gif-318. La Baie du Roi, II **9350 ± 350**
7400 B.C.
E terrace of French base. Base of cliff, alt 13 m.

Gif-319. La Baie du Roi, III **9650 ± 350**
7700 B.C.

Upper terrace, right bank of river La Goule, alt 20 m.

General Comment: rates of isostatic uplift of main island of Spitsbergen may be deduced from these values. If we adopt, from the above values, mean position of -14 m for eustatic sealevel 9300 yr ago, and if we take

from Gif-318 a total differential uplift of 15 m (13 m plus the 2 m mean depth where shells are supposed to have lived before uplift), we deduce a total isostatic uplift of this region of $14 + 15 = 29$ m. Therefore, the mean rate from 9300 B.P. till now is $29/93 = 0.31$ m per century. On the other hand, about 9300 yr ago the 3 dates show that mean differential uplift was much faster, ca. 2.2 m per century, than the mean since that time (Washburn and Stuiver, 1962).

C. Africa

Saoura series, Sahara

Mollusc shells from different layers of Saourian formations. Date phases of last great Saharan sedimentary period. Coll. and subm. 1963 by H. Alimen, Lab. de Géologie du Quaternaire, C.N.R.S., Bellevue, Seine et Oise.

Gif-213. Hassi Zgilma, Saoura, 543

9030 \pm 400

7080 B.C.

Layer Ia, 1.80 m depth, at Hassi Zgilma ($30^{\circ} 13' N$ Lat, $2^{\circ} 29' W$ Long).

Gif-214. Hassi Zgilma, Saoura, 544

7725 \pm 350

5775 B.C.

Layer Ib, 1.50 m depth.

Gif-215. Hassi Zgilma, Saoura, 545

2750 \pm 150

800 B.C.

Layer H, 1 m depth, sandy marl, would correspond to a Guirien; a Neolithic piece of silex has been found in this layer.

Gif-216. El Ouata, Saoura, 556

>30,000

Fossil level, Layer A, 6 m depth. Saourian formations at El Ouata ($2^{\circ} 52' N$ Lat, $1^{\circ} 50' W$ Long) are 17 to 20 m thick. *Comment:* consistent with other dates of last great Saharan pluvial period (Gif-285, 83 this date list).

Hoggar series, Sahara Central

Calcareous lake formations set in crystalline rocks in bottoms of valleys of Hoggar. Fresh water molluscs (physids, succineids and planorbids) have been found in this formation which is at 1 or 2 m above present bed of wadi. Calcium of this calcareous deposit seems to have been mobilized when the country rock (basalt) was altered during or before a damp period (Delibrias and Dutil, 1965); with lacustrine sediments, it now forms a lacustrine limestone. Coll. 1962 and subm. 1964 by P. Dutil, Centre de Recherche Agronomique du S. O. Bordeaux, Gir-donde.

Gif-325. Région d'Hirafok—S.476

8380 \pm 300

6430 B.C.

Alt: ca. 1450 m ($23^{\circ} 39' N$ Lat, $5^{\circ} 40' E$ Long).

Gif-326. Oued Irzerzou—S.483**11,580 \pm 350
9630 B.C.**

Alt: ca. 1300 m (22° 44' N Lat, 5° 23' E Long).

General Comment: makes clear that there was a damp climate in Central Hoggar between 8000 and 11,000 B.P.; in good correlation with age found for carbonates of diatomites of Agadem, E Niger, Africa (16° 50' N Lat, 13° 20' E Long): T-338 A, 8580 \pm 110 (Trondheim IV; see also Faure *et al.*, 1963).

Gif-76. Ténéré, Niger Oriental**3350 \pm 200
1400 B.C.**

Hippopotamus bone from dwellings built over diatomaceous deposits, which were later covered by recent dunes, 30 km W of Fachi, Ténéré (18° 06' N Lat, 11° 18' E Long). Coll. 1955 and subm. 1960 by H. Faure, Lab. de Géologie, Univ. de Dakar, Sénégal. *Comment:* existence of hippopotamus in region at this time indicates that large lakes, known to have existed before the Neolithic, had not yet dried, or perhaps had reformed during a short damp pulsation during general drying of S Sahara.

Gif-284. Puits d'Achegour, Ténéré, Niger No. 3902**3180 \pm 200
1230 B.C.**

Shells of lacustrine bivalves imbedded in nonfissile, impure diatomite at 390 m alt, 25 km SW of Puits d'Achegour (18° 51' N Lat, 11° 36' E Long) Ténéré. Coll. 1963 and subm. 1964 by H. Faure. *Comment:* to be compared to diatomite layer dated as 3350 B.P., Gif-76, this date list. Confirms persistence of damp conditions in this part of Ténéré, now an extremely dry desert.

**Gif-285. Cliff of Kaodi, Oasis of Fachi, Ténéré,
Niger, No. 4005****8500 \pm 35
6550 B.C.**

Shells of freshwater *Melania tuberculata* (gastropod) at foot of diatomite layer outcropping in main cliff of Kaodi (18° 07' N Lat, 11° 37' E Long), oasis of Fachi, Ténéré. Coll. 1963 and subm. 1964 by H. Faure. *Comment:* morphologic situation of this shell-level, 25 m above present bottom of basin, indicates deposition at time of the lake's maximum extension. Consistent with very damp climate in South Sahara during this period.

Gif-221. Pointe-Noire, Brazzaville, Congo**7200 \pm 300
5250 B.C.**

Wood from recent marine sediments, 7 m depth, found in bay of Pointe-Nore (4° 47' S Lat, 11° 50' E Long). Coll. during dredgings at 500 m off shore in water 12 m deep. Subm. 1964 by J. Herman, Direction of the Harbour of Pointe-Noire, Brazzaville. *Comment:* measurement required during harbour work in order to estimate stability of sediments. Results show low rate of sedimentation and imply adequate stability.

*D. Nouvelles Hébrides***Ile de Tongoa series, Nouvelles Hébrides**

Charcoal found under pumice and tuffs at island of Tongoa (16° 55' S Lat, 168° 35' E Long). Coll. 1962 and subm. 1964 by B. Gèze, Lab. de Géologie, Institut Nat. Agronomique, Paris.

620 ± 120

Gif-259. Tongoa, Moerin 1 **A.D. 1330**
Alt: 100 m.

250 ± 120

Gif-260. Tongoa, Moerin 2 **A.D. 1700**
Alt: 5 m.

240 ± 120

Gif-261. Tongoa, Mangarisiu **A.D. 1710**

Comment: dates last major volcanism in Nouvelles Hébrides.

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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES V

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INTRODUCTION

Both the 2-L counter, described in GSC I, and the 5-L counter (GSC IV) were operated routinely during the past year. Approximately one-half of the determinations reported here were obtained from each counter. The 5-L counter was operated mainly at 1 atm.

For more than a year, age calculations have been carried out monthly by an I.B.M. 1620 computer. If the background, standard, and sample counts during a month conform to statistical laws, they are entered on sheets together with their respective counting times and sample identifications and sent to the computing center for processing.

The calculations are based on a C^{14} half-life of 5568 ± 30 yr and 0.95 of the activity of the NBS oxalic-acid standard, and the ages are quoted in years before 1950. The age errors include: counting errors of sample, background, and standard; the 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. "Infinite" ages are based on the 4σ criterion (GSC II).

No changes have been made in the routine sample-preparation and purification techniques described in GSC IV.

For the interest of other laboratories, the average background and standard counting rates over the past 14 months are listed in Tables 1 and 2, respectively. The monthly average background count is made up of 4 individual daily counts. During the 14 month period ten different background preparations were counted in each counter, and no count was rejected. The standard counting rates listed in Table 2 are the monthly averages of 3 individual daily counts. Again none of the oxalic-acid standard preparations (10 for each counter) and none of the daily counts were rejected.

In order to gain further information on the validity of C^{14} dates from bones, several samples were separated into the organic (collagen) and inorganic (carbonate) fractions using the first procedure described by Berger *et al.* (1964). The results are shown in Table 3. As expected, the carbonate fraction is younger than the collagen except for GSC-488, where good agreement between the ages of whale ear bone collagen and carbonate possibly suggests that dates of carbonates from closed bone structure are more reliable than dates from open bone structure. Note the excellent agreement between jaw bone collagen (GSC-447) and tooth dentin (GSC-490) from a bison jaw bone in which the teeth were still

* The introductory part of this paper has been prepared by the first two authors; the latter now operates the laboratory. The date list has been compiled by the third and fourth authors from descriptions of samples and interpretations of dates by various collectors.

TABLE 1
Monthly Background (c/m) for Period
August 1, 1964 to October 1, 1965

Month	2-L counter (2 atm)	5-L counter (1 atm)
August 1964	1.254 \pm .017	2.306 \pm .029
September	1.218 \pm .013	2.366 \pm .028
October	1.253 \pm .021	*3.119 \pm .020
November	1.279 \pm .016	2.362 \pm .017
December	1.240 \pm .014	2.352 \pm .019
January 1965	1.300 \pm .018	2.399 \pm .018
February	1.263 \pm .018	2.399 \pm .025
March	1.209 \pm .017	2.350 \pm .024
April	1.240 \pm .019	*3.093 \pm .026
May	1.244 \pm .019	2.280 \pm .026
June	1.240 \pm .027	2.305 \pm .038
July	1.209 \pm .035	2.318 \pm .038
August	1.239 \pm .017	2.301 \pm .038
September	1.238 \pm .018	2.268 \pm .024

* 5-L counter operating at 4 atm.

in place. In the other 2 cases where comparison of different sample types was possible (GSC-450 and GSC-150; GSC-454 and L604A, L604B, Lamont VII) there is also excellent agreement between the bone collagen and the associated shell material. Sample GSC-454 is rather unique in that the carbonate fraction dates "modern" whereas the collagen date is 10,420 yr.

TABLE 2
Monthly Standard, N_o^* , (c/m) for Period
August 1, 1964 to October 1, 1965

Month	2-L counter (2 atm)	5-L counter (1 atm)
August 1964	20.087 \pm .069	28.536 \pm .118
September	19.965 \pm .067	28.451 \pm .085
October	19.922 \pm .069	**111.003 \pm .219
November	19.931 \pm .070	28.429 \pm .114
December	20.059 \pm .066	28.630 \pm .157
January 1965	19.763 \pm .098	28.752 \pm .116
February	20.008 \pm .095	28.504 \pm .115
March	20.137 \pm .077	29.032 \pm .114
April	20.003 \pm .105	**110.624 \pm .231
May	19.974 \pm .097	28.705 \pm .130
June	19.971 \pm .101	28.820 \pm .124
July	20.044 \pm .150	28.774 \pm .117
August	20.112 \pm .096	28.790 \pm .120
September	19.986 \pm .094	28.940 \pm .114

* $N_o = 0.95 \times$ net counting rate of the NBS oxalic-acid standard.

** 5-L counter operating at 4 atm.

Column 4 of Table 3 lists the fractional counting rates expressed in percent with respect to the corrected oxalic-acid standard. The counting error of the standard is not included in the error of the fractions (GSC IV).

TABLE 3
Comparison of Organic and Inorganic Fractions of Bones*

Sample No.	Fraction	Age (yr)	Net counting rate (% of standard)
GSC-266	Whale rib		
	Collagen	8640 \pm 140	34.09 \pm 0.22
	Carbonate	3260 \pm 130	66.57 \pm 0.30
GSC-355**	Whale baleen	1110 \pm 130	87.06 \pm 0.29
GSC-488**	Whale ear (bone)		
	Collagen	980 \pm 140	88.53 \pm 0.50
	Carbonate	840 \pm 130	90.08 \pm 0.43
GSC-489**	Whale limb		
	Collagen	930 \pm 130	89.06 \pm 0.28
	Carbonate	480 \pm 140	94.14 \pm 0.58
GSC-361	Whale vertebra		
	Collagen	3050 \pm 130	68.40 \pm 0.36
	Carbonate	2310 \pm 150	75.00 \pm 0.72
GSC-362	Whale jaw		
	Collagen	2820 \pm 130	70.36 \pm 0.33
	Carbonate	2220 \pm 130	75.80 \pm 0.33
GSC-447	Bison jaw		
	Collagen	6160 \pm 140	46.48 \pm 0.27
	Carbonate	1090 \pm 140	87.28 \pm 0.47
GSC-490***	Bison teeth		
	Dentin	6100 \pm 180	46.80 \pm 0.70
	Carbonate	2130 \pm 130	76.72 \pm 0.35
GSC-449	Charred bone		
	Organic	1160 \pm 120	86.50 \pm 0.29
	Carbonate	390 \pm 130	95.25 \pm 0.50
GSC-450	Whale vertebra		
	Collagen	8990 \pm 140	32.66 \pm 0.20
	Carbonate	4990 \pm 140	53.75 \pm 0.28
GSC-150	Shells	9180 \pm 170	31.90 \pm 0.13
GSC-452	Whale bone		
	Collagen	1380 \pm 130	84.24 \pm 0.48
	Carbonate	450 \pm 130	94.51 \pm 0.50
GSC-454	Whale bone (beluga)		
	Collagen	10,420 \pm 150	27.33 \pm 0.14
	Carbonate	Modern	105.00 \pm 0.65
L604A	Shells	10,700 \pm 200	
L604B	Shells	10,550 \pm 200	

* Detailed descriptions of all samples appear in this date list except for GSC-150 (GSC III) and L604A, L604B (Lamont VII), and GSC-361, 362, 447, 490 and 452, deferred to a later list.

** These three samples are all from the same whale.

*** Teeth from jaw (GSC-447).

Tests for C^{14} contamination in shell samples (cf. GSC II, GSC III, and GSC IV) were continued during the past year as shown in Part A of Table 4.

Further tests were carried out on the problem of humic contamination of peat samples from permafrost areas (GSC IV). The results are listed in Part B of Table 4, and again show that contamination is absent. This conclusion is strengthened by the analyses of the completely untreated portions of GSC-305 and GSC-310.

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Thanks are extended to Ian M. Robertson for assistance in the preparation and measurement of samples in the laboratory. The second author would like to express thanks to W. Dyck for his invaluable instruction on the intricacies of C^{14} dating.

TABLE 4
Tests for C^{14} contamination*

Sample No.	Fraction	Age (yr B.P.)	Net counting rate (% of standard)
A. MARINE SHELLS			
GSC-277	23-59%	>47,400	0.132 \pm 0.037
	60-100	>49,000	0.117 \pm 0.025
GSC-350	44-72	7860 \pm 150	37.57 \pm 0.32
	73-100	7980 \pm 150	36.97 \pm 0.29
GSC-351	49-74	5910 \pm 140	47.86 \pm 0.26
	75-100	6010 \pm 140	47.27 \pm 0.26
GSC-394	0-50	>32,000	0.173 \pm 0.360
	51-100	>33,000	0.354 \pm 0.466
FRESH WATER SHELLS			
GSC-413	10-55	>35,500	0.249 \pm 0.234
	56-100	>34,400	0.579 \pm 0.197
B. PEAT SAMPLES			
GSC-300	less soluble**	2330 \pm 150	74.80 \pm 0.68
	more "	2210 \pm 130	75.95 \pm 0.37
GSC-305	less soluble***	220 \pm 130	97.25 \pm 0.48
	more "	270 \pm 130	96.73 \pm 0.42
	untreated	270 \pm 130	96.70 \pm 0.37
GSC-310	less soluble	9620 \pm 150	30.18 \pm 0.23
	more "	9510 \pm 150	30.61 \pm 0.23
	untreated	9620 \pm 140	30.18 \pm 0.17
GSC-402	less soluble	1050 \pm 140	87.71 \pm 0.43
	more "	1170 \pm 140	86.42 \pm 0.66
GSC-427	less soluble	>40,700	0.059 \pm 0.16
	more "	>35,000	0.109 \pm 0.32

* Detailed descriptions of all samples appear in this date list except for GSC-350, 351, 394, 402, and 427.

** Degree of solubility refers to solubility in 2% NaOH.

*** This sample from northern Ontario, south of zone of discontinuous permafrost.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Eastern Canada

GSC-370. Hillsborough, Cape Breton Island **>51,000**

Wood from basal part of 0 to 4 ft-thick peat bed at base of 5 ft of clayey strata with carbonaceous and vegetal layers, in road cut at head of Mabou Inlet, W of Hillsborough, Cape Breton Island, Nova Scotia (46° 04' 30" N Lat, 61° 17' W Long), at alt < 50 ft. Peat overlies oxidized sand and gravel; section is capped by red clay till. Coll. 1964 by V. K. Prest*. *Comment* (V.K.P.): pollen study by R. J. Mott indicates a northern boreal forest cover rather than that of the region today. Deposits were earlier dated at >21,000 yr (Y-232; Flint and Rubin, 1955) and >38,000 yr (W-157, USGS II). Date based on one 3-day count in 5-L counter at 4 atm.

GSC-290. Whycocomagh, Cape Breton Island **>44,000**

Wood from 1 ft-thick plant detrital layer in 4 to 5 ft silt and gravel unit beneath 10 ft gravelly till in road cut on N side of Whycocomagh, Cape Breton Island, Nova Scotia (45° 58' 30" N Lat, 61° 07' 30" W Long). Silt-gravel unit is underlain by stony clay till on bedrock. Site first reported by D. G. Kelley in 1955. Coll. 1964 by V. K. Prest. *Comment* (V.K.P.): pollen studies by R. J. Mott suggest possible correlation with Hillsborough organic deposits (GSC-370, this list). Date based on one 3-day count.

GSC-283. Bay St. Lawrence, Cape Breton Island **>38,300**

Wood from 1 to 5 in.-thick organic detrital layer, 20 to 30 ft above base of 150 ft sea cliff, SW shore of Bay St. Lawrence, Cape Breton Island, Nova Scotia (47° 00' 50" N Lat, 60° 27' W Long). Organic layer is underlain by discontinuous silt and gravel (up to 44 in. thick) on this stony till on bedrock, and overlain by thin silt passing upward through sand into gravel. Site discovered by E. R. W. Neale in 1954 (cf. Neale, 1964). E. H. Muller (Syracuse Univ., Syracuse, New York) observed a 12 ft-thick lens of clayey sediment containing fragments of marine shells, above the upper gravels. Whole section overlain by 30 to 90 ft of gravelly boulder till (?). Coll. 1964 by V. K. Prest. *Comment* (V.K.P. and R. J. Mott): dated layer has yielded an arboreal pollen assemblage dominated by alder, with subsidiary amounts of birch and varied conifers. Deposit is inferred to represent an early Wisconsin nonglacial interval.

GSC-281. Cabot Trail, Cape Breton Island **2050 ± 130
100 B.C.**

Wood (root) from basal peat at 44 to 48 in. depth in bog on highlands, at mileage 13 from W coast, Cabot Trail, Cape Breton Island,

* All persons referred to as collectors or submitters of samples or cited as sources of data are with the Geological Survey of Canada unless otherwise specified.

Nova Scotia (46° 45' 30" N Lat, 60° 51' W Long). Peat overlies 20 in. of mixed cobbles, sand, and plant detritus on stony till. Coll. 1964 by V. K. Prest.

8770 ± 150

GSC-336. 'Salmon River Lake,' Cape Breton Island 6820 B.C.

Lake mud from 3.60 to 3.80 m depth in core coll. with piston sampler from 'Salmon River Lake,' Richmond County, Cape Breton Island, Nova Scotia (45° 38' 40" N Lat, 60° 46' 30" W Long), at alt ca. 140 ft. Sample is from B (high pine) zone of the pollen profile. Coll. 1955 by D. A. and B. G. R. Livingstone, Duke Univ., Durham, North Carolina; subm. by J. Terasmae. *Comment* (D.A.L.): date is first from Nova Scotia on B zone in pollen sequence (cf. Flint and Deevey, 1957; Deevey, 1958; Livingstone and Livingstone, 1958). NaOH-leach omitted from sample pretreatment.

9030 ± 170

GSC-335. Wreck Cove, Cape Breton Island 7080 B.C.

Lake mud from 3.10 to 3.30 m depth in core coll. with piston sampler from unnamed pond 1¼ mi SW of Wreck Cove, Victoria County, Cape Breton Island, Nova Scotia (46° 32' 25" N Lat, 60° 26' 50" W Long), at alt ca. 1150 ft. Sample is from base of A zone, immediately above L zone, of the pollen profile. Coll. 1959 by D. A. Livingstone; subm. by J. Terasmae. *Comment* (D.A.L.): date is first giving minimum age for deglaciation of Cape Breton highlands (see comments for GSC-333, this list). NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

9650 ± 150

GSC-333. 'Silver Lake,' Nova Scotia 7700 B.C.

Lake mud from 4.25 to 4.50 m depth in core coll. with piston sampler from 'Silver Lake,' Halifax County, Nova Scotia (44° 33' 48" N Lat, 63° 38' 34" W Long). Sample is from lower part of A zone, immediately above late-glacial L zone, of the pollen profile. Coll. 1955 by D. A. Livingstone; subm. by J. Terasmae. *Comment* (D.A.L.): date is first for the inferred arrival of closed forest at a mainland Nova Scotia locality; it also provides a minimum age for deglaciation. It is younger than Y-524 (10,340 ± 220, Yale IV) but older than GSC-335 (9030 ± 170, this list) which date similar stratigraphic levels at Gillis Lake, in Cape Breton lowlands, and near Wreck Cove, in Cape Breton highlands, respectively. NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

640 ± 250

GSC-293. Freeland, Prince Edward Island A.D. 1310

Carbonaceous body within gravel at 4.5 ft depth in pit in beach material, E side of road, 1 mi W of Callaghan Point and ¾ mi NNE of Freeland, Malpeque map-area, Prince Edward Island (46° 42' 15" N Lat, 63° 57' 30" W Long), at alt 25 ft. Coll. 1964 by V. K. Prest. *Comment*

(V.K.P.): date indicates that organic material is burned root rather than vegetal matter deposited with beach material. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 1-day count.

GSC-312. St. Nazaire-de-Buckland, Quebec **12,640 ± 190**
10,690 B.C.

Gyttja from base of 6 m of organic lake sediments overlying silt and clay in a small lake 3.5 mi NE of St. Nazaire-de-Buckland, Quebec (46° 35' N Lat, 70° 36' 30" W Long), at alt ca 1325 ft. Sample obtained with a Livingstone piston corer. Coll. 1964 by R. J. Mott in support of glacial geology studies by N. R. Gadd. *Comment* (N.R.G. and J. Terasmae): lake is S of a moraine system extending NE from St. Philémon (Dorchester Co.) which in turn is S of Highland Front moraine system (Gadd, 1964); both moraine systems predate Champlain Sea. Date is minimal for deglaciation of this part of N slope of Appalachian Highlands; it suggests contemporaneity of an ice marginal position near St. Nazaire with pre-Champlain Sea stony marine clays in the vicinity of Trois Pistoles, Quebec (Lee, 1963), dated at 12,720 ± 170 (GSC-102, GSC II). NaOH-leach omitted from sample pretreatment.

Lake St. John series, Quebec

GSC-313. Alma **8680 ± 140**
6730 B.C.

Marine shells (mostly *Hiatella arctica* and *Macoma balthica*) overlain by ca. 15 ft sand, in a pit 1 mi S of Alma, Quebec (48° 31' N Lat, 71° 38' W Long), at alt ca. 427 ft. Coll. 1964 by P. Lasalle, Ministère des Richesses Naturelles, Québec.

GSC-375. Metabetchouan **9340 ± 160**
7390 B.C.

Marine shells (mostly *Macoma balthica*) from gravel 3 to 4 ft below ground surface in reworked outwash, in pit 1 mi E of Metabetchouan, Quebec (48° 26' N Lat, 71° 38' W Long), at alt ca. 398 ft. Coll. 1964 by P. Lasalle.

General Comment: shells at each site were believed to have been deposited during marine stands at or close to level at which shells occur. However, GSC-375 is from only ca. 6 mi S (ice retreated N) of GSC-313, yet it is some 600 yr older in spite of being ca. 30 ft lower. Perhaps the difference can be explained by the uplift that occurred during the time it took the ice to retreat 6 mi; alternatively older shells may represent a stand of the sea at some level above 427 ft (the marine limit in the general area is at 550 ft alt). GSC-375 provides minimum date for deglaciation, and dates show that marine invasion of the Lake St. John area occurred later than Champlain Sea episode but earlier than the Tyrrell Sea in James Bay lowlands (Lasalle, 1965). Date for GSC-313 based on one 3-day count. GSC-375 mixed with dead gas for counting.

GSC-454. Foster Sand Pit, Ottawa, Ontario **10,420 ± 150**
8470 B.C.

Bones of white whale (beluga) from Foster Sand Pit, 0.5 mi NW of Uplands Airport, Ottawa, Ontario (45° 20' N Lat, 75° 42' W Long), at depth ca. 20 ft (alt ca. 300 ft) in sand spit developed by shore currents of Champlain Sea (Gadd, 1963). Coll. 1956 by G. B. Rolland, Ottawa, for N. R. Gadd. *Comment*: dated whale bones coll. 15 to 20 ft above shells from same pit dated as 10,700 ± 200 and 10,550 ± 200 (L-604A, 604B, resp., Lamont VII). Date for collagen from bone agrees closely with dates for shells. 'Modern' date of carbonate fraction of same bone illustrates unreliability of dates for inorganic part of bone. As sample was collected since initiation of nuclear bomb testing, the greater than 'modern standard' C¹⁴ activity of the bone carbonate possibly is result of contamination with nuclear bomb carbon. If this is so, an unexpectedly rapid chemical interchange has taken place between air, groundwater, and bone in these permeable deposits above water table. Two determinations were made:

collagen fraction	10,420 ± 150
carbonate fraction	'modern'
	105 ± .65% of standard

GSC-264. Kaladar, Ontario **10,040 ± 150**
8090 B.C.

Silty gyttja from base of peat and lake sediment sequence overlying sand at depth of 590 to 595 cm in Sharbot Creek bog, 15 mi E of Kaladar, Ontario (44° 45' 20" N Lat, 75° 50' 40" W Long). Sample obtained with 2 in. GSC piston corer. Coll. 1964 by J. Terasmae and R. J. Mott. *Comment* (J.T.): this date provides minimum age for deglaciation and beginning of accumulation of organic sediment. Pollen diagram from this bog indicates that sequence is truncated at the base; hence a time gap exists between gyttja and sand.

GSC-270. Harrowsmith, Ontario **10,390 ± 160**
8440 B.C.

Gyttja collected with Hiller sampler from base of peat and lacustrine sediment sequence in Harrowsmith bog, 2 mi WNW of Harrowsmith, Ontario, and ca. 20 mi NW of Kingston (44° 25' N Lat, 76° 42' W Long). Bog lies in E-trending bedrock valley within Dummer moraine. Dated gyttja is underlain by soft clay assigned to Lake Iroquois. *Comment* (J.T.): date represents end of spruce episode in pollen sequence at site (which extends deeper than dated layer). Date is minimal for Lake Iroquois stage. Preliminary acid leach added to sample pretreatment, which also included *cold* NaOH leach.

GSC-314. Kingston Mills, Ontario **10,050 ± 390**
8100 B.C.

Small lacustrine and terrestrial molluscan shells from depth of 4 ft in road cut through a small oriented clay ridge 3 mi NE of Kingston

Mills, Ontario (44° 19' N Lat, 76° 24' W Long). Sample from gently dipping slightly deformed lake clays flooring a long narrow depression between rocky ridges, alt 325 ft (ca. 80 ft above Lake Ontario). Coll. 1963 by E. P. Henderson. *Comment* (E.P.H.): field evidence supports an interpretation of these clays as of glacial-lake origin, and the presence of terrestrial gastropods with normal lacustrine types suggests introduction of the former from nearby water-free ground. Although sample is slightly younger than was expected from information elsewhere in the Ontario basin (see Karrow *et al.*, 1961, p. 666, "Lake Iroquois was probably drained close to 10,400 to 10,600 years ago"), it may represent a shallow, island-studded water body, the lowest and youngest of a series of short-lived, ice-dammed lakes that occupied a transition period between Lakes Iroquois and Ontario. Date is approx. same as I-1223 (10,200 ± 500, unpub.) for earliest Lake Ontario from bottom of bog on S side of Hwy. 401 W of Cataraqui River, some 4.5 mi to SW. However, the difficulty of placing an ice dam blocking the outlet of the Ontario basin compatible both with this date and with those for the Champlain Sea, ranging from 10,200 ± 500 (L-604D, Lamont VIII) to 11,410 ± 150 (GSC-187, GSC IV), suggests that present date should be treated with caution. Sample untreated and mixed with dead gas for counting.

38,900 ± 1300**GSC-271. Scarborough, Ontario****36,950 B.C.**

Peaty layers in silt and sand of Thorncliffe Formation, exposed in Scarborough Bluffs at Cudia Park, Ontario (43° 43' 15" N Lat, 79° 13' 30" W Long). Early Wisconsinan Sunnybrook Till underlies the peaty beds and in turn overlies a thick sequence of peaty sand and clay (Scarborough Formation) dated nearby at >52,000 (Gro-2555; Karrow, 1962, 1964). Three tills above Thorncliffe beds are considered to be Late Wisconsinan; youngest predates Lake Iroquois dated elsewhere at ca. 12,000 yr (Karrow *et al.*, 1961). Coll. 1964 by P. F. Karrow. *Comment* (P.F.K.): date supports previous assignment of Thorncliffe Formation to a mid-Wisconsinan nonglacial interval. Date based on one 4-day count.

Note added in proof: Since preparation of this list, another sample from this deposit has yielded a much older date. Hence, the above date should be treated with caution. Details will be included in next date list.

11,860 ± 170**GSC-211. Tupperville, Ontario****9910 B.C.**

Plant remains from Perry Farm mastodon site 0.4 mi NE of Tupperville, Ontario (42° 35' 30" N Lat, 82° 16' W Long) from top of 4 in. of lacustrine clayey, calcareous silt (Layer c, Dreimanis, 1962, p. 248) covered by a 6 ft-thick sand bar. Coll. 1962 by A. Dreimanis, Univ. of Western Ontario, London. *Comment* (A.D.): this date, for plant material that grew in place, agrees with S-172 (12,000 ± 200; Saskatchewan IV) for fine plant detritus from approx. same stratigraphic horizon, and confirms beginning of Early Lake St. Clair at least 12,000 yr B.P.

GSC-301. Massey, Ontario **4080 ± 130**
2130 B.C.

Wood from uppermost part of 7 to 8 ft-thick unit of silty sand grading down into clayey silt, underlain by sand and gravel and overlain by sand, in river bank S of hwy bridge over River Aux Sables, Massey, Ontario (46° 12' 40" N Lat, 82° 04' 10" W Long). Alt at surface ca. 630 ft, hence 50 ft above Lake Huron. Coll. 1964 by V. K. Prest. *Comment* (V.K.P.): dated stratum is shallow water deposit probably related to lake level ca. 50 ft above Lake Huron, and hence may represent Algoma stage of Nipissing Great Lakes. Date based on one 3-day count.

GSC-334. Sault Ste. Marie, Ontario **8460 ± 140**
6510 B.C.

Gyttja coll. with Livingstone piston sampler 360 to 376 cm below surface of small lake (water depth ca. 1 m) 4 mi NW of Sault Ste. Marie, Ontario (46° 34' 30" N Lat, 84° 25' W Long), from base of lake sediment underlain by sand and gravel. Lake is dammed by a sand and gravel bar, alt 1025 ft, comprising highest distinct shoreline in the vicinity. Coll. 1964 by R. J. Mott for J. Terasmae. *Comment* (J.T.): date is somewhat younger than anticipated age of 1025-ft shoreline. Pollen profile for site is truncated at the base, indicating a lapse of time between isolation of the lake basin and initial organic sedimentation. NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

Chin Lake series, Ontario

Muskeg and bog samples from test site selected for study of history and development of black spruce forest on muskeg 1.5 mi SE of Chin Lake, 30 mi N of Iroquois Falls, Ontario (49° 13' N Lat, 80° 38' W Long). Coll. 1964 by J. Terasmae.

GSC-487. Chin Lake, wood **7660 ± 140**
5710 B.C.

Wood and marly gyttja coll. with piston corer from base of 1 ft layer of lake sediment overlain by 8 ft of peat and underlain by silty clay. Date based on one 4-day count.

GSC-309. Chin Lake, peat (bog) **7150 ± 140**
5200 B.C.

Peat from base of 8 ft-deep bog, underlain by 1 ft of lacustrine sediment; coll. with piston corer at same site as GSC-487. Date based on one 3-day count.

GSC-308. Chin Lake, peat (thick muskeg) **5880 ± 140**
3930 B.C.

Peat coll. with piston corer from base of 3 ft-thick muskeg cover over silty clay. A soil had developed on the clay before peat started to accumulate.

270 ± 130**GSC-305. Chin Lake, peat (thin muskeg) A.D. 1680**

Peat from base of 1 ft-thick muskeg cover over silty clay. A soil had developed on the clay before peat started to accumulate. Three fractions were dated:

untreated fraction (2-L counter)	270 ± 130
soluble in NaOH (2-L counter)	270 ± 130
not dissolved in NaOH (5-L counter)	220 ± 130

First two dates are based on one 3-day count. Soluble fraction was mixed with dead gas for counting.

General Comment (J.T.): GSC-487 dates sediment deposited in small residual pond following drainage of Glacial Lake Barlow-Ojibway and is oldest date, so far, within basin of this glacial lake. GSC-309 is slightly older than dates for bog-bottom peat within glacial lake basin (e.g. GSC-272, 6920 ± 140, GSC IV; Y-223, 6960 ± 90, Yale III). GSC-308 suggests that much of the muskeg expansion in the region has taken place in late postglacial time.

6100 ± 160**GSC-285. Little Pic River, Ontario****4150 B.C.**

Wood chips from drainage ditch, S side of Trans-Canada Highway on E side of bridge over Little Pic River (48° 47' N Lat, 86° 37' W Long), in basal 1 ft of 16 ft of sand, with *Sphaerium sulcatum* in lower part, overlying silty clay with woody debris. Deposit represents a delta built into lake standing ca. 100 ft above Lake Superior and considered to be Nipissing by Farrand (1960). Coll. 1964 by S. C. Zoltai, Ontario Dept. of Lands and Forests, Maple, Ontario, and V. K. Prest. *Comment* (V.K.P.): wood from the silty clay was previously dated as 5960 ± 110 and 5920 ± 120 (GSC-103 and 82, GSC II), whereas shells from overlying sand yielded date of 7060 ± 120 (GSC-91, GSC II). New date indicates that surface sand, as well as subsurface clay, accumulated some 6000 yr ago (see GSC-341, this list). NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on three 1-day counts.

5130 ± 130**GSC-341. Little Cypress River, Ontario****3180 B.C.**

Wood from middle layer of seven woody layers in 13 ft sand unit overlying 3 to 4 ft of fine sand, overlying silt, from natural gully 0.5 mi E of Little Cypress River bridge on Trans-Canada Hwy, 21 mi E of Nipigon, Ontario (48° 56' N Lat, 87° 49' W Long). Coll. 1964 by S. C. Zoltai. *Comment* (S.C.Z.): date indicates age of lower Nipissing Great Lakes beach, at alt 692 ft in this area (Farrand, 1960). Age is greater than generally accepted age of Nipissing Great Lakes, but is consistent with Little Pic River dates (GSC-82, 5920 ± 120, and GSC-103, 5960 ± 110, both in GSC II; GSC-285, 6100 ± 160, this list). Date based on one 3-day count.

GSC-287. Rosslyn, Ontario**9380 ± 150****7430 B.C.**

Wood chips 10 in. above base of 3 to 4 ft sand unit overlying laminated clay with rare shells, from clay pits immediately SW of Rosslyn Village, 7 mi W of Fort William, Ontario (48° 21' 45" N Lat, 89° 27' 15" W Long), at alt 702 ft. Coll. 1964 by S. C. Zoltai. *Comment* (S.C.Z.): date indicates age of a post-Minong beach occurring at 743 ft elevation in Lakehead area (Farrand, 1960; Zoltai, 1965). Sample mixed with dead gas for counting. Date based on one 3-day count.

*B. Western Canada***GSC-410. Grand Rapids, Manitoba****4670 ± 130****2720 B.C.**

Basal peat from 5 ft-thick bog along Hwy 6, sec. 28, tp. 45, rge. 12, W prin. mer. (52° 53' N Lat, 99° 08' W Long). Peat overlies gravel in a drainage ditch near southern edge of The Pas Moraine. Coll. 1965 by R. W. Klassen. *Comment*: sample dated in an attempt to obtain a minimum age for moraine; date believed to be considerably younger than age of moraine. Pretreatment included *cold* NaOH-leach. Date based on one 3-day count.

GSC-284. Duck Mountain, Manitoba**>37,760**

Plant detritus from fossiliferous silt 70 ft below surface along Roaring River, sec. 30, tp. 33, rge. 26, W prin. mer. (51° 51' N Lat, 101° 08' W Long). Silt is overlain by two tills and underlain by sand and gravel. Coll. 1964 by R. W. Klassen. *Comment* (R.W.K.): studies of ostracods and mollusca from silt suggest interstadial climate, rather than interglacial as suggested by Tyrrell (1892, p. 217E). Date based on one 3-day count.

GSC-346. Grandview, Manitoba**1670 ± 130****A.D. 230**

Charcoal from base of 4 ft-thick clay unit overlying till in bank of stream channel, NW ¼ sec. 33, tp. 23, rge. 22, W prin. mer. (51° 02' N Lat, 100° 31' W Long). Coll. 1963 by R. W. Klassen. *Comment*: in view of young date, clay is alluvial rather than a deposit of Glacial Lake Agassiz. Pretreatment included *cold* NaOH-leach. Sample mixed with dead gas for counting.

GSC-297. Minnedosa, Manitoba**>31,300**

Grass from inter-till silt exposed in 83 ft-high road cut along Minnedosa River valley, NE ¼ sec. 20, tp. 16, rge. 18, W prin. mer. (50° 22' N Lat, 99° 54' W Long). Silt is overlain by three tills separated by stratified sediments. Bones of a large ground squirrel (*Citellus*) and a large vole (*Microtus*), both id. by A. W. F. Banfield, Natl. Mus., Canada, were associated with the grass. Coll. 1964 by R. W. Klassen. *Comment* (R.W.K.): close resemblance of bones to those of Arctic ground squirrel

(*Citellus undulatus*) and tundra vole (*Microtus oeconomus*) suggests silt is an interstadial deposit. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

360 ± 130**GSC-443. Steveville Dinosaur Park, Alberta A.D. 1590**

Willow wood from 7 in. log at 12 ft depth in silty floodplain of Little Sandhill Creek just above its confluence with Red Deer River, in Steveville Provincial Dinosaur Park, Alberta, SW ¼ sec. 7, tp. 21, rge. 11, W 4th mer. (50° 46' N Lat, 111° 31.5' W Long), at alt ca. 2100 ft. Sample obtained from a well. Coll. 1958 by R. Fowler, High River, Alberta; subm. by A. M. Stalker. *Comment* (A.M.S.): date on wood believed to be in place gives indication of rate of aggradation of Little Sandhill Creek. Date based on one 3-day count.

5430 ± 320**GSC-369. Lomond, Alberta****3480 B.C.**

Freshwater gastropod shells from farm dugout, ca. 2 mi W of Lake McGregor and 11 mi W of Lomond, Alberta, SW ¼ sec. 7, tp. 16, rge. 21, W 4th mer. (50° 19.5' N Lat, 112° 53.5' W Long), at alt ca. 3200 ft. The 11 ft-high dugout face exposes pond and slopewash deposits, with an 8 in. bed of volcanic ash 5 ft from the base. An incipient soil ca. 1 ft above the ash marks a halt in deposition of the pond sediments and probably represents the 'Climatic Optimum'. Shells are from upper part of volcanic ash and lower few in. of overlying pond deposits. Coll. 1964 by A. M. Stalker. *Comment* (A.M.S.): assuming shells are not appreciably contaminated with recycled carbon, date is minimum for deposition of ash. No pretreatment. Sample mixed with dead gas for counting.

2930 ± 150**GSC-316. Drummond Valley, Alberta****980 B.C.**

Wood and organic debris from a mudflow in Drummond Valley, Alberta, tp. 36, rge. 15, W 5th mer. (51° 33' N Lat, 116° 40' W Long), at alt ca. 6500 ft. Sample, 9.5 ft below surface, is from lowest of several organic horizons. It is not considered to be much above bedrock, although nature of underlying deposits is unknown. Site is in mouth of valley, ca. 3 mi from Drummond Glacier. Coll. 1964 by J. G. Nelson, Univ. of Alberta, Calgary. Subm. by A. M. Stalker. *Comment* (J.G.N.): date is minimum for ice retreat from area and also provides information on rate of mass wasting; i.e., 9 to 10 ft of mudflow debris has accumulated in 3000 yr. Sample mixed with dead gas for counting.

9330 ± 170**GSC-332. North Saskatchewan Crossing, Alberta 7380 B.C.**

Charcoal 6 ft below surface in river bank 300 ft SW of bridge over North Saskatchewan River, Banff National Park, Alberta (51° 58' N Lat, 116° 43' W Long), from lower part of 2 to 8 ft section of loess containing two volcanic ash beds, overlying outwash gravel. Coll. 1964 by J. Westgate, Univ. of Alberta, Edmonton. *Comment* (J.W.): charcoal is be-

lieved to have washed into the loess during or slightly later than deglaciation of this part of the valley.

5470 \pm 140

GSC-197. Ruddock Creek, British Columbia

3520 B.C.

Spruce log (id. by J. N. Roff, Forest Products Lab., Vancouver, B.C.) at alt 7600 ft, W of Gordenhorne Peak, head of Ruddock Creek, Monashee Range, British Columbia ($51^{\circ} 46.5' \text{ N Lat}$, $118^{\circ} 54' \text{ W Long}$). Log exposed at E end of small lake by artificial melting of semi-permanent snow bank during mining exploration of "E" zone of I. T. Group. No trees grow at site, and highest trees of comparable size are below alt 6700 ft. Dated tree grew at or above sample site and hence represents climate more favourable than present. Coll. 1962 by E. Dodson, Falconbridge Nickel Mines, Vancouver; subm. by W. H. Mathews, Univ. of British Columbia, Vancouver. *Comment*: other dated occurrences of high-level wood in southern British Columbia are GSC-169 (3760 ± 140 , GSC III) from Downie Creek 50 mi SE and Y-140 (5850 ± 180 , Yale II) from Mt Garibaldi 200 mi SW; both were exposed by glacier retreat.

Kamloops series, British Columbia

GSC-275. Peterson Creek

>32,700

Wood fragments from a stream cut on Peterson Creek $\frac{3}{4}$ mi S of Hwy 1 at Kamloops, British Columbia ($50^{\circ} 39' 45'' \text{ N Lat}$, $120^{\circ} 19' 40'' \text{ W Long}$). Sample from 50 ft below till at base of an exposure of partially oxidized, interbedded silt and sand. A second till, stratigraphically below the oxidized succession, outcrops 600 ft to the S. Coll. 1964 by R. J. Fulton. *Comment* (R.J.F.): sand and silt are delta bottom-set beds deposited in a lake which occupied Thompson Valley at Kamloops at some time prior to Fraser Glaciation. Sample mixed with dead gas for counting. Date based on one 3-day count.

GSC-413. Mission Flats

>35,500

Freshwater shells (*Margaritifera margaritifera*, *Anodonta nuttalliana*; id. by F. J. E. Wagner) from a borrow pit in 35 ft of partially oxidized clayey, silty sand at base of S wall of Thompson River Valley ca. 5 mi W of Kamloops, British Columbia ($50^{\circ} 41' 20'' \text{ N Lat}$, $120^{\circ} 26' 30'' \text{ W Long}$). Shells were incorporated in an alluvial fan deposit built into a lake which occupied Kamloops Lake basin prior to Fraser Glaciation. Coll. 1965 by R. J. Fulton. *Comment* (R.J.F.): date is minimum age for enclosing interstadial or interglacial deposits tentatively correlated lithologically with those at Peterson Creek. Date suggests that an earlier sample (GSC-79, GSC III), for which a finite age of $25,000 \pm 460$ was obtained, was contaminated. Two fractions were dated after removal of the outermost 10%:

outer fraction (10-55% leach), one 1-day count **>35,500**
inner fraction (56-100% leach), one 3-day count **>34,400**

GSC-298. Otter Creek, British Columbia **3390 ± 130**
1440 B.C.

Mucky peat directly below a 2 cm band of volcanic ash, 85 cm below surface of a bog, along Hwy 5 in valley of Otter Creek, 34.2 mi N of Princeton, British Columbia (49° 53' 00" N Lat, 120° 37' 30" W Long). Collected with Hiller peat borer. Peat from base of the 395-cm thick bog has been dated at 9320 ± 160 (GSC-256, GSC IV). Coll. 1964 by R. J. Fulton. *Comment* (R.J.F.): date suggests the volcanic ash resulted from the Mt St. Helens eruption 3200 yr ago (Crandell *et al.*, 1962). Pretreatment included *cold* NaOH-leach. Date based on one 3-day count.

GSC-345. Pemberton Creek, British Columbia **3410 ± 130**
1460 B.C.

Charcoal and humic-rich silt from depth of 180 cm in Recent alluvium exposed in a natural cut on Pemberton Creek, NW of South Thompson River 1.1 mi W of Pritchard, British Columbia (50° 41' 25" N Lat, 119° 50' 50" W Long). Charcoal was taken from lower part of a 5-cm band of volcanic ash and top of an underlying 7.5-cm band of humic silt. An elk horn wedge was incorporated in massive sandy silt 25 cm below the volcanic ash. Coll. 1963 by R. J. Fulton. *Comment* (R.J.F.): date is maximum for ash deposition and confirms petrologic correlation with the Mt St. Helen "Y" ash fall of 3200 B.P. (Crandell *et al.*, 1962). It also places minimum age on the horn artifact. NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

GSC-321. Burnaby Lake, British Columbia **7340 ± 360**
5390 B.C.

Peat from 13.5 ft depth at Sperling Street Interchange, W end of Burnaby Lake, Vancouver, British Columbia (49° 14' 45" N Lat, 122° 57' 15" W Long). Shelby tube samples reported to have contained two ash layers separated by 6 in. peat; dated peat is from finer-grained, presumably upper, side of lower ash. Both ash beds are described by R. E. Wilcox (written commun., 1963) as not significantly different from Mazama "O" pumice. Coll. 1962, subm. by W. H. Mathews, Univ. of British Columbia, Vancouver. *Comment*: date is older than accepted age of Mazama eruption (6600 yr B.P., Powers and Wilcox, 1964) and thus is at variance with the stratigraphic relations inferred above. Possibly the dated material came from below rather than above the ash. Pretreatment included *cold* NaOH-leach. Sample mixed with dead gas for counting.

GSC-395. Fraser Delta, British Columbia **6790 ± 150**
4840 B.C.

Marine pelecypod shells from borehole in Fraser Delta, 1000 ft N of 16th Ave., E side of 56th St., Delta Municipality, British Columbia (49° 02' 30" N Lat, 123° 04' 00" W Long), in silty sand 50 ft below surface and ca. 45 ft below sealevel. Coll. 1964 by W. L. Brown, Vancouver, British Columbia; subm. by J. E. Armstrong. *Comment* (J.E.A.): date

represents stage in growth of Fraser Delta when Point Roberts was still an island.

GSC-396. Mitchell Island, British Columbia **>40,000**

Wood from borehole on Mitchell Island, Vancouver metropolitan area, British Columbia (49° 12' 15" N Lat, 123° 05' 30" W Long), in clayey silt and silty sand 680 ft below surface and 675 ft below sealevel. Sampled horizon is overlain by ca. 300 ft of fine stratified sediments capped by 170 ft of till tentatively assigned to Surrey Drift of Vashon Stade of Fraser Glaciation. Coll. 1962 by W. L. Brown; subm. by J. E. Armstrong. *Comment* (J.E.A.): dated sub-till sediments were originally assigned to Quadra sediments of Olympia Interglaciation on basis of stratigraphy. Date is older than those typical of the Olympia (36,000 yr and less, Armstrong *et al.*, 1965) and deposit may represent an earlier nonglacial interval.

Koksilah River series, Vancouver Island

Peat from top and bottom of 18-ft section of organic sandy to clayey alluvium in road cut, Island Highway SE of Koksilah River bridge near Duncan, Vancouver Island, British Columbia (48° 45' 22" N Lat, 123° 40' 15" W Long). Organic strata are underlain by coarse silty gravel, enclose a bed of gravel 3 ft above base, and are overlain by discontinuous till capped by marine clay. Coll. 1964 by E. C. Halstead.

24,060 ± 300

GSC-318. Koksilah River upper peat **22,110 B.C.**

Peat from highest exposed organic bed, 18 ft above GSC-385.

24,380 ± 350

GSC-385. Koksilah River lower peat **22,430 B.C.**

Peat from base of organic section at alt 50 ft.

General Comment (E.C.H.): dated unit is assigned to Quadra sediments, formed during Olympia Interglaciation. Similar deposits at Cowichan Bay 2 mi SE yielded wood dated as 24,560 ± 800 (I-1225, unpub.). NaOH-leach omitted from pretreatment of both samples.

21,730 ± 230

GSC-317. Marie Canyon wood, Vancouver Island **19,780 B.C.**

Wood 100 ft above Cowichan River at Marie Canyon, Vancouver Island, British Columbia (48° 46' 43" N Lat, 123° 53' 36" W Long), from fine sand and silt within thick succession of clay, silt, and gravel beneath till. Coll. 1964 by E. C. Halstead. *Comment* (E.C.H.): date supports the less reliable date of 19,150 ± 250 (GSC-210, GSC IV) for diffuse organic matter in silt 15 ft higher in the sub-till succession, and confirms correlation with Quadra sediments. Date based on one 3-day count.

>47,400

GSC-163-2. Crofton peat, Vancouver Island

Peat at alt 100 ft on cut bank 'behind' pulp mill 0.75 mi N of Crofton, Vancouver Island, British Columbia (48° 52' 30" N Lat, 123° 38'

40" W Long), from 4 to 6 in. bed of peaty silt and wood within 15 ft of silt and clay underlain by sand and overlain by 10 ft of silty sand; succession is overlain and truncated by Vashon till. Coll. 1963 by E. C. Halstead. *Comment*: date is based on one 4-day count in 5-L counter at 4 atm and supersedes earlier date of >38,800 for same sample (GSC-163, GSC III).

GSC-358. Muir Point, Vancouver Island **>40,300**

Peat 76 ft above shore in coastal cliff at Muir Point near Sooke, Vancouver Island, British Columbia (48° 21' 28" N Lat, 123° 44' 48" W Long), from uppermost of several peat beds in silt, clay, sand, and gravel underlain and overlain by till. Overlying till is tentatively assigned to last (Fraser) Glaciation. Coll. 1964 by E. C. Halstead. *Comment* (E.C.M. and J.G.F.): dated deposit, facing the Strait of Juan de Fuca, has not been placed in the stratigraphic sequence of Strait of Georgia-Puget Lowland to the E (Armstrong *et al.*, 1965; Crandell, 1965), but pollen analysis (J. Terasmae) suggests it is older than Olympia Interglacial, characteristically dated as 36,000 yr and younger (Armstrong *et al.*, 1965).

GSC-277. Denman Island shells, British Columbia **>49,000**

Barnacle shells (*Balanus evermanni*) ca. 10 ft above high tide on Komas Bluff, Denman Island, British Columbia (49° 35.6' N Lat, 124° 49.3' W Long), from marine stony clay in basal part of Quadra sediments. Coll. 1963 by J. G. Fyles. *Comment*: sample duplicates L-475A (>41,500, Lamont VII); date extends known age of clay unit of Quadra sediments (other dates GSC-207, GSC IV; GSC II; L-514C, Lamont V; L-275A, Lamont VII). Two fractions were dated in the 5-L counter at 4 atm:

outer fraction (23-59% leach), two 1-day counts **>47,170**
 inner fraction (60-100% leach), two 3-day counts **>49,000**

Data for inner fraction permits calculation of the date as $54,200 \pm 1800$, but the corresponding infinite date is more realistic.

GSC-325. Blenkinsop Lake peat, Vancouver Island **5790 ± 140**
3840 B.C.

Peat and organic sand coll. with Hiller sampler at depth 4.5 to 5 m from base of bog, Blenkinsop Lake (alt ca. 90 ft), Victoria, Vancouver Island, British Columbia (48° 28' 30" N Lat, 123° 21' 30" W Long). Coll. 1964 by E. C. Halstead. *Comment* (E.C.H.): dated peat is underlain by clay that yielded marine shells at a nearby site dated at $12,660 \pm 160$ (GSC-246, GSC IV). Sample dated to gain information on time of emergence of site, but date probably is considerably younger than emergence. NaOH-leach omitted from sample pretreatment; date based on one 3-day count.

GSC-398. Saanichton, Vancouver Island **12,440 ± 230**
10,490 B.C.

Marine pelecypod shell fragments from gravel pit, Saanich Indian Reserve No. 2 near Saanichton, Vancouver Island, British Columbia (48° 35' 30" N Lat, 123° 23' 30" W Long), in clay (alt 25 ft) at base of deltaic deposit. Clay was deposited when sealevel stood at or above top of delta (alt 60 ft); marine limit is at ca. 250 ft. Coll. 1964 by E. C. Halstead. *Comment* (E.C.H.): date applies to an intermediate stage in uplift following deglaciation.

GSC-418. Patricia Bay, Vancouver Island **12,750 ± 170**
10,800 B.C.

Marine shells (*Saxidomus* sp.) at alt 65 ft in gravel pit 0.5 mi E of Patricia Bay, N of airport, on Mills Crossroad, Saanich Peninsula, Vancouver Island, British Columbia (48° 39' 30" N Lat, 123° 26' W Long), from shell-rich bed in sand forming lower part of gravelly, sandy, and till-like shore deposit up to 15 ft thick (before excavation). Beneath shore deposit are 1 to 3 ft of marine clay over 5 ft of till over sand. Shell bed probably represents relative sealevel approx. at top of deposit (alt ca. 80 ft). Coll. 1961 by E. Livingston, Water Rights Branch, Victoria, British Columbia; subm. by J. E. Armstrong. Stratigraphy revised 1963 by J. G. Fyles. *Comment*: date appears to apply to a somewhat higher relative sealevel and earlier stage in uplift than GSC-398 (this list). Outer 40% of shells removed before dating.

GSC-389. Wellington, Vancouver Island **12,740 ± 170**
10,790 B.C.

Worm tubes (*Serpula*) at alt 230 ft in gravel pit, N side of Island Highway 0.5 mi E of Wellington, Vancouver Island, British Columbia (49° 12.3' N Lat, 124° 00' W Long), associated with varied pelecypod shells in stony silt beneath inclined sand and gravel on flank of marine spit or bar. Crest of deposit is at alt 350 ft, ca. 100 ft below local marine limit. Coll. 1963 by E. C. Halstead and J. G. Fyles. *Comment*: date probably applies to relative sealevel at or above alt 350 ft during an early stage in the marine inundation that followed deglaciation. Shells from a nearby site at alt 350 ft have been dated as 12,420 ± 150 (GSC-80, GSC II). This area has undergone greater emergence and was deglaciated slightly later than the area 50 mi SE represented by the approx. equivalent dates GSC-398, GSC-418 (this list). Date based on one 3-day count.

GSC-265. Willemar Bluff soil, Vancouver Island **8680 ± 140**
6730 B.C.

Organic material from paleosol 10 ft above high tide at NE end of Willemar Bluff, 2 mi E of Comox, Vancouver Island, British Columbia (49° 40' 20" N Lat, 124° 53' W Long). Sandy soil 12 in. thick is underlain by 2 ft of marine beach gravel over till and is capped by ca. 100 ft of dune sand. Dunes probably formed when relative sealevel was a few ft below present. Coll. 1963 by J. G. Fyles. *Comment*: date agrees

with others from surrounding region relating to relative sealevel at or below present following early post-glacial rapid uplift (S-99, 7300 ± 120 , Saskatchewan III; 8300 ± 200 , S-142, Capes, 1964, p. 60; GSC-229, 8290 ± 140 , GSC IV). NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

C. Northern Canada, Mainland

GSC-412. Liard River, Yukon **>40,100**

Wood from log in lower part of more than 100-ft section of stratified and crossbedded sand and pebbly sand, overlain by ca. 100 ft of boulder till, in turn overlain by 2 ft grey-brown sand with intercalated 1/2-in. white ash bed, and capped by reddish soil, humus, and moss. Sample from actively eroding cliff, E side of Liard River, 39.2 mi NW of Upper Liard bridge, Alaska Hwy, Yukon Territory ($60^{\circ} 28' \text{ N Lat}$, $129^{\circ} 41' \text{ W Long}$). Coll. 1952 by W. H. Poole. *Comment* (W.H.P.): preservation of wood suggests Pleistocene rather than pre-Pleistocene age, whereas highly kaolinized state of feldspar in granite pebbles within sand suggests age considerably older than latest ice advance. Feldspar in granite pebbles in till overlying sand is fresh.

GSC-342. Stewart River, Yukon **>38,940**

Wood enclosed in lenticular ash layer beneath 10 to 15 ft silt, organic silt and peat in natural exposure on SE side Stewart River, at mouth of small stream ca. 8.5 mi upstream from mouth of Valley Creek, Yukon Territory ($63^{\circ} 24' \text{ N Lat}$, $138^{\circ} 10' \text{ W Long}$). Coll. 1964 by O. L. Hughes. *Comment* (O.L.H.): as suspected from field relationships, ash is much older than surface or near-surface ash layer of central and western Yukon (Bostock, 1952; Stuiver *et al.*, 1964).

GSC-331. Mayo, Yukon **>46,580**

Wood from beneath till, right bank of Stewart River 1.5 mi downstream from Mayo, Yukon Territory ($63^{\circ} 36' \text{ N Lat}$, $135^{\circ} 56' \text{ W Long}$), from same locality as I (GSC)-180, ($>35,000$, Isotopes II). Exposure had been freshened by erosion to expose thin-bedded silt and fine-grained sand and minor gravel extending 35 to 50 ft above river level and overlain in turn by ca. 10 ft till and up to 50 ft silt and sand. Abundant pieces of wood up to 5 in. diam occur near top of lower silt unit. Coll. 1964 by E. B. Owen. *Comment* (O. L. Hughes): till overlying wood represents last glaciation in region; it is exposed intermittently downstream, and terminates ca. 7 mi downstream at a well-marked moraine. Despite age of sample, last glaciation may have culminated as recently as 10,500 yr ago. Sample dated in 5-L counter at 4 atm. Date based on one 4-day count.

GSC-365. Twin Buttes, Yukon **$10,840 \pm 150$**
8890 B.C.

Organic silt obtained from perennially frozen palsa bog using SIPRE-type ice-coring drill (Hughes and Terasmae, 1962). Sample was

at 7.3 to 7.5 ft depth, immediately above pebbly gritty silt interpreted as bog bottom. Bog is ca. 1 mi N of W butte at Twin Buttes, Talbot Plateau, Yukon Territory (63° 30' N Lat, 135° 23.5' W Long), and 2.5 mi SW of (beyond) the limit, as inferred from a well-defined moraine, of late Wisconsinan ice which occupied Stewart River Valley to the N. Coll. 1964 by O. L. Hughes. *Comment* (O.L.H.): date is minimal for deglaciation of locality. NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

5190 ± 140

GSC-294. Glacier Creek, Yukon

3240 B.C.

Basal peat coll. with SIPRE-type ice-coring drill from depth of 6.1 ft in bog between North Klondike River and Dempster Hwy, 1.5 mi S of bridge over Glacier Creek, Yukon Territory (64° 08.6' N Lat, 138° 32.5' W Long). Coll. 1964 by O. L. Hughes. *Comment* (O.L.H.): ice advanced S beyond bog site almost to South Klondike River during an "intermediate" glaciation (Vernon and Hughes, in press); this event was approximately correlative with construction of moraine at Chapman Lake and hence older than 13,870 yr (GSC-296, this list). Date is minimal for deglaciation of site. Pretreatment included *cold* NaOH-leach.

4930 ± 140

GSC-366. Hart Lake, Yukon

2980 B.C.

Organic silt and twigs coll. from permanently frozen bog on NW side of moraine ridge impounding Hart Lake, Yukon Territory (64° 37' N Lat, 135° 10' W Long), using SIPRE-type ice-coring drill. Sample from 13 ft below surface in palsa mound; bog bottom not reached. Coll. 1964 by O. L. Hughes. *Comment* (O.L.H.): date is minimal for deglaciation of locality, which may have taken place more than 12,000 yr ago (GSC-67, GSC-67-2; GSC II). NaOH-leach omitted from sample pretreatment.

Chapman Lake series, Yukon

Peat and organic silt, coll. with SIPRE-type ice-coring drill from bog on a moraine 0.4 mi E of Chapman Lake, between the lake and Dempster Hwy, Yukon Territory (64° 51.5' N Lat, 138° 19' W Long). Moraine marks northern limit of glaciation in Blackstone River valley during an "intermediate" glacial advance (Vernon and Hughes, in press). Ice advanced to ca. 16 mi S of site during last advance recognized in the region. Coll. 1962 by O. L. Hughes.

13,870 ± 180

GSC-296. Chapman Lake, basal organic silt

11,920 B.C.

Basal organic silt in bog at 12.6 to 13.0 ft depth.

10,900 ± 150

GSC-311. Chapman Lake, organic silt

8950 B.C.

Organic silt at 8.05 to 8.45 ft depth, from base of a prominent silt layer within the bog succession.

GSC-310. Chapman Lake, peat**9620 ± 150****7670 B.C.**

Peat from 5.1 to 5.5 ft depth, above the prominent silt layer. Pollen studies by J. Terasmae indicate significant increases in spruce and alder pollen at ca. this level. Three determinations were made:

untreated fraction	9620 ± 140
soluble in NaOH	9510 ± 150
not dissolved in NaOH	9620 ± 150

General Comment (O.L.H.): GSC-296 (basal organic silt) provides minimum date for deglaciation of site and is compatible with the assumption, based on field evidence, that moraine is comparable in age to that at Gill Lake, Y.T. (GSC-128, 12,550 ± 190, GSC III). GSC-311 supports hypothesis that the prominent silt layer is loess derived from the nearby Blackstone River at beginning of last glacial advance, as it is comparable with dates of ca. 11,000 yr for Alaskan advances (Vernon and Hughes, in press); GSC-311 and GSC-310 together place this advance between 10,900 and 9600 yr ago. NaOH-leach omitted in the pretreatment of GSC-296, date for GSC-311 based on one 3-day count, and date on untreated fraction of GSC-310 based on one 4-day count.

GSC-295. Blackstone River, Yukon**6650 ± 140****4700 B.C.**

Silty peat from 11.4 ft depth in boring made with SIPRE-type ice-coring drill on SW edge of small pond, W of Blackstone River and 5.2 mi N of Chapman Lake, Yukon Territory (64° 56' N Lat, 138° 20' W Long). Pond is in subdued moraine beyond limit of and higher than moraine of "intermediate" age in vicinity of Chapman Lake. Coll. 1964 by O. L. Hughes. *Comment* (O.L.H.): moraine is older than that at Chapman Lake, hence older than 13,870 yr (GSC-296, this list). Pretreatment included cold NaOH-leach. Date based on one 2-day count.

GSC-372. Old Crow River, Yukon**6430 ± 140****4480 B.C.**

Wood at base of 6 ft surface peat layer overlying 100 ft of sediments, mainly silt and clay, from riverbank exposure, Old Crow River, Yukon Territory (68° 03.5' N Lat, 139° 50' W Long). Coll. 1962 by V. N. Ramp-ton. *Comment* (O. L. Hughes): the silt and clay, probably lacustrine in origin, are believed to have been deposited when Old Crow Basin was more or less completely occupied by one or more large lakes. Date is minimal for initiation of present environment of numerous lakes interspersed with bogs. Date based on one 5-day count.

GSC-151-2. King Point, Yukon**>51,100**

Wood and peaty fragments coll. 2 ft above base of sea cliff 3.5 mi E of E end of King Point Spit, Yukon Territory (69° 04.5' N Lat, 137° 50' W Long). Sample from organic silt grading up into stony clay with marine shells (thickness 10 to 18 ft) overlain in succession by till (20 to

30 ft), sand and silt (8 to 15 ft), and surface peat (up to 3 ft). The till, representing last glaciation of the site, apparently terminates in vicinity of a moraine ca. 4 mi W which is assumed to mark maximum (classical?) Wisconsin stand of Laurentide ice sheet. Coll. 1962 by O. L. Hughes. *Comment:* date is based on one 6-day count in 5-L counter at 4 atm and supersedes earlier date of $>38,200$ for same sample (GSC-151, GSC III), Pretreatment included *cold* NaOH-leach.

Southern Eskimo Lakes series, Northwest Territories

Peat from partly overgrown bluff, SW Eskimo Lakes ($68^{\circ} 45' \text{ N Lat}$, $133^{\circ} 16' \text{ W Long}$). Coll. 1962 by O. L. Hughes.

GSC-329. S Eskimo Lakes, beneath gravel $>50,900$

Peat 62 ft above lake level (sealevel) and ca. 10 ft below top of organic silt overlain by 75 ft glaciofluvial gravel capped by 7 ft peat. Two determinations have been made:

5-L counter (standard procedure)	$>42,620$
5-L counter (one 3-day count at 4 atm)	$>50,900$

GSC-371. S Eskimo Lakes, above gravel 7120 ± 140 5170 B.C.

Basal peat from 7 ft-thick surface peat layer overlying gravel.

General Comment (O.L.H.): gravel is outwash from a glacial lobe in Sitidgi Lake basin which stood at a well-defined moraine along E and N sides of the lake during a late Wisconsinan stillstand or readvance. GSC-371 is minimal for this event, but probably is considerably younger than the outwash. Other 'basal peat' dates from region are GSC-16, 7400 ± 200 and GSC-25, 8200 ± 300 (GSC I; Mackay and Terasmae, 1963). When collected, GSC-329 was expected to date approximately beginning of outwash deposition, but subsequent study of nearby sections suggests that an unconformity separates organic silt from outwash gravel and that an ice advance occurred after deposition of silt and before deposition of gravel (J. G. Fyles, oral commun., 1965). Pretreatment of GSC-329 included *cold* NaOH-leach; date for GSC-371 based on one 3-day count.

GSC-397. Horton River, Northwest Territories 3050 ± 150 1100 B.C.

Peat from intercalated lacustrine and peat layers exposed in crater of a pingo 50 ft high, 11 mi E of Horton River and 65 mi S of Darnley Bay, Northwest Territories ($68^{\circ} 29' \text{ N Lat}$, $123^{\circ} 16' \text{ W Long}$; Craig, 1960, p. 7), at alt ca. 1650 ft. Coll. 1959 by T. N. Irvine for B. G. Craig. *Comment:* NaOH-leach omitted from sample pretreatment.

Bathurst Inlet series, Northwest Territories

Marine pelecypod shells coll. on surface of sorted polygons among raised beaches, near summit of isolated hill ca. 0.5 mi W of Bathurst In-

let, Northwest Territories (66° 42' N Lat, 107° 55' W Long), at alt ca. 465 to 475 ft. Shells dated to check on age of different species at same site. Coll. 1962 by W. Blake, Jr.

GSC-230. Bathurst Inlet, *Mytilus* **8000 ± 150**
6050 B.C.
Shell fragments of *Mytilus edulis*.

GSC-359. Bathurst Inlet, *Hiatella* **8060 ± 140**
6110 B.C.
Shell fragments of *Hiatella arctica*.

General Comment (W.B., Jr.): the two dates agree very closely, which is of interest because *Hiatella* lives over a greater depth range than *Mytilus*. Date for GSC-359 based on one 3-day count.

GSC-300. MacAlpine Moraine **2330 ± 150**
380 B.C.

Peat among boulders in pool on crest of end moraine ca. 6 mi SW of MacAlpine Lake, Northwest Territories (66° 32' N Lat, 103° 15' W Long), at alt ca. 900 ft. Peat was at lowest level that could be coll. by hand, 25 cm below water surface and 50 to 55 cm below surface of peat. Sample unfrozen but peat 5 to 10 cm above water level frozen (June 22nd). Coll. 1962 by W. Blake, Jr. *Comment* (W.B., Jr.): sample was dated in attempt to gain more information about age of this major end moraine, believed to have been forming ca. 8200 yr ago (GSC-110, 8160 ± 110, GSC-III; Blake, 1963), but a considerable time apparently elapsed before organic material started to accumulate (cf. GSC-116, 1090 ± 100, GSC III). Dates on the two fractions of peat agree within limits of error. Two fractions were dated (cf. Table 4, this list); date on soluble fraction is based on average of one 1-day count with the sample unmixed (2190 yr) and one 1-day count with the sample mixed with dead gas (2230 yr):

soluble in NaOH	2210 ± 130
not dissolved in NaOH	2330 ± 150

Thelon Shell series, Northwest Territories

Marine shells from Thelon Valley-Baker Lake area, central District of Keewatin, pertaining to deglaciation and uplift sequence in central section of Keewatin Ice Divide zone (Lee *et al.*, 1957; Fyles, 1955). In addition to the following two dates, series includes I-1224 (6015 ± 150), Beverly Lake, alt 360 ft, to appear in a future Isotopes date list.

GSC-299. Baker Lake shells **5480 ± 150**
3540 B.C.

Marine pelecypod shells (*Hiatella arctica*) from ground surface of fine sand and gravel, alt 295 ft, ca. 130 ft below marine limit, 3 mi N of Baker Lake settlement, Northwest Territories (64° 31' N Lat, 96° 03' W Long). Coll. 1964 by J. A. Donaldson for B. G. Craig and J. G. Fyles.

GSC-439. Kazan River shells**5900 ± 130****3950 B.C.**

Marine pelecypod shells (*Hiatella arctica*) from sandy ground surface, alt 250 ft, ca. 200 ft below marine limit, 20 mi upstream from mouth of Kazan River, Northwest Territories (63° 46' N Lat, 95° 40' W Long). Coll. 1963 by J. A. Donaldson for B. G. Craig and J. G. Fyles. *General Comment* (B.G.C. and J.G.F.): GSC-299 and 439 are from SE part of ice-divide zone whereas I-1224 is from Thelon Valley W (inland) from ice-divide. Together, dates indicate that remnant ice along the divide broke up more than 6000 yr ago, permitting Hudson Bay water to penetrate W through the divide zone up Thelon Valley. Deglaciation of ice divide zone was estimated earlier (Craig and Fyles, 1960, 1965) as ca. 7000 yr B.P. based on I (GSC)-8, 6975 ± 250 (Isotopes I), E of ice divide ca. 100 mi S of Thelon Valley and on L-428, 5500 ± 250 (Lamont V; Craig, 1959) from Thelon Valley near W limit of marine inundation.

GSC-289. Mistake Creek, Northwest Territories**6830 ± 170****4880 B.C.**

Marine pelecypod shell from sand in bank of 8 ft deep stream valley cut in extensive area of beaches, alt 415 ft, ca. 75 ft below marine limit, 15 mi NW of mouth of Mistake Creek, Roes Welcome Sound, Northwest Territories (64° 19' N Lat, 88° 29' W Long; Craig, 1965, Fig. 2, loc 5). Coll. 1964 by B. G. Craig. *Comment* (B.G.C.): date is minimum for withdrawal of ice and entry of sea along this part of W coast of Hudson Bay. Sample mixed with dead gas for counting.

GSC-288. Ellice Hills, Northwest Territories**8620 ± 140****6670 B.C.**

Shells of *Mya truncata* from gravelly surface of marine silt deposit, alt 624 ft, at least 75 ft below the marine limit, 8 mi NW of Cape Weynton, W side of Committee Bay, Northwest Territories (67° 49' N Lat, 88° 25' W Long; Craig, 1965, Fig. 2, loc 1). Coll. 1964 by J. A. Donaldson for B. G. Craig. *Comment* (B.G.C.): date is minimum for withdrawal of ice and entry of sea into central part of Committee Bay, but shells were probably deposited when Rae Isthmus was still ice covered cf. GSC-286, 6850 ± 140 yr, this list). Date based on one 3-day count.

GSC-286. Anigorchli Lake, Northwest Territories**6850 ± 140****4900 B.C.**

Marine pelecypod shells for ground surface, alt 397 ft, ca. 65 ft below marine limit, 20 mi NW of Repulse Bay settlement, Rae Isthmus, Northwest Territories (66° 44' N Lat, 86° 42' W Long; Craig, 1965, Fig. 2, loc 4). Coll. 1964 by J. A. Donaldson for B. G. Craig. *Comment* (B.G.C.): shells are highest found in region and provide minimum date for marine connection through Rae Isthmus between Committee Bay and Repulse Bay. Date based on one 3-day count.

GSC-291. Parry Bay, Northwest Territories **6880 ± 180**
4930 B.C.

Marine pelecypod shells from fine sand in 30 ft gully cut in terrace remnant, probably deltaic, alt 441 ft, ca. 40 ft below marine limit, 4 mi inland and 12 mi NW of Cape Jermain, Parry Bay, E side of Melville Peninsula, Northwest Territories (67° 52' N Lat, 82° 10' W Long; Craig, 1965, Fig. 2, loc 3). Coll. 1964 by B. G. Craig. *Comment* (B.G.C.): date is minimum for retreat of ice from this area on W side of Foxe Basin and gives close approximation to time of formation of terrace now at 441 ft. Sample mixed with dead gas for counting.

GSC-327. Erik Cove, Quebec **7350 ± 150**
5400 B.C.

Shells of *Mya truncata* from raised marine deposits in Erik Cove, Wolstenholme, Quebec (62° 33' N Lat, 77° 23' W Long), at alt ca. 360 ft. Coll. 1935 by D. A. Nichols. *Comment*: age is in accordance with date of 6900 ± 130 yr (NPL-58, NPL III) on marine shells coll. by B. Matthews from 271 ft in same area.

D. Northern Canada, Arctic Archipelago

GSC-122. Ice Ridge Moraine C, Baffin Island **10,940 ± 240**
8990 B.C.

Microscopic organic debris from buried ice in ice-cored moraine, western margin Barnes Ice-cap, Baffin Island, Northwest Territories (70° 00' N Lat, 74° 20' W Long; cf. Østrem, 1964), at alt ca. 1600 ft. Coll. 1962 by G. Østrem. *Comment* (G.Ø.): contaminating particles, in the form of hickory chips from the picks used and plastic from the bottles in which sample was stored, were found among the organic debris; date was first thought to be based on this combination of modern hickory and infinitely old plastic. Two additional ice samples were coll. with great care in 1963, and these were processed in the field. They were believed free from contamination, but similar ages were obtained (12,540 ± 360, St-1329; 11,910 ± 140, St-1388, Stockholm VI). It would appear now that contamination was negligible in the case of GSC-122 also, and that date does reflect age of the vegetative material. However, the windblown debris originally deposited on snowbanks (which have later been covered by morainic material) probably consists of a mixture of contemporaneous vegetation (pollen, leaf fragments, etc.) and older humified material; thus age is greater than expected. Similar results have been obtained in Scandinavia (Østrem, 1965). NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count.

GSC-390. Magda River, Baffin Island **6890 ± 150**
4940 B.C.

Marine pelecypod shells from surface of delta, alt 129 ft, 12 mi E of mouth of Magda River, Baffin Island, Northwest Territories (71° 39' N

Lat, 84° 13' W Long). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): sample is highest collected in area, although ca. 80 to 100 ft below marine limit. Date provides minimum for withdrawal of ice and an approximate age for 130 ft delta. Sample mixed with dead gas for counting.

7120 ± 140

GSC-307. Ivisarak Lake, Baffin Island

5170 B.C.

Marine pelecypod shells (*Hiatella arctica*) from surface of fine sand in probable deltaic terrace, alt 319 ft, N side, W end of Ivisarak Lake, Baffin Island, Northwest Territories (70° 36' N Lat, 86° 08' W Long; Craig, 1965, Fig. 2, loc 9). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): date is minimum for withdrawal of ice from area and gives approximate age of terrace now at 320 ft. Ice retreat in immediate area related to valley ice tongue phase of deglaciation. Sample mixed with dead gas for counting. Date based on one 4-day count.

7240 ± 150

GSC-304. Berlinguet Inlet, Baffin Island

5290 B.C.

Marine pelecypod shells (*Hiatella arctica*) from surface of sand terrace, alt 293 ft, 10 mi SW of head of Berlinguet Inlet, Baffin Island, Northwest Territories (70° 55' N Lat, 86° 27' W Long; Craig, 1965, Fig. 2, loc 7). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): sample lies close to marine limit and was dated to determine if postglacial in origin. Date gives age of highest marine features and is minimum for withdrawal of ice from this part of Bernier Bay-Berlinguet Inlet trough. Sample mixed with dead gas for counting.

7690 ± 140

GSC-306. Agu Bay, Baffin Island

5740 B.C.

Marine pelecypod shells (*Hiatella arctica*) from frost boil a few ft above highest well-developed beach, alt 319 ft, central part of peninsula in Agu Bay, Baffin Island, Northwest Territories (70° 20' N Lat, 86° 48' W Long; Craig, 1965, Fig. 2, loc 8). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): date gives age of highest marine features and provides minimum for withdrawal of ice from area. Sample mixed with dead gas for counting. Date based on one 4-day count.

9260 ± 150

GSC-392. Cape Kater, Baffin Island

7310 B.C.

Marine pelecypod shells (*Hiatella arctica* and *Mya truncata*) from frost boil in stony silt on top of knoll slightly above highest distinct beach, at 312 ft, 13 mi SE of Cape Kater, SW Brodeur Peninsula, Baffin Island, Northwest Territories (71° 46' N Lat, 89° 48' W Long). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): shells dated to confirm or deny postglacial age. Date provides minimum for withdrawal of ice and entry of sea along W coast Brodeur Peninsula (cf. GSC-241, 9280 ± 150, GSC IV). Date based on one 3-day count.

GSC-450. Cunningham River, Somerset Island **8990 ± 140**
(whale bone) **7040 B.C.**

Part of bowhead whale (*Balaena mysticetus*) vertebra from eroded surface of marine silt, alt 219 ft, 7 mi inland (S) from mouth of Cunningham River, Somerset Island, Northwest Territories (73° 59' N Lat, 93° 40' W Long). Coll. 1962 by B. G. Craig. *Comment* (B.G.C.): this sample from same locality and 15 ft higher than GSC-150 (9180 ± 170, GSC III; Craig, 1964), was dated to check accuracy of dating bone (cf. Table 3, this list). Two determinations were made, and dates on bone collagen and shells (GSC-150) agree within limits of error:

collagen fraction, one 3-day count 8990 ± 140
 carbonate fraction, one 3-day count 4990 ± 130

GSC-319. Aston Bay, Somerset Island **9380 ± 180**
7430 B.C.

Fragments of marine pelecypod shells (*Mya truncata*) on ground surface of uppermost in series of beach ridges, alt 390 to 400 ft, mouth of Aston Bay, 8 mi S of Pressure Point, Somerset Island, Northwest Territories (73° 53' 30" N Lat, 95° 19' W Long). Coll. 1964 by D. I. Smith, Univ. of Bristol, Bristol, England; subm. by B. G. Craig. *Comment* (B.G.C.): site lies close to marine limit and date is probably close to time of ice withdrawal from area (cf. GSC-150, 9180 ± 170, GSC III; Craig, 1964). Sample mixed with dead gas for counting.

GSC-378. Markham Point, Bathurst Island **33,940 ± 1100**
32,830 B.C.

Marine pelecypod shells (*Hiatella* sp., *Mya* sp., and *Astarte* sp.) from ground surface less than 5 ft above highest visible raised beaches, ca. 3 mi N of Markham Point, Bathurst Island, Northwest Territories (75° 29.5' N Lat, 97° 49' W Long), at alt ca. 345 ft. Coll. 1964 by W. Blake, Jr. and J. G. Fyles. *Comment* (W.B., Jr.): date suggests that highest beach represents limit of postglacial marine action, and that higher shells probably have been emplaced by glacier ice moving across a bay and incorporating shells into till (cf. GSC-166, 25,000 ± 500; GSC-212, 35,900 ⁺¹⁴⁰⁰ ₋₁₂₀₀; GSC-223, >28,000; GSC IV). Sample mixed with dead gas for counting. Date based on one 3-day count.

GSC-401. 'Muskox River', Bathurst Island **4070 ± 140**
2120 B.C.

Organic material from 2 to 8 in.-thick layer whose top is at 6 to 12 in. depth, overlying till, and underlying alluvium (or possibly slope deposit) along S bank of unnamed stream 1.5 mi NW of its junction with 'Muskox River', Bathurst Island, Northwest Territories (75° 45' N Lat, 98° 32' W Long), at alt ca. 170 ft. Coll. 1963 by W. Blake, Jr. *Comment* (W.B., Jr.): organic material is believed to be in place, and presence of lemming droppings suggests that climate was similar to that existing today. Sometime in the last 4100 yr the organic debris has been

buried, but no evidence was seen to suggest that present-day surface vegetation is being buried in same way. NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

GSC-233. 'Dartmouth Bight', Bathurst Island **7820 ± 140**
5870 B.C.

Peat at 6.7 to 8.3 in. depth from hummock in depression near top of ridge, alt ca. 450 ft, 1.5 mi S of 'Dartmouth Bight' and 7 mi E of Bracebridge Inlet, Bathurst Island, Northwest Territories (75° 38.5' N Lat, 99° 20' W Long). Sample just above level at which peat was frozen in July 1963. Coll. 1963 by W. Blake, Jr. *Comment* (W.B., Jr.): age of sample suggests (1) that accumulation of organic material, which began ca. 9200 yr ago (GSC-180, GSC IV; Blake, 1964) ceased shortly after 7800 yr ago, perhaps because depression became filled, or (2) that any younger material has been removed from the surface. Two fractions were dated (cf. Table 3, GSC IV), and dates on the two fractions agree within limits of error:

soluble in NaOH	7820 ± 140
not dissolved in NaOH	7680 ± 140

Dundee Bight series, Bathurst Island

Marine pelecypod shells from two localities on E side of Dundee Bight, Bathurst Island, Northwest Territories. Coll. 1963 by W. Blake Jr.

GSC-386. Dundee Bight, east **9030 ± 150**
7080 B.C.

Shell fragments, mostly of *Hiatella arctica* and some of *Mya truncata*, from frost boils on shingle beach, E side of Dundee Bight (76° 0.5' N Lat, 99° 59' W Long), at alt ca. 390 ft.

GSC-387. Dundee Bight, southeast **8780 ± 160**
6830 B.C.

Shell fragments of *Hiatella arctica* and *Mya truncata* from surface of delta ca. 3 mi E of head of Dundee Bight (75° 58' N Lat, 99° 18' W Long) at alt ca. 300 ft. *General Comment* (W.B., Jr.): since both collections are close to marine limit in their respective areas, dates give approximate ages for highest beaches and minimum values for time of deglaciation. Dates are in accordance with a date of 9040 ± 170 yr (GSC-164, GSC IV; Blake, 1964) for shells at 320 ft in Stuart River valley to NE of Dundee Bight. Both samples mixed with dead gas for counting. Each date based on one 3-day count.

Tullett Point series, Prince Patrick Island

Bones and baleen of large (bowhead) whale on and in modern ice-push ridge at Tullett Point, Prince Patrick Island, Northwest Territories (76° 44' N Lat, 121° 10' W Long). Coll. 1964 by J. G. Fyles.

GSC-355. Tullett Point, baleen **1110 ± 130**
A.D. 840

Sample pretreatment includes *cold* NaOH-leach; date based on one 3-day count.

GSC-488. Tullett Point, whale ear **980 ± 140**
A.D. 970

Dense ear-bone ca. 4 in. across. Sample dated in two fractions:

collagen fraction	980 ± 140
carbonate fraction	840 ± 130

GSC-489. Tullett Point, whale limb **930 ± 130**
A.D. 1020

Porous 'long bone' from whale flipper. Sample dated in two fractions; carbonate fraction mixed with dead gas for counting:

collagen fraction	930 ± 130
carbonate fraction	480 ± 140

General Comment: samples were dated to check accuracy of dating bone (cf. Table 3, this list). Dates for collagen fraction of dense bone and porous bone agree with each other and with date for baleen, within limits of error. As expected, date from carbonate fraction of dense bone is much closer to collagen and baleen dates than is carbonate date for porous bone.

GSC-266. Ferguson Lake, Victoria Island **8640 ± 140**
6690 B.C.

Rib of large whale projecting from sand at alt 370 ft, ca. 200 ft below marine limit, 18 mi N of Ferguson Lake, Victoria Island, Northwest Territories (69° 38' N Lat, 104° 50' W Long; Fyles, 1963, Fig. 1). Coll. 1959 by J. G. Fyles. *Comment:* date for collagen fraction is reasonable relative to somewhat older dates for marine shells closer to marine limit in this region (GSC-255, 9540 ± 150; GSC-269, 9400 ± 150; both in GSC IV). Two determinations were made:

collagen fraction, one 3-day count	8640 ± 140
carbonate fraction, one 3-day count	3260 ± 130

GSC-367. Worth Point, Banks Island **>49,000**

Willow twigs from 6-ft bed of uncompressed moss peat at top of 100-ft coastal cliff at Worth Point, W coast of Banks Island, Northwest Territories (72° 15' N Lat, 125° 40' W Long). Peat is underlain in succession by till-like glacial or slope deposits and by interglacial pond silts. Because of uncompressed nature of dated peat bed it is inferred to post-date the latest glaciation of W part of Banks Island. Coll. 1959 by J. G. Fyles. *Comment:* date based on one 4-day count in 5-L counter at 4 atm, and supersedes earlier date of >38,000 for same sample (I(GSC)-26, Isotopes I).

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GIF-SUR-YVETTE NATURAL RADIOCARBON MEASUREMENTS I

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The following list shows the age measurements carried out from 1958 to March 1963 at the Radiocarbon Laboratory at Gif-sur-Yvette. This laboratory has been replaced by a new one whose first measurements are also given in this volume.

It was equipped with 2 proportional counters similar to those used in Saclay laboratory and operating with 1 atm of pure CO₂. These counters were shielded by 15 cm lead, 5 cm iron and 1.5 cm of mercury.

Data have been calculated on the basis of a C¹⁴ half-life of 5570 yr, in agreement with the decision of the Fifth Radiocarbon Dating Conference. As a modern carbon standard, wood taken from old furniture was used. This standard was found equivalent to 95% of the activity of the NBS oxalic acid, if a 2‰ Suess-effect is adopted for this wood.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Southern France

Perte du Cros series, Saillac, Lot

Burnt wheat from Hearth III at entrance of cave of Perte du Cros, Saillac, Lot (44° 20' N Lat, 1° 37' E Long). Coll. 1957 by A. Calan; subm. by J. Arnal, Treviers, Herault.

	4210 ± 150
Gsy-35 A. Perte du Cros	2260 B.C.

	4800 ± 130
Gsy-35 B. Perte du Cros	2850 B.C.

General Comment: associated with Middle Neolithic of Chasséen type (Galan 1958); Gsy-35 A may be contaminated. There are Heidelberg unpublished dates from this site.

Roucadour series, Lot

Burnt wheat from stratified Neolithic levels in Doline de Roucadour, Thémines, Lot (44° 50' N Lat, 1° 30' E Long). Coll. 1956 by A. Niederlender; subm. by Dr. J. Arnal (Coursaget *et al.*, 1960).

	5940 ± 150
Gsy-36 A. Roucadour A	3990 B.C.

From Early Neolithic level.

Gsy-36 B. Roucadour B **5190 ± 140**
3240 B.C.
 From Middle Neolithic B 1 level.

Gsy-36 C. Roucadour C **4280 ± 125**
2330 B.C.
 From Middle Neolithic B 2 level. *Comment:* somewhat contaminated.
General Comment: there are Heidelberg unpublished dates from this site.

Grotte de l'Eglise series, Var

Charcoal from Neolithic site at 60 m in interior of Grotte de l'Eglise, Baudinard, Var -Gorges du Verdon (43° 45' N Lat, 6° 15' E Long). Coll. 1959 and subm. by J. Courtin, Centre de la Recherche Scientifique, Marseille, France (Courtin, 1959).

Gsy-112 A. Grotte de l'Eglise, Layer 5 **4510 ± 125**
2560 B.C.
 Associated with end of Middle Neolithic (Chasséen) ceramics.

Gsy-112 B. Grotte de l'Eglise, Layer 9 **4825 ± 130**
2875 B.C.
 Associated with Middle Neolithic (Chasséen) ceramics.
General Comment: in good range of dates for meridional Chasséen Neolithic.

Gsy-77. Trou Arnaud, Drôme **4140 ± 135**
2190 B.C.
 Wheat and wood from cave called Trou Arnaud, Saint-Nazaire-le-Désert, Drôme (44° 34' N Lat, 5° 17' E Long), Coll. 1958 and subm. by A. Blanc, C.N.R.S. *Comment:* associated with ceramics and artifacts of Middle Neolithic Chasséen style. A somewhat older date would have been expected (Blanc, 1956).

Gsy-57. La Bouissière, Var **3975 ± 130**
2025 B.C.
 Patch of resin and charcoal, from under the under-paving in the megalithic cist of La Bouissière, Cabasse, Var (43° 25' N Lat, 6° 15' E Long). Coll. 1950 and subm. by G. Bérard, Direction de la Circonscription des Antiquités Préhistoriques, Draguignan, Var. *Comment:* agrees with grave goods of the tomb, of Late Neolithic or Chalcolithic appearance (Bérard, 1954).

Gsy-116. La Grotte Murée, Montpezat **3960 ± 175**
(Basses-Alpes, France) 2010 B.C.
 Charcoal from Layer 6 from sealed stratigraphy of la Grotte Murée (Courtin, 1962), Montpezat, Basses-Alpes -Gorges du Verdon (43° 45' N Lat, 6° 15' E Long). Coll. 1960 and subm. by J. Courtin. *Comment:* in very good agreement with associated campaniform beakers.

3930 \pm 150
1980 B.C.

Gsy-37. Les Côtes de Roquefort, Aveyron

Carbonized acorns from Chalcolithic ossuary in cave of Les Côtes de Roquefort, Saint-Romé de Cernon, Aveyron (44° 0' N Lat, 2° 55' E Long). Coll. 1947-1950 and subm. by L. Balsan, Direction de la Circonscription des Antiquités Préhistoriques de Clermont-Ferrand. *Comment:* dates nicely the Chalcolithic of the Grands Causses.

3890 \pm 150
1940 B.C.

Gsy-38. Aven du Gendarme, Aveyron

Charcoal from falling-in of *aven*-cave called the Aven du Gendarme, La Roque Sainte-Marguerite, Aveyron (44° 05' N Lat, 3° 10' E Long). Coll. 1959 and subm. by L. Balsan. *Comment:* agrees with ceramics of the Chalcolithic of the Grands Causses type.

3295 \pm 110
1345 B.C.

Gsy-120. Castello de Ceccia 3, Porto-Vecchio, Corsica

Charcoal from lower layer of archaeological filling of the torrean monument of Castello de Ceccia, Porto-Vecchio, Corsica (41° 35' N Lat, 9° 15' E Long). Coll. 1961 and subm. by R. Grosjean, C.N.R.S., Paris. *Comment:* this type of monument is of the series of Corsican *torre* most like the archaic nuraghi of Sardinia.

3150 \pm 150
1200 B.C.

Gsy-58. Filitosa, Corsica

Charcoal from hearth in Cella I of a circular torrean monument of the complex site of Filitosa, Sollacaro, Corsica (41° 45' N Lat, 8° 0' E Long). Coll. 1959 and subm. by R. Grosjean. *Comment:* comparable to other dates of Corsican *torre* (Grosjean, 1961).

Tappa series, Corsica

Charcoal from interior of circular torrean monument (Grosjean, 1962), Tappa, Porto-Vecchio, Corsica (41° 35' N Lat, 9° 15' E Long). Coll. 1960 and subm. by R. Grosjean.

2630 \pm 200
680 B.C.

Gsy-94 A. Tappa I
Last occupation of the monument.

3865 \pm 125
1915 B.C.

Gsy-94 B. Tappa II

Sample from near foundations of the monument. Probably dates an occupation preceding the monument.
General Comment: to be compared with the other dates of Corsican *torre*.

Malpas series

Charcoal from the Oppidum of Malpas, Soyons, Ardèche (44° 50' N Lat, 4° 45' E Long). Coll. and subm. by A. Blanc.

Gsy-141. Malpas, Level 2	2060 ± 105 110 B.C.
Gsy-142. Malpas, Level 4	2230 ± 105 280 B.C.
Gsy-143. Malpas, Level 6	2470 ± 105 520 B.C.
Gsy-144. Malpas, Level 7	2580 ± 110 630 B.C.

General Comment: a site with occupation during whole Iron age.

Abri du Facteur series, Tursac, Dordogne

Charred bone from hearths from the Abri du Facteur, Tursac, Dordogne (45° 0' N Lat, 1° 5' E Long) (Delporte, 1962). Coll. 1957-1959 and subm. by H. Delporte, C.N.R.S., 19 Avenue de la Libération, Montbrison, Loire.

Gsy-67. Abri du Facteur G 1 + 2	27,890 ± 2000 25,940 B.C.
Layer G, with Aurignacian I industry.	

Gsy-69. Abri du Facteur B 1 3 + 4	23,180 ± 1500 21,230 B.C.
Layer B 1, with Upper Perigordian industry.	

General Comment: date Gsy-69 corresponds to layer containing a Venus; date Gsy-67 may be younger than expected.

B. North, East, Central France

Gsy-39. La Brèche au Diable, Calvados	4790 ± 150 2840 B.C.
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Charcoal from Neolithic hearth (No. 2), situated inside rampart of promontory-camp of La Brèche au Diable, Mont-Joly, Soumont-Saint-Quentin, Calvados (48° 55' N Lat, 0° 5' W Long). Coll. 1954 and subm. by B. Edeine, C.N.R.S., Caen. *Comment:* fits with the ceramics, of Chasséen type (Edeine, 1960).

Gsy-97. Fort-Harrouard, Eure et Loir	4400 ± 125 2450 B.C.
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Charcoal from Level I, Hearths 128 and 133, from site of Fort-Harrouard, Sorel-Moussel, Eure-et-Loir (48° 45' N Lat, 1° 25' E Long). Coll. about 1930 by Abbé J. Philippe and subm. by G. Bailloud, C.N.R.S., Paris. *Comment:* dates the Middle Neolithic level, of Chasséen affinities, of this celebrated settlement (Bailloud, 1964).

Gsy-32. Les Matignons, Charente	4570 ± 200 2620 B.C.
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Charcoal from Level C 3 of the filling of the interior ditch of Neolithic camp of Les Matignons (Burnez *et al.*, 1958), Juillac-le-Coq, Charente (45° 40' N Lat, 0° 15' W Long). Coll. 1958 and subm. by C. Burnez,

41 rue de Bellefonds, Cognac, Charente. *Comment*: dates end of Chasséen utilization of the site.

4470 \pm 200

Gsy-49. Montagne de Lumbres, Pas de Calais

2520 B.C.

Charcoal from Layer B of Neolithic habitation site of La Montagne de Lumbres, Lumbres, Pas-de-Calais (50° 40' N Lat, 2° 15' E Long). Coll. 1958 and subm. by Dom R. Prévost, St. Omer, Pas-de-Calais. *Comment*: date agrees with Chasséen Middle Neolithic ceramics and industry (Prévost, 1962).

4435 \pm 200

Gsy-71. Biard, Charente

2485 B.C.

Charcoal from bottom of the filling of the ditch of Neolithic camp of Biard, Segonzac, Charente (45° 40' N Lat, 0° 15' W Long). Coll. 1959 and subm. by C. Burnez. *Comment*: this camp belongs to the Peu-Richard culture.

3750 \pm 150

Gsy-114. Les Mournouards II, Marne

1800 B.C.

Charcoal from artificial sepulchral cave, Les Mournouards, Le Mesnil-sur-Oger, Marne (48° 50' N Lat, 4° 0' E Long). Coll. 1960 and subm. by A. Leroi-Gourhan, Faculté des Lettres, Paris. *Comment*: associated with Late Neolithic industry of Seine-Oise-Marne culture (Leroi-Gourhan, 1962).

3320 \pm 110

Gsy-91. Cys-la-Commune, Aisne

1370 B.C.

Charcoal from a sort of "henge-monument" with concentric circles, inner ditch, on a terrace on the river Aisne (Jouillié, 1962), Cys-la-Commune, Aisne (49° 25' N Lat, 3° 35' E Long). Coll. 1960 and subm. by H. Jouillié, 3, rue du Docteur Brocard, Vailly-sur-Aisne. *Comment*: Middle Bronze age.

2930 \pm 250

Gsy-110. Videlles, Locus 5, Seine-et-Oise

980 B.C.

Charcoal from settlement of les Roches (Bailloud, 1958), Videlles, Seine-et-Oise (48° 25' N Lat. 2° 30' E Long). Coll. and subm. by G. Bailloud. *Comment*: sample was expected to come from a Late Neolithic level, but it appears to correspond to Middle and Late Bronze age material above it.

3215 \pm 150

Gsy-85. Cronenbourg, Bas-Rhin

1265 B.C.

Carbonized apples and wood from a potter's kiln, in an underground excavation, Cronenbourg, Strasbourg, Bas-Rhin (48° 35' N Lat, 7° 45' E Long). Coll. 1959 and subm. by J. J. Hatt, Faculté des Lettres, Strasbourg. *Comment*: the ceramics from the potter's kiln correspond to Late Bronze age II of E France, expected age between 1050 and 950 B.C.

Gsy-62. La Viaube, Vienne **3075 ± 175**
1125 B.C.

Charcoal, from Middle Bronze Age settlement, La Viaube, Jaunay-Clan, Vienne (46° 40' N Lat, 0° 20' E Long) (Coursaget *et al.*, 1961). Coll. 1948 and subm. by M. Taillet, Massy-Verrières, Seine-et-Oise. *Comment*: in good agreement.

Gsy-84. Charmodot, Côte-d'Or **2510 ± 100**
560 B.C.

Charcoal from hearth in a barrow at Charmodot, Villecomte, Côte-d'Or (47° 20' N Lat, 5° 07' E Long). Coll. 1960 and subm. by R. Ratel, 8 Bd. Thiers, Dijon, Côte-d'Or. *Comment*: this barrow contains sepulchres between the Late Bronze age and early La Tène period; its internal structures are very complex (Ratel, 1965).

Gsy-113. Royat, Puy-de-Dôme **2110 ± 100**
160 B.C.

Carbonized wood from ruins of a burnt building, on S side of Puy Chateix, Royat, Puy-de-Dôme (45° 45' N Lat, 3° 05' E Long). Coll. 1961 and subm. by P. Fournier, Director of Historic Antiquities, Clermont-Ferrand. *Comment*: no archaeological clue to date of building.

Gsy-117. La Bellière, Maine-et-Loire **1760 ± 95**
A.D. 190

Wood from a tank, Gallo-Roman mines of La Bellière, Saint-Pierre-Montlimart, Maine-et-Loire (47° 15' N Lat, 1° 0' W Long). Coll. 1900 by A. Poilane; subm. by A. Champigneulle, 9 R. d'Anjou, Leste, Maine-et-Loire. *Comment*: in good agreement (Giot, 1963).

Gsy-60. Gorges, Manche **1500 ± 100**
A.D. 450

Wood from a dug-out canoe, found at depth of 2.10 m to 2.40 m in peat-bog of Gorges, in Carentan marsh, Manche (49° 20' N Lat, 1° 15' W Long). (Coll. 1956 and subm. by H. Elhai, Mus. Natl. d'Histoire Naturelle, Paris. *Comment*: dug-out appears to be late Gallo-Roman or Dark-age.

Gsy-48. La Garnache, Vendée **970 ± 100**
A.D. 980

Charcoal from fire in central pit of a feudal motte, La Garnache, Vendée (46° 50' N Lat, 1° 45' W Long). Coll. 1959 and subm. by F. Eygun and P. R. Giot, Laboratoire d'Anthropologie Préhistorique Rennes (Ille-et-Vilaine). *Comment*: in the expected range of dating.

Gsy-41. Alençon, Orne **850 ± 100**
A.D. 1100

Wood from medieval fortification from Alençon, Orne (48° 25' N Lat, 0° 5' E Long). Subm. 1958 by du Mesnil du Buisson, 63, rue de Varenne, Paris.

- 575 \pm 95**
- Gsy-45. Richemont, Charente** **A.D. 1375**
 Charcoal from souterrains of a castle built during 11th century, and sacked in 1179, Richemont, Charente ($45^{\circ} 40'$ N Lat, $0^{\circ} 20'$ W Long). Coll. 1958 by Abbé J. Boucherit; subm. 1959 by J. Hennessy, Ecole Polytechnique, Paris. *Comment:* agrees with numerous sherds of 13th and 14th century found in these souterrains, possibly used for potter's workshop after destruction of castle.

- 11,230 \pm 500**
- Gsy-34. La Garenne, Indre** **9280 B.C.**
 Charcoal cinders and charred bone from a lower hearth from Magdalenian site of La Garenne (Allain, 1961), Saint-Marcel, Indre ($46^{\circ} 34'$ N Lat, $1^{\circ} 30'$ E Long). Coll. 1953 and subm. 1959 by J. Allain, 15 Bd. Gambetta, Bourges, Cher. *Comment:* this hearth was stratigraphically between those dated L 399 D and C577-578-579.

C. Western France: Brittany

- 5195 \pm 300**
- Gsy-64. Ile Bono, Côtes du Nord** **3245 B.C.**
 Charcoal from bottom of chamber of a ruined passage grave, Ile Bono, Les Sept-Iles, Perros-Guirec, Côtes-du-Nord ($48^{\circ} 50'$ N Lat, $3^{\circ} 30'$ W Long). Coll. and subm. 1959 by P. R. Giot. *Comment:* one of oldest passage graves with Middle Neolithic ceramics.

Curnic series I, Guissény, Finistère

Charcoal from submerged Neolithic settlement site on beach of Curic, Guissény, Finistère ($48^{\circ} 35'$ N Lat, $4^{\circ} 25'$ W Long). Coll. and subm. 1959 by P. R. Giot.

- 4600 \pm 200**
- Gsy-47 A. Curnic** **2650 B.C.**
 Charcoal disseminated in the old ground and coll. in 1959.

- 5980 \pm 150**
- Gsy-47 B. Curnic** **4030 B.C.**
 Charcoal from a single hearth, coll. in 1960.

General Comment: the settlement site contains ceramics and implements from the Middle and possibly early Late Neolithic. Date GRN-1966, 5340 ± 60 (Groningen IV), and date Gsy-47 A span the evidence of the artifacts. Date Gsy-47 B is a hint to the presence of Early Neolithic populations on this coast.

Mané-Miguel series, Carnac, Morbihan

Charcoal from small cists in interior of huge mound of Mané-Miguel (Mont-Saint-Michel), Carnac, Morbihan ($47^{\circ} 35'$ N Lat, $3^{\circ} 05'$ W Long). Coll. 1900-1906 by Z. Le Rouzic; subm. by P. R. Giot.

Gsy-89. Mané-Miguel Y **4980 ± 150**
3030 B.C.

Gsy-90. Mané-Miguel Z **8800 ± 300**
6850 B.C.

General Comment: Gsy-89 corresponds to beginning of Middle Neolithic, and goes well with present ideas about date of large mounds of the Carnac group. But Gsy-90 is very extraordinary, and can only be explained by the use of sub-fossil wood from a peat-bog for some ritual fire.

Compare with date Sa-96 from central funeral vault of same monument, a date rather older than could be expected: 5840 ± 300 (Saclay I).

Gsy-56. Le Restudo, Côtes-du-Nord **4830 ± 150**
2880 B.C.

Cinders and charcoal from a layer, covered by 1.20 m of earth, near chapel of Restudo, Saint-Pever, Côtes-du-Nord ($48^{\circ} 25' N$ Lat, $3^{\circ} 5' W$ Long). Coll. and subm. 1959 by P. R. Giot. *Comment:* shows site to be a Neolithic habitation place.

Gsy-111. Kerléven, Finistère **4825 ± 125**
2875 B.C.

Charcoal from chamber of a passage-grave with compartmented chamber, at Saint-Laurent, Kerléven, La Forêt-Fouesnant, Finistère ($47^{\circ} 55' N$ Lat, $3^{\circ} 55' W$ Long). Coll. and subm. 1961 by J. L'Helgouach, Laboratoire d'Anthropologie, Rennes. *Comment:* associated with Middle Neolithic ceramics, in good agreement with other dates for passage graves (L'Helgouach, 1965).

Gsy-88. Mané-Kernaplaye, Morbihan **4585 ± 200**
2635 B.C.

Charcoal from passage grave of Mané-Kernaplaye, Saint-Philibert, Morbihan ($47^{\circ} 35' N$ Lat, $3^{\circ} 05' W$ Long). Coll. 1938 by Z. Le Rouzic; subm. 1960 by P. R. Giot. *Comment:* these collective tombs having being in use during long periods of the Neolithic, it is always the oldest date which gives the nearest approximation for the construction (Giot, 1962).

Gsy-31. Cojoux, Ille-et-Vilaine **4270 ± 120**
2320 B.C.

Charcoal from a Late Neolithic long barrow, La Croix-Saint-Pierre, Grée de Cojoux, Saint-Just, Ille-et-Vilaine ($47^{\circ} 40' N$ Lat, $2^{\circ} 0' W$ Long). Coll. 1953-1954 and subm. by P. R. Giot, 1958. *Comment:* agreement with the grave goods.

Gsy-73. Kerméné, Morbihan **4030 ± 110**
2080 B.C.

Charcoal from a Late Neolithic barrow, Kermené, Guidel, Morbihan ($47^{\circ} 45' N$ Lat, $3^{\circ} 30' W$ Long). Coll. 1958 and subm. 1960 by P. R. Giot. *Comment:* associated with Late Neolithic ceramics and artifacts, and fragments of a broken statue menhir.

Curnic series II, Guissény, Finistère

Charcoal from hearths in pits corresponding to a Late Bronze age salt-pan industry, submerged site on the beach of Curnic, Guissény, Finistère (48° 35' N Lat, 4° 25' W Long). Coll. and subm. 1962 by P. R. Giot.

3220 ± 110

Gsy-47 C. Curnic **1270 B.C.**

W pit.

Poulguen series, Finistère

Wood and charcoal from T-shaped passage grave, under a barrow, of Poulguen, Penmarc'h, Finistère (47° 45' N Lat, 4° 20' W Long). Coll. by A. du Châtellier, 1862, and A. Martin and P. du Châtellier, 1902; subm. 1959 by P. R. Giot.

1460 ± 105

Gsy-55 A. Poulguen 1902 **A.D. 490**

Charcoal from a secondary use of the tomb. *Comment:* site has given some Gallo-Roman material.

3560 ± 120

Gsy-55 B. Poulguen 1862 **1610 B.C.**

Wood from a sort of flooring.

General Comment: agrees with a very late Neolithic (Secondary Neolithic) dating of this special monument (Giot, 1961).

3295 ± 150

Gsy-86. Kervellerin, Morbihan **1345 B.C.**

Charcoal from Middle Bronze Age barrow, Kervellerin, Cléguer, Morbihan (47° 50' N Lat, 3° 20' W Long). Coll. and subm. 1960 by P. R. Giot. *Comment:* date A comes from charcoal found in the funeral vault itself; date B from charcoal disseminated in earth of the barrow.

2520 ± 110

Gsy-42. Saint-Bugan, Côtes-du-Nord **570 B.C.**

Charcoal from hearth next to a hoard of 800 socketed axes of Late Bronze age, Saint-Bugan, Loudéac, Côtes-du-Nord (48° 10' N Lat, 2° 45' W Long). Coll. and subm. 1959 by P. R. Giot. *Comment:* good proof that Late Bronze age armorican socketed axes are contemporary with Early Iron age elsewhere.

Grée de Carate series, Morbihan

Charcoal from small barrows on Grée de Carate, Pluherlin, Morbihan (47° 40' N Lat, 2° 20' W Long) (Giot, 1960). Coll. 1957-1958 by A. Lepart; subm. 1958 by P. R. Giot.

Gsy-33. Grée de Carate No. 9 **2460 ± 150**
510 B.C.

Gsy-46. Grée de Carate No. 15 **2540 ± 150**
590 B.C.

General Comment: confirms that these barrows are Late Bronze age and Early Iron Age. To be compared with date GRN-1973, 2650 ± 60 (Groningen IV).

Gsy-107. Kervernier, Côtes-du-Nord **2635 ± 175**
685 B.C.

Charcoal from artificial souterrain of the Iron age, Kervernier, Pluzunet, Côtes-du-Nord (48° 35' N Lat, 3° 20' W Long). Coll. 1960 by J. R. Geoffroy; subm. 1961 by P. R. Giot. *Comment:* several hundred years older than expected.

Gsy-63. Kervénarc'hant, Finistère **2565 ± 150**
615 B.C.

Charcoal from an Iron age souterrain, Kervénarc'hant, Pleyber-Christ, Finistère (48° 25' N Lat, 3° 55' W Long). Coll. and subm. 1959 by P. R. Giot. *Comment:* a few centuries older than expected.

Gsy-87. Kerlescan, Morbihan **2360 ± 110**
400 B.C.

Carbonized acorns from the long barrow at Kerlescan Carnac, Morbihan (47° 35' N Lat, 3° 05' W Long). Coll. 1942 by M. Jacq; subm. 1960 by P. R. Giot. *Comment:* a Neolithic date was expected.

Barnenez series, Finistère

From the reutilization of the different passage-graves of the great cairn or Barnenez, Plouézoch, Finistère (48° 40' N Lat, 3° 51' W Long). Coll. 1955-1956 and subm. 1962 by P. R. Giot.

Gsy-30. Barnenez E **2200 ± 200**
250 B.C.
Burnt grains and plants.

Gsy-147. Barnenez C **2690 ± 105**
740 B.C.
Charcoal.

General Comment: large collective tombs such as the 11 passage graves of the cairn of Barnenez have been revisited at various times.

D. Asia

Ras-Shamra series, Syria

Charcoal from monuments of Ras Shamra, North Syria (35° 37' N Lat, 35° 48' E Long). Coll. 1958, 1960 and subm. 1961 by C. F. A. Schaeffer, College de France, Paris.

Gsy-102. Ras Shamra 60 No. 7 **9030 ± 400**
7080 B.C.

From old Neolithic level, probing of the Temple of Baal, topographic point 125, depth 12.15 m. *Comment*: 1000 yr older than expected from P-459 and P-458 V (Pennsylvania VI).

Gsy-104. Ras Shamra 58 No. 11 **3070 ± 200**
1120 B.C.

From Late Bronze age III level, dromos of Tomb I, S small palace of Ugarit. *Comment*: agrees with P-462.

Mundigak series, Afghanistan

Charcoal from site of Mundigak (Casal, 1961), near Kandahar, Afghanistan (32° 30' N Lat, 65° 30' E Long). Coll. 1956-1958 and subm. 1959 by J. M. Casal, C.N.R.S., Paris.

Gsy-50. Mundigak CCCXXIV **3945 ± 150**
1995 B.C.

Period I, Layer 5 (Neolithic).

Gsy-51. Mundigak CCIV **2995 ± 110**
1045 B.C.

Period III, Layer I.

Gsy-52. Mundigak CCCII **3480 ± 115**
1530 B.C.

Period II, Layer 1.

Gsy-53. Mundigak CXXXII **4185 ± 150**
2235 B.C.

Period III, Layer 5.

General Comment: there are numerous difficulties in this sequence of dates.

Enkomi-Alasia series, Cyprus

Charcoal from site Enkomi-Alasia, near Famagouste, Cyprus (35° 07' N Lat, 33° 57' E Long. Coll. 1959-1960 and subm. 1961 by C. F. A. Schaeffer.

Gsy-105. Enkomi 59 No. 13 **2850 ± 200**
900 B.C.

From topographical point 239, depth 2 m, extreme end of Late Bronze age, Late Cypriot III ("close style" of the Mycenaean chronology). *Comment*: younger than expected.

Gsy-106. Enkomi 60 No. 14 **3280 ± 110**
1330 B.C.

From topographic point 512, Z.74, depth 1.20 m, Cypriot Iron age I (corresponding to Mycenaean III C 1/2). *Comment*: slightly older than expected.

General Comment: samples 105 and 106 appear to have been inverted.

*E. Africa***Tchad series, Africa**

Charcoal from habitation mounds in Chari delta, 17 km N of Fort-Lamy, Tchad (12° 30' N Lat, 15° E Long). Coll. and subm. 1960 by J. P. Lebeuf, C.N.R.S., Paris.

Gsy-92. Maguira, Tchad, No. 148 **250 ± 90**
A.D. 1700

Gsy-93. Mdaga, Tchad, No. 69 **165 ± 100**
A.D. 1785

Gsy-109. Tedgaoust No. 2, Mauritania **145 ± 100**
A.D. 1805

Charcoal from Tedgaoust, Pit 1 bis, Mauritania (17° N Lat, 12° W Long). Coll. and subm. by J. Devisse, 1961, Faculté des Lettres, Dakar, Sénégal. *Comment:* result identical to Sa-219: 150 ± 100 (Saclay I).

*F. South and Central America***Sambaqui series, Paraña, Brasil**

Charcoal from sambaqui kitchen-middens, Paraña, Brasil. Coll. 1958 and subm. 1960 by A. Laming-Emperaire, Faculté des Lettres, Paris.

Gsy-79. Sambaqui Guaraguassu, Paraña **4220 ± 200**
2070 B.C.

Gsy-78. Sambaqui José Viéra VIII **6685 ± 175**
4735 B.C.

Gsy-82. Sambaqui José Viéra VI **3435 ± 175**
1485 B.C.

Gsy-80. Sambaqui José Viéra IV **5240 ± 150**
3290 B.C.

Gsy-81. Sambaqui José Viéra II **1380 ± 150**
A.D. 570

Gsy-61. Mixco Viejo, Gautemala **825 ± 150**
A.D. 1125

Charcoal from bottom of a wall, near and under Structure A 9, ruins of Mixco Viejo, Guatemala (14° 38' N Lat, 90° 22' W Long). Coll. 1957 and subm. 1959 by H. Lehmann, Musée de l'Homme, Paris.

Gsy-100. Ortega 3/L6, Costa Rica **2195 ± 130**
245 B.C.

Charcoal from hearth in site of Ortega, Guanacaste province, Costa Rica (31° 20' N Lat, 112° 40' W Long). Coll. 1960 and subm. 1961 by C. Baudez, C.N.R.S., Paris. *Comment:* corresponds to the expected age.

La Bocana series, Costa Rica

Charcoal from cave of La Bocana, Guanacaste province, Costa Rica (31° 20' N Lat, 112° 40' W Long). Coll. 1960 and subm. by C. Baudez.

Gsy-98. La Bocana 1/G1 **515 ± 150**
A.D. 1435

Gsy-99. La Bocana 1/M3 **1005 ± 90**
A.D. 945

General Comment: somewhat later than expected.

Gsy-74. Chillon Valley, Peru **3275 ± 175**
1325 B.C.

Human bones from basis of a scree, in Chillon Valley, Central Peru (11° 50' S Lat, 76° 37' W Long). Coll. 1958 and subm. 1960 by O. Dollfus, French Embassy, Lima, Peru.

II. GEOLOGIC SAMPLES—FRANCE

Gsy-95. La Motte d'Aveillans, Isère **>30,000**

Fossil wood of *Picea* from interglacial clay of La Motte d'Aveillans, near La Mure, Isère (44° 55' N Lat, 5° 45' E Long). Coll. and subm. 1960 by L. Moret, Faculté des Sciences, Grenoble.

Gsy-135. Appeville 2, Cotentin **6950 ± 170**
5000 B.C.

Peat from 3.05 to 3.10 m in sub-littoral peat-bog of Carentan, at Appeville, Manche (49° 20' N Lat, 1° 15' W Long). Coll. and subm. 1961 by H. Elhaï. *Comment:* on palynological evidence corresponds to Sub-boreal phase, but date agrees with Atlantic phase (Elhaï, 1963).

Gsy-75. Brignogan, Finistère **4980 ± 120**
3030 B.C.

Peat from submerged peat bog on beach of Chardons Bleus, Brignogan, Finistère (48° 42' N Lat, 4° 40' W Long). Coll. and subm. 1960 by M. T. Kerfourn, Inst. de Géologie, Rennes, who has studied it palynologically (Kerfourn, 1960). *Comment:* Zone VII of Atlantic period in good agreement.

Gsy-59. Lingreville, Manche **1435 ± 200**
A.D. 515

Peaty mud from Level C No. 43 of submerged bog of Lingreville, Manche (48° 55' N Lat, 1° 35' W Long). Coll. 1958 and 1959 by H. Elhaï, Rouen. *Comment:* younger than expected, as level is covered by a layer with Gallo-Roman pottery of the 1st century A.D.

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GEOCHRON LABORATORIES, INC. RADIOCARBON MEASUREMENTS II

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INTRODUCTION

The following list presents dates on a small fraction of the total number of measurements made during 1964 and 1965 as well as data on some samples previously dated but not published. Results not appearing have not been released by our clients.

Procedures of analysis are essentially unchanged from those reported previously (Geochron I). Additional counting equipment identical to that previously described has been installed during the past year. Details of the apparatus and procedure for separating collagen from the bone samples may be found in Krueger (in press).

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Eastern United States

GX-16. Waterville, Maine shells	12,770 \pm 320
	10,820 B.C.
	12,210 \pm 290
	10,260 B.C.

Duplicate of above

Shells of *Hiatella arctica*, from pit on Drummond Ave., Waterville, Maine (44° 34' N Lat, 69° 38' W Long). Found in shelly till. Coll. 1957 and subm. by C. A. Kaye, U.S.G.S., Boston, Mass. *Comment* (C.A.K.): shells from the same lot dated previously at 12,450 \pm 250 (L-677, unpub.), intermediate between the two new measurements (see also W-737, USGS V; W-947, W-1011, USGS VII; GSC-89, GSC-101, GSC-102, GSC II).

GX-17. West Lynn, Mass. shells	13,230 \pm 320
	11,370 B.C.

Plates of barnacle *Balanus hameri* (Ascanius) from Blakely clay pit, West Lynn, Massachusetts (42° 38' N Lat, 69° 59' W Long). Embedded in blue-gray clay (see Kaye and Barghoorn, 1964, p. 75 for details). Coll. 1957 and subm. by C. A. Kaye. *Comment* (C.A.K.): sample is part of that reported as Sample L by Kaye and Barghoorn (1964) and dated at 14,250 \pm 250 (W-735) and at 13,800 \pm 300 (L-598A). New date is compatible with latter but not former. Shells differing in age by several hundred years may have been present in original whole sample.

Madison County, New York series

Peat cores, SW Madison Co., New York (42° 40' 30" N Lat, 75° 50' W Long). From swamp in narrow through valley, gradational from basal

calcareous silty clay to overlying silty peat. Coll. 1964 and subm. by C. D. Holmes, Tulley, New York.

**GX-205. Peat, depth 8'9" to 9'3" 10,415 ± 145
8465 B.C.**

**GX-206. Peat, depth 12'6" to 13'6" 10,930 ± 150
8980 B.C.**

Comment (C.D.H.): pollen evidence for this locality suggests a cooler interval following an early postglacial warming trend. Dates are early postglacial for this locality.

Chesapeake Bay oyster beds series

Shells of oyster *Crassostrea virginica* dredged from Chesapeake Bay localities as part of a study of the development of oyster biostromes. Coll. 1964 and subm. by R. B. Biggs, Chesapeake Biological Lab., Solomons, Maryland.

**GX-424. 2010 ± 105
60 B.C.**

Chesapeake Bay, Tangier Sound, S of Sharkfin Shoal light (38° 11' 30" N Lat., 75° 57' 40" W Long). Composite from 23 to 27 ft below MSL, water depth 19 ft.

**GX-425. 1845 ± 115
105 B.C.**

From Choptank R. off town of Oxford (38° 40' 12" N Lat, 76° 13' 03" W Long). Composite from 20 to 24 ft below MSL, water depth 16 ft.

**GX-426. 2090 ± 110
140 B.C.**

Chesapeake Bay, 1 mi N of Baltimore Light Station (39° 04' 17" N Lat, 76° 24' 32" W Long). Composite from 24 to 29 ft below MSL, water depth 14 ft.

**GX-427. 545 ± 90
A.D. 1045**

Chesapeake Bay 1 mi E of Hart Island (39° 13' 17" N Lat, 76° 22' 24" W Long). Composite from 17.5 to 21 ft below MSL, water depth 14 ft.

**GX-428. 285 ± 155
A.D. 1665**

From mouth of Manokin R., Tangier Sound (38° 02' 35" N Lat, 75° 55' 15" W Long). Composite from 20 to 25 ft below MSL, water depth 15 ft. *Comment* (H.W.K.): these large composite samples were cleaned, crushed, and mixed and an aliquot was taken for roasting at 500°C in oxygen.

**GX-459. Reef algae 19,200 ± 650
17,250 B.C.**

Reef algae *Lithothamnion* from a protuberance (reef) on the continental shelf off North Carolina (33° 40' N Lat, 76° 40' W Long). Coll.

1965 by R. J. Menzies; subm. by O. H. Pilkey, Duke Univ., Durham, North Carolina. *Comment* (O.H.P.): it is possible that sample may have been contaminated with small amounts of living *Lithothamnion*.

1365 ± 90

GX-331. Florida Bay core

A.D. 585

Recent carbonate mud from a core in Florida Bay, Crossbank, 6 km W of Tavernier (25° 00' 42" N Lat, 80° 35' 12" W Long). Lowest layer in a 1.55 m core. Coll. 1964 and subm. by G. Müller, Min.-Pet. Inst., Heidelberg, Germany. *Comment* (G.M.): date will be used in a study of the mineralogy and petrology of the core.

B. Minnesota

Lake Agassiz Peatlands series

Peat samples from a bog in Lake Agassiz Peatlands Natural Area, NE¼, Sec. 2, T64N, R25W, Koochiching Co., Minnesota (48° 05' N Lat, 93° 30' W Long). Coll. 1964 and 1965 and subm. by M. L. Heinselmann, Lake States Forest Experiment Station, Grand Rapids, Minnesota.

3160 ± 75

GX-429. Sphagnum peat, 4.30 m

1210 B.C.

Base of upper sphagnum peat layer, 4.30 m beneath top of raised bog. *Comment* (M.L.H.): should date initiation of raised bog development in this peatland.

10,310 ± 260

GX-498. Decomposed peat, 7.60 m

8360 B.C.

Decomposed peat from the first largely organic layer above substratum, depth of 7.60 m beneath top of raised bog. *Comment* (M.L.H.): should date beginnings of peat formation in this portion of peatland and establish that Lake Agassiz had abandoned this site by ca. 10,310 B.P. or earlier.

C. Alaska

Central Alaska series

Samples from various sites in Central and South Central Alaska coll. 1957 to 1964 and subm. by T. L. Péwé, Arizona State Univ., Tempe, Arizona (unless noted otherwise). Page references are to Péwé (1965).

10,565 ± 225

GX-249. Pingo peat

8615 B.C.

Pingo peat from along Denali highway at mile 40.8, Alaska (63° 2' N Lat. 147° 30' W Long). Taken at base of unparched peat layer in contact with underlying pure ice and ice-rich silt (see p. 91). *Comment* (T.L.P.): date is a minimum age for withdrawal of Donnelly glaciation on S side of Alaska range in this area.

GX-250. Chatanika Cut, 8 m **14,760 ± 850**
12,910 B.C.

Rodent's nest (*Citellus undulatus*) from bank of Chatanika R. ¼ mi N of Elliott highway crossing, Alaska (65° 5' N Lat, 147° 45' W Long). From 8 m below surface in Wisconsin organic silt. *Comment* (T.L.P.): dates a ground squirrel living in thawed layer above frozen ground (see p. 34).

GX-251. Chatanika Cut, 5 m **8530 ± 115**
6580 B.C.

Wood twigs from same locality as GX-250, depth 5 m below surface in lower part of retransported, perennially frozen silt of post-Wisconsin age (see p. 34). *Comment* (T.L.P.): oldest date received for post-Wisconsin frozen silt overlying Wisconsin permafrost.

GX-252. Ready Bullion Creek, 20 m **>38,000**

Root fragments from Ready Bullion Creek, Alaska (64° 51' N Lat, 148° 01' W Long). Found 20 m below surface in retransported, perennially frozen silt of Wisconsin age (see p. 23). *Comment* (T.L.P.): provides minimum date of lower Wisconsin sediments in Ready Bullion Creek.

GX-253. Ready Bullion Creek, 8 m **14,300 ± 1200**
12,350 B.C.

Organic fragments in silt from same site as GX-252, depth 8 m below surface in Wisconsin silt (see p. 23). *Comment* (T.L.P.): occurred in upper part of Wisconsin sediments.

GX-254. Fowler Road Pit **2565 ± 295**
615 B.C.

Charcoal from Fowler Road pit, ¼ mi from junction with Richardson highway, milepost 296.7, Alaska (64° 15' N Lat, 146° 02' W Long). From 2 m below surface in Wisconsin-to-recent loess (see Fig. 4-22). *Comment* (T.L.P.): upper loess layers are younger than heretofore thought at this locality. Older loess could have been washed off the hill.

GX-255. Shaw Creek Flats **8040 ± 190**
6090 B.C.

Charcoal from Tanana R. bank at Shaw Creek Flats, Alaska (64° 15' N Lat, 145° 59' W Long). Found in loess at depth of 1.2 m (see p. 53). *Comment* (T.L.P.): gives minimum age of the underlying Wisconsin sand dunes adjacent to Tanana R. Loess is post-Wisconsin in age.

GX-257. Banner Creek **3920 ± 75**
1790 B.C.

Wood from log along Banner Creek, 220 ft downstream from Richardson highway crossing, Alaska (64° 15' N Lat, 146° 25' W Long). In Banner Creek Gravels at depth of 1.2 m (see p. 45). Coll. by M. Blackwell. *Comment* (T.L.P.): dates upper part of Banner Creek gravel.

GX-277. Canyon Creek**3005 ± 75****1055 B.C.**

Wood from mouth of Canyon Creek at mile 300 on the Richardson highway, Alaska (64° 15' N Lat, 146° 25' W Long). From 17 ft below surface at base of a silt layer and on top of gravel layer (see p. 44-45). Coll. by M. Blackwell. *Comment* (T.L.P.): minimum date on lower terrace of Tanana R. near Fairbanks.

GX-360. Engineer Creek Mammoth site**>39,000**

Wood from mining cut near junction of Engineer Creek and Steese highway, Alaska. Thought to be in silt of Wisconsin age (see p. 9). Coll. by R. D. Guthrie.

*D. Canada***GX-73. Sable Island, N.S. shells****1430 ± 125****A.D. 520**

Scallop shells (*Aequipecten irradians sablensis* Clarke) from beach of Sable Is., Nova Scotia (44° N Lat, 60° W Long). Coll. 1962 by F. Andrewsckuk; subm. by A. H. Clark, Jr., Natl. Mus. of Canada, Ottawa, Ontario. *Comment* (A.H.C.): date is on an extinct subspecies of scallop.

GX-201. Hemlock Park, Ont., horse bone, collagen**815 ± 110****A.D. 1135****310 ± 115****Same, carbonate****A.D. 1640**

Horse bone, unaltered in appearance, from gravel pit near Hemlock Park, Farm, Ontario (44° 18' 40" N Lat, 76° 28' 20" W Long). Apparently in glacial outwash. Coll. 1963 and subm. by W. A. Gorman, Queens Univ., Kingston, Ontario. *Comment* (W.A.G.): structure of the teeth suggested a fossil horse. Experience in dating bone suggests that collagen date is far superior in cases of discordance (see Krueger, in press).

**29,200 + 8100
- 4000****GX-102. Twin Cliffs, Alberta, wood****27,250 B.C.****GX-210. Repeat on new sample, same material****>36,600**

Partially carbonized wood from bank of S. Sask. R., near Medicine Hat, Alberta (50° 04' N Lat, 110° 38' W Long). From uppermost beds of preglacial Saskatchewan gravels. Coll. 1963 and 1964 by J. A. Westgate; subm. by J. A. W. and R. E. Follinsbee, Univ. of Alberta, Edmonton, Alberta. *Comment* (J.A.W. and R.E.F.): GX-102 was considered a maximum for glacial drift in this area, but repeat analysis shows that the gravels are older than 36,600 B.P. Latter date (GX-210) agrees with other unpublished dates on this horizon and finite date is now considered to be due to contamination (see Westgate, 1965).

GX-438. Vancouver Island peat **390 ± 90**
A.D. 1560

Silty peat from Long Beach, W coast Vancouver Is., B.C. (74° 10' N Lat, 125° 45' W Long). Basal silty peat from 1.5 m depth below surface, overlying clay and supposedly glacial gravel. Coll. 1965 by L. K. Wade; subm. by G. E. Rouse, Univ. of British Columbia, Vancouver.

E. Central America

GX-284. Lago de San Marcos wood **22,300 + 6200**
- 3400
20,350 B.C.

Twig or root from Lago de San Marcos, Jalisco, Mexico (20° 16' N Lat, 103° 33' 30" W Long). From Pleistocene lake beds at 5 ft depth. Coll. 1964 by H. Smith; subm. by J. R. Macdonald, Los Angeles Co. Mus., Los Angeles, California.

GX-279. Cachí damsite wood **14,260 ± 160**
12,310 B.C.

Fossil wood from near damsite of Cachí Hydroelectric Project, Reventazón R., Costa Rica (9° 50' 30" N Lat, 83° 48' W Long). In fluvio-lacustrine deposits covered by the youngest lava flow of Irazú volcano. Coll. 1964 and subm. by J. E. Umaña, Inst. Costarricense de Electricidad, San José, Costa Rica. *Comment* (J.E.U.): date establishes time of damming of the river which gave rise to fluvio-lacustrine deposits near Cachí damsite.

F. Europe

GX-248. Gösing Site charcoal **>38,200**

Charcoal fragments from Gösing site, Wagram region, NW of Vienna, Austria. Associated with mammoth bone in main Würm interstadial complex. Coll. 1964 and subm. by K. Hözl, Vienna, Austria. *Comment* (K.H.): date is related to the transition from Middle Paleolithic. Sample was very small. A finite date of 47,500 B.P. was obtained at one standard deviation, but it is not considered reliable (H.W.K.).

II. ARCHAEOLOGIC SAMPLES

A. Southeastern United States

Lake George site series

Materials excavated at the Lake George site (21-N-1), T11N, R5W, Sec. 11, Yazoo Co., Mississippi (32° 46' N Lat, 90° 45' W Long), by Harvard Peabody Mus. expedition directed by Stephen Williams, 1958-1960. The major occupations at this large ceremonial center span a thousand years from ca. A.D. 500 to 1500.

635 ± 65

GX-494. Mound F' structure **A.D. 1315**

Charcoal, fragments of rafter from a burned rectangular house associated with Plaquemine culture.

370 ± 115

GX-495. Mound E **A.D. 1580**

Charcoal, mainly cane fragments, from trash pit associated with Late Coles Creek ceramics. *Comment* (S.W.): these two dates were run to check the materials previously run from the site at Humble lab. (unpub.). GX-494 was from structure dated between A.D. 1000 and 1200 by samples from same log. New date falls within range of the later of the two Humble dates. The other date, GX-495, is a real puzzle as there is nothing but Coles Creek material in this portion of the mound, and this phase of construction should date around A.D. 1000 and correlate with Balmoral date (GX-485). No possible explanation for this date comes to mind; site was indeed occupied nearly this late, as other Humble dates indicate, but the late period is marked by a very distinctive ceramic complex not found in Mound E.

Upper Tensas Basin series, Louisiana

This series of dates are from excavations carried out in the course of an archaeological survey of the region, 1963-1964. They were selected to compliment the sequence previously worked out in the adjacent Lower Yazoo Basin, N of Vicksburg, Mississippi, and dated by Humble Lab. This project was part of Lower Mississippi Survey of Harvard Peabody Mus. with Stephen Williams directing the field work. All samples subm. by Stephen Williams.

1390 ± 85

GX-483. Marsden site **A.D. 560**

Charcoal fragments from Marsden site (23-K-4) Sec. 6, T18N, R10E, Richland Parish, Louisiana (31° 29' N Lat, 91° 29' W Long). From a firepit associated with Deasonville culture layer. Coll. 1964 by A. Toth.

1480 ± 85

GX-484. Neely site **A.D. 470**

Wood charcoal from a single charred log, Neely site (22-K-10), Sec. 13, T20N, R10E, West Carroll Parish, Louisiana (32° 43' N Lat, 91° 24' W Long). From firepit associated with Deasonville ceramics. Coll. 1964 by J. S. Belmont.

970 ± 85

GX-485. Balmoral site **A.D. 980**

Wood charcoal from Balmoral site (24-L-1), Sec. 58, T13N, R12E, Tensas Parish, Louisiana (32° 08' N Lat, 91° 14' W Long). From test pit in Mound C, associated with Balmoral phase, Late Coles Creek culture. Coll. 1963 by G. Tourtellot.

GX-486. Transylvania site **735 ± 90**
A.D. 1215

Charcoal fragments from Transylvania site (22-L-3), Sec. 34, T20N, R12E, E. Carroll Parish, Louisiana (32° 42' N Lat, 91° 13' W Long). Associated with burned structure of Plaquemine-Mississippi period. Coll. 1963 by W. Kean.

GX-487. Panther Lake site **1770 ± 190**
A.D. 180

Charcoal fragments from Panther Lake site (22-K-20), Sec. 21, T18N, R11E, Madison Parish, Louisiana (32° 32' N Lat, 91° 21' W Long). From mound summit, associated with Tchefuncte and Marksville ceramics. Coll. 1964 by W. L. Kean.

GX-488. Canebrake site **1390 ± 115**
A.D. 560

Charcoal fragments from Canebrake site (24-J-9), Sec. 35, T15N, R9E, Madison Parish, Louisiana (32° 15' N Lat, 91° 31' W Long). From large posthole in mixed level, but probably associated with Issaquena phase, Marksville culture. Coll. 1964 by J. E. Terrell.

GX-489. Hilly Grove site **310 ± 115**
A.D. 1640

Charcoal fragments from Hilly Grove site (24-L-7), Sec. 22, T12N, R12E, Tensas Parish, Louisiana (32° 01' N Lat, 91° 14' W Long). From large hearth associated with late Plaquemine ceramics. Coll. 1964 by D. J. Hally. *Comment* (S.W.): dates in general correlate very well with those previously obtained at the Lake George site (see GX-494 and GX-495). Earliest date (GX-487) most likely dates Marksville not Tchefuncte material at Panther Lake. Two dates for Deasonville (GX-483 and GX-484) are internally consistent for early and late portions of this culture and give ample time for the subsequent development of the Coles Creek culture, a late phase of which is dated by GX-485. The subsequent Plaquemine culture is dated by GX-486 and GX-489, although latter date is later than expected as no historic materials are known from the site. The only anomalous date is GX-488, which is ceramically associated with Issaquena and should date around A.D. 200-300. No ceramic materials from this pit would seem to fit the date obtained.

GX-316. Boyd Mound No. 2, Mississippi **1080 ± 80**
A.D. 870

Charred log from Boyd Mound No. 2, Natches Trace Parkway, Madison Co., Mississippi (32° 27' N Lat, 90° 04' W Long). From base of mound on surface of undisturbed clay. Coll. 1964 by C. F. Bohannon; subm. by J. W. Griffin, Natl. Park Service, Richmond, Virginia. *Comment* (J.W.G.): date seems to be 300 to 400 years too early for the ceramic and stratigraphic context.

GX-315. Mayport Burial Mound, Florida **1865 ± 95**
A.D. 85

Charcoal from Mayport Burial Mound, Florida (30° 22' N Lat, 81° 25' 30" W Long). From gray-brown sand zone, 24 in. below surface at E edge of mound, possibly a fire pit. Coll. 1964 by R. L. Wilson; subm. by J. W. Griffin (see Wilson, in press).

GX-287. Shoal Creek Rock Shelter, Alabama **4445 ± 160**
2495 B.C.

Charcoal fragments in sand from Shoal Creek rock shelter, Marshall Co., Alabama (34° N Lat, 86° W Long). From hearth at bottom of earliest occupational stratum, Dalton phase material in apparent association. Coll. 1964 and subm. by D. L. DeJarnette, Univ. of Alabama, University, Alabama. *Comment* (D.L.D.): in view of the well-established C¹⁴ dates on Dalton material in this area, it is unlikely that date represents earliest occupation at the site (see DeJarnette *et al.*, 1962; Clayton, 1965).

GX-414. Chucalissa site, Tennessee **1600 ± 60**
A.D. 350

Wood charcoal fragments from Chucalissa site, Unit 2 Village area on bluff, Memphis, Tennessee (35° 04' N Lat, 90° 08' W Long). From clay-lined roasting pit associated with mixed Mississippi and Woodland material. Coll. 1961 by M. Printup; subm. by C. H. Nash, Chucalissa Mus., Memphis, Tennessee. *Comment* (C.H.N.): charred corn and a few Baytown Plain sherds were mixed with the ash in the pit. Corn association seems good.

GX-452. Arnold site, Brentwood, Tennessee **270 ± 65**
A.D. 1680

Bone (human femur) from Burial 38, Arnold site, Williamson Co., Tennessee (36° 01' 15" N Lat, 86° 48' 30" W Long). From intact skeleton in previously undisturbed burial in stone-box grave 18 in. from surface. Coll. 1965 by B. Ferguson; subm. by R. A. McGraw, Vanderbilt Univ., Nashville, Tennessee. *Comment*: date is on collagen from the bones.

B. Western United States

Snaketown site, Arizona

Samples from Snaketown site, Gila Indian Reservation, Arizona (33° 11' N Lat, 111° 55' W Long). Subm. by E. W. Haury, Arizona State Mus., Tucson, Arizona.

GX-328. Snaketown, 11F **1580 ± 105**
A.D. 370

Charred wood scattered through trash, Sweetwater phase association based upon ca. 2000 sherds. Coll. 1964 by J. V. Sciscenti. *Comment* (E.W.H.): trash pit showed some mixed phases at top but this level was pure Sweetwater phase.

GX-329. Snaketown, 10F

2375 ± 110

425 B.C.

Charred wood scattered through trash pit. Pit produced ca. 11,000 sherds and the lower three levels, represented by sample, were Vahki phase. Coll. 1964 by J. A. Lancaster.

Smith Creek Cave site, Nevada

Samples from Smith Creek Cave site, R69E, T17N, White Pine Co., Nevada; coll. 1955 and subm. by J. R. Macdonald.

GX-285. Smith Creek Cave, 0-6 in.

2170 ± 70

220 B.C.

Charcoal fragments from cave section 12 NE, 0 to 6 in. depth.

GX-286. Smith Creek Cave, 12-18 in.

1675 ± 90

A.D. 275

Charcoal fragments from cave section 12 NE, 12 to 18 in. depth.

Pine Spring Site, Wyoming

Samples from Pine Spring Site, R10W, T14N, Sweetwater Co., Wyoming (41° 10' N Lat, 109° 45' W Long). Coll. 1964 and subm. by F. W. Sharrock, Univ. of Utah, Salt Lake City, Utah.

GX-354. Pine Spring site, 39 in.

9695 ± 195

7745 B.C.

Bone from articulated skeleton of *Bison sp.*, collagen fraction dated. Found 39 in. below surface in earliest of three occupational strata at the site.

GX-355. Pine Spring site, 36-39 in.

11,830 ± 410

9880 B.C.

Bone of *Bison sp.*, scattered through deposits in lowest occupational level, depth 36 to 39 in. Collagen fraction dated.

GX-356. Pine Spring site, 18-24 in.

3650 ± 80

1700 B.C.

Uncharred bone of *Ovis canadensis*, collagen fraction dated. Found in second of three occupational levels at depth of 18 to 24 in.

GX-357. Caldwell Village site, Utah

1430 ± 70

A.D. 520

Charred wood from timber of Pithouse 7 of Caldwell village, SW of LaPoint, Uinta Co., Utah (40° 24' N Lat, 109° 48' W Long). Coll. 1964 by J. R. Ambler; subm. by F. W. Sharrock. *Comment* (J.R.A.): date appears much too early for this site. The small amount of trade pottery recovered (Tusayan Black-on-red, Mancos Black-on-white, McElmo Black-on-white) indicates that site was occupied between ca. A.D. 1050 and 1200.

1505 \pm 95

GX-358. Snake Rock site, Utah **A.D. 445**

In situ roof support post from pithouse at Snake Rock site,, Sec. 34, T23S, R5E, Sevier Co., Utah (38° 40' N Lat, 111° 20' W Long). Pithouse belongs to latest occupational level at site, presumably Fremont culture. Coll. 1964 by C. M. Aikens; subm. by F. W. Sharrock. *Comment* (C.M.A.): date does not accord well with what is known of Fremont chronology; it may be 400 to 500 yr too early.

1065 \pm 120

GX-359. Bear River site, Utah **A.D. 885**

Bison bone containing abundant clean collagen which was dated, Bear River site No. 1, Sec. 18, T9N, R2W, Box Elder Co., Utah (41° 30' N Lat, 112° 05' W Long). Associated with Fremont pottery in a shallow pit at buffalo butchering site. Coll. 1964 by C. M. Aikens; subm. by F. W. Sharrock. *Comment* (C.M.A.): date accords well with temporal position assigned to site by ceramic cross-dating.

C. Mexico

2045 \pm 160

GX-397. Alabolal site, Mexico **95 B.C.**

Charcoal from Mayan site of Alabolal, Territory of Quintana Roo, Mexico (21° 13' N Lat, 87° 03' W Long). Depth of 85 cm and mixed with potsherds under a limestone overhand and between two stelae. Coll. 1965 and subm. by G. Schmidt, Bruce Mus., Greenwich, Connecticut.

D. Guatemala

Bilbao (Santa Lucia Cotzumalhuapa), Escuintla, series

Excavation at Bilbao site (14° 20' N Lat, 91° 01' W Long) was conducted by Milwaukee Public Mus. and Science Mus. of St. Paul during 1961-62 and 1962-63 (see preliminary report, Parsons and others, 1963). Stephen F. de Borhegyi directed the project, which was financed by the National Science Foundation. Based upon both general comparative studies and the radiocarbon samples, the major occupational phases at Bilbao have been estimated as follows:

<i>Period</i>	<i>Phase Name</i>	<i>Estimated Duration</i>
Late Classic	Santa Lucia	A.D. 650-900
"Middle Classic"	Laguneta	A.D. 400-650
Late Preclassic and Proto Classic?)	Ilusiones	400 B.C.-A.D. 100

Santa Lucia phase at Bilbao corresponds roughly to Pamplona phase at Kaminaljuyu (Yale IV, p. 162), and San Juan plumbate phase at El Baul (Thompson, 1948, p. 42), as well as Marcos phase of La Victoria (Coe, 1961, p. 86). Laguneta phase at Bilbao is comparable to Esperanza phase and at least the first part of Amatle phase at Kaminaljuyu (Yale

IV, p. 162; Kidder and others, 1946), and the San Francisco and San Juan pre-plumbate phases at El Baul (Thompson, 1948, p. 42). Bilbao Ilusiones phase is approx. equivalent to the Providencia (Sacatepequez), Miraflores, and Arenal phases at Kaminaljuyu (Yale IV, p. 162-164; Shook and Kidder, 1952) as well as Crucero phase at La Victoria (Coe, 1961, p. 133).

At Bilbao there seems to be a lull in activity during Early Classic period, which is represented at Kaminaljuyu by the Aurora phase, where four radiocarbon dates significantly range from ca. A.D. 100-400 (Yale IV, p. 164). A previous radiocarbon sample from Bilbao (Texas Bio-Nuclear I, p. 60) yielded the date A.D. 527 with the standard deviation ranging from A.D. 391-663. Sample was recovered from a rubble platform surrounding Monument 21, Mound B-2. (All Bilbao monument numbers cited herewith refer to Thompson, 1948, who illustrated them under the site name Santa Lucia Cotzumalhuapa.) Associated pottery was Laguneta phase and earlier, therefore corroborating the Laguneta phase dates processed by Geochron.

It should be noted that the seven Geochron dates which extend from 510 B.C. to A.D. 85 (GX-125, 130, 131, 132, 134, and 260) are for the most part associated with mixed ceramic lots from mound fill, which include styles of both early (Ilusiones) and late (Laguneta or even Santa Lucia) phases. These radiocarbon samples therefore cannot be accepted as dating the deposition of the respective excavated levels (which correspond in time to the latest pottery), but may be considered instead as dating redeposited material of the earlier Ilusiones phase which had been gathered up in the course of mound construction. These seven dates, taken as a group, average ca. 150 B.C. which we are using as a more or less central date for the prevalent, but generally unstratified, Ilusiones phase pottery at Bilbao. Only GX-134 seems to be associated with a pure Ilusiones phase deposit (L.A.P.). Samples were coll. 1962 and 1963 by P. Jenson, S. Garrett and L. A. Parsons; subm. by L. A. Parsons, Milwaukee Public Mus., Milwaukee, Wisconsin.

1350 ± 120

GX-123. Mound D-1, Santa Lucia phase A.D. 600

Charcoal from layer of ash at base of upper structure. Ceramics 18% Santa Lucia phase, 55% Laguneta phase, remainder earlier. *Comment* (L.P.A.): upper part of the range, A.D. 600 to 700, seems correct for beginning of Santa Lucia phase.

2070 ± 125

GX-131. Mound B-4, Santa Lucia phase 120 B.C.

Charcoal from base of upper structure and just above the F-2 adobe floor. Ceramics: some Santa Lucia, much Laguneta and some Ilusiones. *Comment* (L.A.P.): sample must represent redeposited Ilusiones material.

2075 \pm 230

GX-132. Monument Plaza, Santa Lucia phase 125 B.C.

Charcoal from 3 to 5 ft depth under center of W stairway and above F-8 adobe floor. Ceramics: 33% Santa Lucia and Laguneta, remainder earlier. *Comment* (L.A.P.): sample must represent redeposited Ilusiones material.

2660 \pm 115

GX-135. Monument 19, Santa Lucia phase 710 B.C.

Charcoal from 20 in. below base of a plain altar stone in the front of Monument 19. Ceramics: almost exclusively Santa Lucia and Laguneta. *Comment* (L.A.P.): date is unacceptable considering the ceramic assemblage.

1460 \pm 120

GX-124. Mound D-1, Laguneta phase A.D. 490

Charcoal from mound fill near base of structure. Ceramics: Laguneta phase and earlier. *Comment* (L.A.P.): range of the standard deviation closely approximates our estimate for the span of Laguneta phase.

2095 \pm 75

GX-125. Mound D-4, Laguneta phase 145 B.C.

Charcoal from mound fill near top of lower structure. Ceramics: 50% Laguneta and 50% Ilusiones or earlier. *Comment* (L.A.P.): sample must represent redeposited Ilusiones material.

1865 \pm 110

GX-260. Mound C-2, Laguneta phase A.D. 85

Charcoal from undisturbed mound fill. Ceramics: 75% Laguneta and 25% Ilusiones or earlier. *Comment* (L.A.P.): date must represent redeposited fill from Ilusiones phase.

1690 \pm 110

GX-126. Mound C-2, Laguneta phase A.D. 260

Charcoal from mound fill, 7 to 10 ft below summit. Ceramics; 10% Laguneta, remainder earlier. *Comment* (L.A.P.): date appears ca. 200 yr too early for associated structure and pottery.

1560 \pm 120

GX-127. Mound C-2, Laguneta phase A.D. 390

Charcoal from level 20 to 22 ft below summit, and below original acropolis surface. Just below base of mound. Ceramics: 50% Laguneta and 50% Ilusiones or earlier. *Comment* (L.A.P.): perfectly acceptable date for first stage of this mound and for the building of the Bilbao acropolis, as well as for inception of Laguneta phase at this site. Structural features of mound resemble Esperanza phase mounds at Kaminaljuyu.

1990 \pm 115

GX-128. Mound B-4, Laguneta phase 40 B.C.

Charcoal from below and behind base of Monument 18, and 2.8 ft below F-2 adobe which abuts rear of monument. Ceramics: 30% La-

guneta and 70% Ilusiones phase. *Comment* (L.A.P.): sample must represent redeposited Ilusiones fill.

1980 ± 420

GX-130. Mound B-4, Laguneta phase

30 B.C.

Charcoal from fill of mound just above sterile zone. Ceramics: 31% Laguneta and 69% Ilusiones or earlier phases. *Comment* (L.A.P.): sample probably belongs to redeposited fill from Ilusiones phase.

145 ± 120

GX-133. Monument Plaza, Laguneta phase A.D. 1805

Charcoal from 5 to 7 ft depth under E edge of W stairway. Ceramics: 24% Laguneta, remainder earlier. *Comment* (L.A.P.): this was possibly a disturbed area. The Monument Plaza was extensively explored in the late 1870's. At any rate date is unacceptable for the supposed context.

2460 ± 130

GX-134. Mound A-2, Ilusiones phase

510 B.C.

Charcoal from base of E side, 8 to 10 ft and below the F-8 adobe floor. Ceramics: Ilusiones phase only. *Comment* (L.A.P.): upper limit (380 B.C.) seems most reasonable for the date of the deposit.

E. Peru

Peru series

Samples from various sites in Peru, coll. 1958 to 1964 by F. Engel and others; subm. by F. Engel, Universidad Nacional Agraria, Lima, Peru.

3610 ± 80

GX-202. Village 24, charcoal

1660 B.C.

Charcoal fragments from Village 24, close to S bank of Chilca R., 4 km from Pacific, Central Coast of Peru (12° 30' 12" S Lat, 76° 44' 06" W Long). From Level 2 inside hut. *Comment* (F.E.): may date first appearance of Chavin culture on the Central Coast since refuse at the site has yielded typical Chavinoid pottery. See also GX-228 and GX-275 below.

3330 ± 240

GX-203. Chanapata

1380 B.C.

Charcoal in soil from Site 1, Chanapata, in outskirts of Cuzco, Peru (13° 32' S Lat, 71° 58' W Long). From test pit. *Comment* (F.E.): should confirm early spreading of Chavin culture all over Peru.

2280 ± 110

GX-217. Site 100, Chilca Canyon

330 B.C.

Charcoal from Site 100, a large stone and conical adobe pyramidal village atop Llapa Llapa (Ciudadela) hill, Chilca canyon, Peru (12° 33' 12" S Lat, 76° 44' 00" W Long). From Level 600 in testpit. *Comment* (F.E.): pottery found in this site is post-fired and has not yet been de-

scribed; this type also found in nearby Omas drainage and higher up in Chilca canyon. Date fits in with the conical adobes.

GX-218. Site 514, Paracas

5890 \pm 145

3940 B.C.

Vegetable stalks and leaves from Site 514, village of reed huts, Paracas area, Peru ($13^{\circ} 51' 50''$ S Lat, $76^{\circ} 15' 00''$ W Long). Found inside a hut. *Comment* (F.E.): may date end of pre-bean period on South Coast of Peru.

GX-219. Shell Mound, Km 127

2785 \pm 75

835 B.C.

Small shell fragments in soil from a shell mound in dry arroyo, Km 127, S of Pan American Highway, Peru ($12^{\circ} 56' 09''$ S Lat, $76^{\circ} 28' 57''$ W Long). *Comment* (F.E.): date too young; no cotton, no pottery at site; should date 4500 or more.

GX-228. Village 24, Cloth A

2495 \pm 95

545 B.C.

Coarsely woven cloth from same site as GX-202. *Comment* (F.E.): site yields Chavinoid pottery; date does not agree with GX-202 and GX-275 from same site.

GX-245. Owl's Cave

530 \pm 105

A.D. 1420

Wood and nuts from Owl's Cave site, Monzon R., near Tingo Maria, Peru ($9^{\circ} 16' 30''$ S Lat, $76^{\circ} 04' 24''$ W Long). *Comment* (F.E.): dates Lathrop's modeled incised Hupa-ya pottery, found inside pit; also would date "Monzon coarse ware" and "Cave of the Owls fine ware" if a stratigraphic test should be tempted with further carbon dating.

GX-264. Site 20, Plataforme

7270 \pm 125

5320 B.C.

Carbonized and powdered matting wrapping a body in a grave, Site 20, Plataforme, on the Centinela hill, S end of Lurin drainage, Peru ($12^{\circ} 16' 12''$ S Lat, $76^{\circ} 52' 42''$ W Long). From test pit in refuse. *Comment* (F.E.): dates one more of numerous villages of similar age.

GX-271. Site 22

990 \pm 85

A.D. 960

Coarse fabric from Site 22, a Chavin terraced platform, reoccupied during at least two further periods, close to modern cemetery of Lurin, Peru ($12^{\circ} 16' 28''$ S Lat, $76^{\circ} 52' 23''$ W Long). Cloth was wrapping a bundle in Grave 1. *Comment* (F.E.): should date "Huaca Malena" post-Tiahuanaco period of the Rimao, Lurin, and Omas Drainages.

GX-275. Village 24, Cloth B

3510 \pm 70

1560 B.C.

Coarsely woven cotton cloth from same site as GX-202. *Comment* (F.E.): village yields Chavin pottery. Date confirms GX-202, but GX-228 is much younger. Refuse is shallow and reoccupation seems unlikely.

F. Europe

GX-393. Chassemy, France, La Tene Ia

**2540 ± 60
590 B.C.**

Fine charcoal in ashes from Chassemy (Aisne) France, "Le Saule Bailler" (54° 52' 12" N Lat, 1° 14' 25" E Long). Bottom of firepit in Bottom Hearth, Layer 5, resting on a sherd of La Tene I Plate (*assiente*), in a deposit relatively dated by other pottery to La Tene Ia, within the ground plan of a house. Coll. 1964 and subm. by R. M. Rowlett, Peabody Mus., Cambridge, Massachusetts. *Comment* (R.M.R.): estimated absolute dating by archaeological means would be 475 to 400 B.C. Date is somewhat older but agrees within two standard deviations.

G. Africa

Northern Province, Sudan series

Samples coll. 1964 by members of Univ. of Colorado Nubian Expedition; subm. by G. W. Hewes, Univ. of Colorado, Boulder, Colorado.

GX-421. Site 11-I-16 shell

**13,650 ± 300
11,700 B.C.**

Shells of *Unio* sp. from Site 11-I-16, W bank Nile, S end Karagan Valley, Murshid W, N. Prov., Sudan (21° 39' N Lat, 31° 10' E Long). From compacted layer containing lithic implements and flakes of Upper Paleolithic facies, along with some fossilized bovid teeth and jaw fragments. Layer 20 to 30 cm thick and below 2 to 3 cm of windblown sand. *Comment* (G.W.H.): date accords well with age of lithic remains estimated by independent means, and with date for abandonment of old Nile Channel (see GX-422; Hewes, in press).

GX-422. Karagan Valley Corbicula shells

**12,970 ± 300
11,020 B.C.**

Shells of *Corbicula* sp. from ancient western channel of Nile, W bank, near Murshid, N. Prov., Sudan (21° 42' N Lat, 31° 10' E Long). Found on or near a relict Nile silt surface, in original living position, valves upward and in conjunction. *Comment* (G.W.H.): date of these shells should indicate date of abandonment by R. Nile of this high western channel, after which river did not again reach this elevation. Date agrees with several other molluscan shell dates from similar high terraces or channels (see Hewes, in press).

GX-423. Site 11-I-16, charcoal

**4935 ± 130
2985 B.C.**

Charcoal from same site as GX-421, from hearths in living surface area, 25 to 30 cm below surface, associated with plain potsherds, quartz implements, and some animal bones. *Comment* (G.W.H.): clear association with late Neolithic cultural level including pottery, animal bones, crude quartz implements, and some ground stone milling implements. Agrees with expectations (see Hewes, in press; Carlson, in press).

GX-445. Site 6-8-36, Wadi Halfa, bone**6485 ± 160
4535 B.C.**

Fossil bone from Site 6-B-36 burials, 2.5 km W of Nile R., opposite Wadi Halfa, Sudan (21° 57' 28" N Lat, 31° 19' 10" E Long). From deliberate burials in two adjacent grave areas, with living site debris intermixed; animal bones (bovine) and epipalaeolithic stone tools associated. *Comment* (G.W.H.): chipped stone tools of an epipalaeolithic facies, with some ground stone milling implements are in association. Reported date seems 2000 to 3000 yr too recent. *Comment* (H.W.K.): date is on the carbonate fraction of bone in part permineralized. Our experience indicates that this is a minimum age. See also Hewes *et al.* (1964); Saxe (in press).

Engaruka series, Tanzania

Samples from sites at Engaruka, W side of Rift Valley, Tanzania (2° 59' S Lat, 35° 57' E Long. Coll. 1964 and subm. by H. Sassoon, Dar Es Salaam, Tanzania.

GX-247. Stone circle, ci**490 ± 90
A.D. 1460**

Charcoal from 45 cm below surface associated with pottery and animal bones in 30 ft stone circle. *Comment* (H.S.): subsequent study showed that deposits had been much disturbed, possibly by treasure seekers.

GX-347. Hillside A2-A3**1230 ± 120
A.D. 720**

Charcoal from 45 cm below surface of terrace platform on hillside; associated with some potsherds. *Comment* (H.S.): unexpectedly early; should not be accepted until confirmed.

GX-348. Hillside, A2-A4**1620 ± 90
A.D. 330**

Charcoal from 60 cm below surface of terrace platform on hillside. *Comment* (H.S.): unexpectedly early; should not be accepted until confirmed.

GX-224. Prospect Farm, Kenya**10,560 ± 1650
8610 B.C.**

Small sample of charcoal from Prospect Farm, Elmenteita, Kenya (0° 35' 30" S Lat, 36° 10' 03" E Long). Locality II, Trench 1, 14 to 20 in. below surface; associated with stone tools of Kenya Capsian Industry in volcanic tuff. Coll. 1964 and subm. by B. W. Anthony, Peabody Mus., Cambridge, Massachusetts. *Comment* (B.W.A.): this is first date on a Kenya Capsian horizon.

GX-267. Peers Cave, So. Africa**>35,600**

Charcoal from Peers Cave, Fish Hoek, Cape Province, South Africa (34° 07' 11" S Lat, 18° 24' 52" E Long). Associated with "Stillbay" assemblage in cave earth at depth of 72 in. Coll. 1963 and subm. by B. W. Anthony. *Comment* (B.W.A.): first date from new excavations.

GX-398. Kilwa I, Tanzania **1825 ± 110**
A.D. 125

Charcoal from Kilwa Kisiwani, Tanzania (8° 57' S Lat, 39° 31' E Long). From lower strata, pre-Shirazi settlement. Coll. 1964 and subm. by H. N. Chittick, British Inst. Hist. and Archaeol. E. Africa, Nairobi. *Comment* (H.N.C.): date too early. Deposit unlikely to be earlier than 9th century A.D.

H. Japan

Hokkaido, Japan series

Samples from sites on Hokkaido; coll. 1963 and 1964 by T. Oba; subm. by C. S. Chard, Univ. of Wisconsin, Madison, Wisconsin.

GX-281. Omagari Cave **6795 ± 150**
4845 B.C.

Charcoal from Omagari cave, W of Abashiri, Hokkaido, Japan (44° 00' N Lat, 144° 15" E Long). In layer of ash associated with tsunamon type pottery. *Comment* (C.H.C.): provides date for tsunamon style (ropemarked) pottery, considered to be one of the very early wares of Hokkaido. Date consistent with this.

GX-282. Rankoshi site **1215 ± 85**
A.D. 735

Charcoal from Rankoshi, Chitose site, Hokkaido, Japan (42° 45' N Lat, 141° 40' E Long). House pit No. 1 assigned to Satsumon culture. *Comment* (C.H.C.): extends time range of Satsumon culture, the latest prehistoric culture on Hokkaido. Prior dates centered around 900 to 1000 B.P.

GX-283. Eniwa site **1520 ± 65**
A.D. 430

Charcoal from Eniwa, Chitose County, Hokkaido, Japan (42° 47' N Lat, 141° 37' E Long). House pit No. 1 assigned to Satsumon culture. *Comment* (C.H.C.): see GX-282.

I. Pacific Islands

GX-394. Kipuka Ki, Hawaii **2170 ± 200**
220 B.C.

Disintegrated charcoal and ash from 70 cm depth, Kipuka Ki, Hawaii Volcanoes Natl. Park (19° N Lat, 155° W Long). Coll. 1965 by D. Mueller-Dombois; subm. by D. L. Hamilton, Hawaii Volcanoes Natl. Park, Hawaii.

GX-276. Maupiti burial No. 6 **760 ± 90**
A.D. 1190

Human bone from burial on Paeao Is., Maupiti, Fr. Polynesia (16° 27' 30" S Lat, 152° 11' 40" W Long). Site No. Ma3 burial 6, female from a multiple burial associated with adzes. Coll. 1963 by Y. Sinoto; subm by K. P. Emory, Bishop Mus., Honolulu, Hawaii, *Comment* (K.P.E.): this clearly prehistoric burial ground produced adzes, fishhooks, and orna-

ments as well as 15 burials. Adzes were clearly prototypes of modern adzes while shaped whale-tooth ornaments were identical to those found in Wairau Bar burials in New Zealand. See Emory and Sinoto (1964).

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ISOTOPES, INC. RADIOCARBON MEASUREMENTS V

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INTRODUCTION

This list presents dates on samples measured at Isotopes, Inc., during the years 1963 to 1965 and measurements made previously for which sample data has been recently received. The many results which do not appear are withheld pending additional information or at the request of our clients.

Procedures employed in sample pretreatment, preparation of CO₂, and method of counting are generally unchanged, as are our methods of age calculation. Suitable bone samples are now pretreated by the method of Berger, Harney and Libby (1964).

In May, 1965, the three counters and associated electronics previously described (Isotopes I, II, III) were retired after producing well over 2000 radiocarbon dates, geophysical measurements, and ultralow-level C¹⁴ measurements. A completely new laboratory was activated employing four new counters. Shielding consists of 31 cm of selected low-background steel, 10 cm paraffin and 2.5 cm "aged" lead. Each counter has its own multianode annular anticoincidence geiger counter. Electronics were designed and fabricated at Isotopes, Inc. The counters have an active volume of 1 L and when operated at a normal pressure of 3 atm, yield background counts of slightly over 2 counts/min, A_{0x} × 0.95 is ca. 18.7 at 24° C.

C¹³/C¹² ratios are measured periodically by our mass spectrometry section, but not routinely on samples unless requested by clients.

ACKNOWLEDGMENTS

It is recognized that data obtained at Isotopes, Inc. remain the sole property of our clients. We are indebted to those who have consented to have their data published here, and particularly to those supplying the comments on the ages.

The laboratory operations have been supervised throughout by Charles Tucek, and to him and his assistants, J. Bonicos, C. Tatsch, and E. Stapleton we are greatly indebted. We would particularly like to thank Miss Joan Gaetjen for her singular help in the task of assembling the mass of data associated with this date list.

I. GEOLOGIC SAMPLES

A. Alaska

Upper Tanana River Valley series, Alaska

Samples from Upper Tanana River Valley, Alaska. Coll. and subm. between 1959 and 1961 by A. T. Fernald, U.S. Geol. Survey, Washington.

- 8175 \pm 175**
6225 B.C.
- I-305. Tahamund Lake, Alaska**
Woody material from exposed alluvial-colluvial material in bluff bordering Tahamund Lake (62° 45' N Lat, 141° 42' W Long), Alaska. *Comment* (A.T.F.): sample provides date for accumulation of material in middle section of bluff.
- 1270 \pm 80**
A.D. 680
- I-303. Nabesna River Flood Plain, Alaska**
Peat from within flood-plain deposits of the Nabesna River (62° 57' N Lat, 141° 58' W Long), Alaska. *Comment* (A.T.F.): sample provides date of flood-plain deposition at site.
- 11,250 \pm 250**
9300 B.C.
- I-302. Nabesna River, Alaska**
Woody material from thin organic zone between dune sand in low bluff along Nabesna River (61° 01' N Lat, 141° 55' W Long), Alaska. *Comment* (A.T.F.): dune at locality was stabilized during late Wisconsin time and subsequently reactivated.
- 850 \pm 90**
A.D. 1100
- I-278. Midway Lake, Alaska, No. 1**
Woody material from exposed lacustrine silt and clay in a low bluff bordering Midway Lake (63° 13' N Lat, 142° 16' W Long), Alaska. *Comment* (A.T.F.): date relates to lake that once covered this locality.
- 5300 \pm 250**
3350 B.C.
- I-277. Midway Lake, Alaska, No. 2**
Peat from exposed loess and alluvial-colluvial material in bluff at same site as I-278. *Comment* (A.T.F.): dates accumulation of material in upper section of bluff.
- 3000 \pm 120**
1050 B.C.
- I-274. Tetlin Lake, Alaska**
Woody material from exposed lacustrine silt and clay in a low bluff near Tetlin Lake (63° 07' N Lat, 142° 39' W Long), Alaska. *Comment* (A.T.F.): date relates to lake that covered the locality.
- 2400 \pm 100**
450 B.C.
- I-279. Fish Lake, Alaska**
Woody material from exposed lacustrine silt and clay in a low bluff bordering Fish Lake (62° 58' N Lat, 141° 50' W Long), Alaska. *Comment* (A.T.F.): date relates to lake that once covered this locality.
- Naknek drainage, pollen profile series, Alaska**
Samples from Naknek drainage area dated in order to provide evidence of the climatic sequence in the area of research. Coll. 1961 by D. E. Dumond, Univ. of Oregon, Eugene, Oregon; subm. 1961 by L. S. Cressman, Univ. of Oregon, Eugene, Oregon. Pollen analysis of material performed by C. J. Heusser, Am. Geog. Soc., New York, New York.

I-506. Naknek River Mouth, Alaska **3450 ± 200**
1500 B.C.

Peat from basal section of bog on N bank near mouth of Naknek River (58° 44' N Lat, 157° 02' W Long), Alaska. Sampled from 2.1 m below surface of bog and ca. 15 m above mean high tide.

I-528. Brooks River, Alaska, 1.5 m **4800 ± 175**
2850 B.C.

I-529. Brooks River, Alaska, 2.5 m **5570 ± 200**
3620 B.C.

Peats from bog on W bank upper Brooks River (58° 35' N Lat, 155° 44' W Long), Alaska. I-528 from depth of 1.5 m below bog surface, I-529 from 2.5 m below surface. Bog is ca. 5 m below elevation of river. *Comment* (D.E.D.): samples I-506, I-528 are assigned by Heusser (Heusser, 1963), to late postglacial zone as was Y-931, 3860 ± 90 (Yale VII). I-529 is assigned to boundary between hypsithermal and late postglacial zones. I-529 is only slightly above base of Brooks River bog and indicates that pollen sequence does not greatly predate 6000 B.P. Inasmuch as Brooks River bog lies upon areas covered by early postglacial lake which was ancestral to present Brooks and Naknek Lakes of Naknek drainage, it may also be concluded that date provides an indication of the time at which the ancestral lake subsided to the point where Brooks River, which drains Brooks Lake into Naknek Lake, was formed.

I-462. Goodnews Bay, Alaska **11,500 ± 250**
9550 B.C.

Peat from shore bluffs of Kuskokwim Bay (58° 53' N Lat, 161° 47' W Long), 1 mi N of mouth of Salmon River. From base of sequence of peat and silt 12 ft thick filling a kettle hole in till comprising outermost loop of the end moraine of ice that flowed SW out of Kilbuck Mountains through Goodnews Bay, then spread in a piedmont lobe on the then-dry floor of Bering Sea. Peat layer is slightly disturbed as though it had accumulated before ice had completely melted out of the underlying drift; thus, it is believed to have accumulated shortly after ice retreated from this terminal position. Coll. 1957 and subm. 1961 by D. M. Hopkins, U. S. Geol. Survey, Washington. *Comment* (D.M.H.): date establishes that outermost Wisconsin moraines in Goodnews Bay area are of "classical" Wisconsin rather than Iowan age.

I-439. Yakutat, Alaska **560 ± 75**
A.D. 1390

Wood (*Picea*) 3 ft above high tide line in sea cliff 0.75 mi SE (50° 32' N Lat, 139° 51' W Long) of Ocean Cape at entrance to Yakutat Bay, Alaska. From stump rooted in 3 in. organic layer (peat) beneath clay till. Stump is sheared off at contact between peat and till. Coll. 1958 and subm. 1959 by D. J. Miller, U. S. Geol. Survey, Washington. *Comment* (D.J.M.): the end moraine at the mouth of Yakutat Bay records the last

advance of ice to the mouth of the bay, interpreted from a previous date (W-559, 830 ± 160 , USGS V) as occurring no earlier than 1000 B.P. Present sample from ice-sheared stump below the youngest till should date more precisely the last advance and will provide the first direct check on radiocarbon dating of recent events in the Gulf of Alaska Tertiary province.

I-440. Point Hope, Alaska **>38,000**

Wood from log exposed in sea cliff along Arctic Coast 27 mi SE ($68^{\circ} 07' \text{ N Lat, } 165^{\circ} 55' \text{ W Long}$) of Point Hope, Alaska. From top 1 ft of 17.5 ft thick marine gravel 40 ft above present level of Chukchi Sea in platform cut onto Jurassic mudstone by the sea. Coll. 1958 and subm. 1959 by Ruben Kachadoorian, U. S. Geol. Survey, Menlo Park, California. *Comment* (R.K.): marine platform and gravels record last major high stand of Chukchi Sea in NE Alaska. Date is evidence that gravels were deposited during Sangamon age and can be correlated with Second Beach in the vicinity of Nome, Alaska.

Barrow Beach Ridge series, Alaska

Peat samples from an inland beach ridge SE of Barrow Camp, Alaska.

I-1182. Barrow Ridge, Alaska, No. 1 **8715 ± 250
6765 B.C.**

1.8 mi SE of Barrow Camp ($71^{\circ} 19' 10'' \text{ N Lat, } 156^{\circ} 36' 15'' \text{ W Long}$), Alaska. Well-humified, buried peat layer 2 in. thick beneath 1 ft of silt and overlying a relatively clean pea gravel. Exposed in 2nd trench S of U. S. Coast and Geodetic Survey station. Coll. 1963 by Jerry Brown and P. V. Sellman, U. S. Army Cold Regions Research and Engineering Lab., Hanover, New Hampshire; subm. 1963 by Jerry Brown.

I-1183. Barrow Ridge, Alaska, No. 2 **9155 ± 300
7205 B.C.**

2.75 mi SE ($71^{\circ} 18' 25'' \text{ N Lat, } 156^{\circ} 35' 40'' \text{ W Long}$) of Barrow Camp, Alaska. Frozen peat inclusion at depth of 3 ft, overlain by silty soil. Surface elevation 16 ft. Coll. 1962 by Jerry Brown and J. B. O'Sullivan, Allis-Chalmers, Milwaukee, Wisconsin; subm. 1963 by Jerry Brown.

I-1384. Barrow Ridge, Alaska, No. 3 **$25,300 \pm 2300$
23,300 B.C.**

1.75 mi SE of Barrow Camp, Alaska in shaft of U. S. Coast and Geodetic Survey seismic station. Sample from a thin ($\frac{1}{4}$ in.), continuous layer of reworked and retransported organic fibers in a gravelly sand at depth of 7 ft. Surface elev 24 ft. Coll. 1964 by P. V. Sellman; subm. 1964 by Jerry Brown.

Comment (J.B.): date on I-1384 provides maximum age for upper 7 ft of gravelly and silty sediment of beach ridge. Dates from 4 soil sites are

available from this ridge: A₁ horizon of the well-drained Arctic Brown soil is 3000 yr old (L-400A, Lamont V). Surface of beach ridge has been, therefore, stable for the past 3000 yr. I-1182 is probably a buried surface horizon of a paleo-Arctic Brown type soil. The abrupt contacts suggest burial by local eolian deposition for this site. Samples L-400B (11,050 \pm 350, Lamont V) and I-1183, from opposite ends of beach ridge further substantiate existence of an organic soil surface between 8700 and 11,000 B.P. Pollen analyses (Colinvaux, 1964) indicate a paucity or absence of alder pollen suggesting that burial of peat was prior to alder maximum (Porter, 1964), and probably close to 8300 B.P. (I-1202, this list). A burial mechanism by frost heave has been proposed (Douglass and Tedrow, 1960).

Barrow Ice Wedge series, Alaska

Plant fragments from buried ice wedge in ridge between Voth Creek and Village Slough Barrow (71° 17' 50" N Lat, 156° 42' 25" W Long), Alaska. Ice sample contained ca. 10 organic-rich, vertical foliations including leaves, stems, twigs, moss fragments, and lemming pellets. Organic residue collected by filtration from thawed ice. Coll. and subm. 1963 by Jerry Brown.

8200 \pm 300

I-922. Barrow Ice Wedge, No. 1 **6250 B.C.**

From 11 ft depth and just below I-701 (Isotopes IV).

14,000 \pm 500

I-1171. Barrow Ice Wedge, No. 2 **12,050 B.C.**

From 12 ft depth, 6 ft from lateral contact of ice wedge, 12 ft E of I-922.

Comment (J.B.): organic residues were incorporated into ice through contraction-crack mechanism and were derived from surface vegetation and organic debris in the polygon troughs. Incorporation occurred prior to truncation and/or burial of ice mass. The two dates provide a period during which growth of the complex ice mass occurred (Brown, 1964). Pollen analysis of I-1171 (Colinvaux, 1964) indicated a severe Arctic climate ca. 14,000 B.P. Absence of present day pollen spectra in the ice substantiates lack of recent contamination. Dates provide additional evidence that present-day polygonal ground and active, surface ice wedges are of relatively young age (post-Wisconsin).

8330 \pm 250

I-1202. Barrow Topographic High **6380 B.C.**

Buried soil peat from lowest peaty inclusion in perennially frozen silty sediment at 9 ft depth, 2 mi S of Barrow Camp (71° 17' 45" N Lat, 156° 39' 40" W Long), Alaska. Topographic high, with surface elev. ca. 20 ft, is probably a weakly defined continuation of the inland beach ridge (Barrow Beach Ridge series, this list). Coll. 1959 by J. B. O'Sullivan; subm. 1963 by Jerry Brown. *Comment* (J.B.): this deep burial of

masses of peat corresponds closely to events that caused burial of I-701 ($10,525 \pm 280$, Isotopes IV; Brown, 1964). It is postulated that a deep thaw occurred, followed by freeze-up of supersaturated sediments with the resulting burial. These events are probably associated with burial of peats in Barrow Ridge series (this list).

I-1394. Gubik formation, Alaska **>36,300**

Buried, retransported peat from 2.75 mi SE of Barrow Camp ($71^{\circ} 18' 20''$ N Lat, $156^{\circ} 35' 30''$ W Long), Alaska. Sample consists of several $\frac{1}{4}$ in. layers of reworked, retransported fibers at 49 ft below sealevel (surface elev 49 ft) in frozen dark gray sands. Coll. and subm. 1964 by Jerry Brown. *Comment* (J.B.): date confirms that sediments are pre-Wisconsin unit of Pleistocene Gubik formation. Black considers this unit at Barrow to be the Skull Cliff unit, of Illinoian age (Black, 1964). Date of $>38,000$ (W-380, Coulter, 1960) had been obtained for a log ca. 13 mi SW in what may be considered Wisconsin or Barrow Unit of the Gubik.

I-437. Galena, Alaska

**3250 ± 150
1300 B.C.**

Wood from a 24 ft layer (channel fill) of frozen muck 206 ft above Yukon River on "Cave-Off Cliffs," 6 mi up river from Galena Air Force Base, Alaska ($64^{\circ} 43'$ N Lat, $156^{\circ} 44'$ W Long). Coll. 1954 and subm. 1962 by T. L. Péwé, U. S. Geol. Survey, College, Alaska. *Comment* (T.L.P.): Pleistocene mammal remains are reported from lower part of channel fill. Date suggests filling process continued until quite recently and did not terminate in the Pleistocene as originally suspected (Weber and Péwé, 1961a).

I-993. Flora Lake, Alaska

**5650 ± 275
3700 B.C.**

Silty gyttja from pollen-dated core from Flora Lake ($63^{\circ} 29'$ N Lat, $170^{\circ} 06'$ W Long), St. Lawrence Island, Alaska. Core consists of 1 m of lacustrine sediment overlying 1 m of buried soil. Sample is from 0.5 m from top of core. Coll. and subm. 1963 by P. A. Colinvaux, now at Dept. of Zoology and Entomology, Ohio State Univ., Columbus, Ohio. *Comment* (P.A.C.): date suggests unexpectedly great age of 11,000 yr for the lake, indicating that underlying soil is of glacial and Bering land bridge age. Post-glacial pollen sequence consists of only two zones as at Imuruk Lake (Livingstone, 1955).

B. Western United States

I-955. Butte County, Idaho

>40,000

Lignitic material from clay zone 1250 ft below land surface ca. 46 mi W ($43^{\circ} 38' 44''$ N Lat, $112^{\circ} 55' 02''$ W Long) of Idaho Falls, Idaho. Coll. and subm. 1963 by W. S. Keyes, U. S. AEC, Idaho Operations Office, Idaho Falls, Idaho.

I-423. Mesa Verde National Park, Colorado $\geq 35,500$

Caliche from Cca horizon in face of large garbage pit on Chapin Mesa S of Mesa Verde Natl. Park Headquarters ($37^{\circ} 09' 45''$ N Lat, $108^{\circ} 28'$ W Long), Colorado. Sampled from lowest level immediately above sandstone of the Cliff House (K) formation. Coll. and subm. 1961 by Douglas Osborne, U. S. Natl. Park Service, Mesa Verde Natl. Park, Colorado.

**I-698. Logan City Well, Main St., Utah $22,000 \pm 600$
 $20,050$ B.C.**

Wood trash from 90 ft level of City water well on E Main St. at junction of Canyon Road, Logan City ($41^{\circ} 43'$ N Lat, $111^{\circ} 50'$ W Long), Cache County, Utah. Taken by bailer from top of gravel aquifer. Much gas, apparently methane, escaped from the bed. Coll. and subm. 1962 by J. S. Williams, Physical Sciences Dept., Utah State Univ., Logan, Utah. *Comment* (J.S.W.): aquifer that contained sample could belong to Farmdalian interglacial and represent Bonneville-Provo I-Provo II interlake stade.

**I-697. Logan City Well, 6th E and 7th N Streets, Utah $13,150 \pm 275$
 $11,200$ B.C.**

Wood trash from 150 ft depth of city water well at NW corner of intersection of 7th N and 6th E Streets, Logan City ($41^{\circ} 44'$ N Lat, $111^{\circ} 49'$ W Long), Cache County, Utah. Taken by bailer from top level of gravel aquifer. Coll. and subm. 1961 by J. S. Williams. *Comment* (J.S.W.): date indicates that gravels here at elev 4485 ft are younger than in Main Street Well (I-698, this list) at 4452 ft, and may belong to Provo II-Provo III interlake stade.

**I-696. Willard Canal, Utah $10,300 \pm 275$
 8350 B.C.**

Wood from Willard Canal, Station 320 ± 50 , sec. 26, T7N, R2W, Salt Lake Base and Meridian, North Ogden ($41^{\circ} 19'$ N Lat, $112^{\circ} 2' 30''$ W Long), Utah. Taken from bed of black coarse sand at water level in canal, 12 ft below ground surface. Bed continues S for at least 300 ft with wood fragments common. Coll. and subm. 1962 by J. S. Williams. *Comment* (J.S.W.): overlay is 12 ft of clean, well-bedded medium-grained sand with considerable crossbedding, probably representing last cycle of Lake Bonneville, Provo IV.

**I-1093. Ebeyes Prairie, Washington 935 ± 110
A.D. 1015**

Marine pelecypod shells from near top of 90-ft bluff marking edge of terrace at Ebeyes Prairie ($48^{\circ} 12'$ N Lat, $122^{\circ} 43'$ W Long), 2 mi SW of Coupeville, Whidbey Island, Washington. Shells occur in a horizon beneath 12 to 18 in. of black organic soil which is unfossiliferous. Coll. and subm. 1963 by D. J. Easterbrook, Dept. of Geology, Western Washington State College, Bellingham, Washington. *Comment* (D.J.E.): shells

occur in what appears to be a marine terrace 80 to 100 ft above present mean sealevel.

Whidbey Interglacial sediments series, Washington

Samples from interglacial deposits of the Whidbey formation which lie between the older Double Bluff and Possession units in Northern and Central Puget Lowlands (Easterbrook, 1965). Coll. and subm. 1962 to 1965 by D. J. Easterbrook.

I-722. Oak Harbor, Washington **>42,000**

Wood from sea cliff along W side Whidbey Island, 5 mi SW of Oak Harbor at intersection of Willamette Meridian and Strait of Juan de Fuca (48° 15' N Lat, 122° 45' W Long). Taken from log 3 ft in diam imbedded in sand beneath Vashon drift. *Comment* (D.J.E.): sample sets limiting date on accumulation of thick stratified section beneath Vashon drift on Whidbey Island and indicates that stratified deposits could not be outwash from advancing Vashon glacier.

I-723. Crescent Beach, Washington **>42,000**

Wood from sea cliff at Crescent Beach at N end of East Sound on Orcas Island (48° 42' N Lat, 122° 53' W Long), Washington. Taken from poorly sorted, unstratified pebbly clay about 3 ft above sealevel. *Comment* (D.J.E.): radiocarbon age is much greater than 11,500 B.P. expected based on stratigraphic relationships. Sediments may represent a remnant of a pre-Vashon section where Vashon drift and younger sediments have been eroded, or wood may have been reworked from older deposits.

I-974. Guemes Island, Washington **>40,000**

Peat from bed near top of sand and silty clay sequence overlain by gravel and Vashon till or glaciomarine drift at Yellow Bluff (48° 32' N Lat, 122° 39' W Long), Guemes Island, Washington. *Comment* (D.J.E.): date indicates that these sediments are older than the interglacial which immediately preceded Vashon glaciation.

I-975. Everett Gorge, Washington **>40,000**

Peat from bed near middle of stratified sequence underlying Vashon till at Reservoir near Pigeon Creek (47° 58' N Lat, 122° 13' W Long), Everett, Washington. *Comment* (D.J.E.): sample from uppermost peat bed in pre-Vashon Everett Gorge section previously interpreted by Hansen and Mackin (Hansen and Mackin, 1949), as from an interglacial period earlier than the interglacial immediately preceding Vashon glaciation. Date tends to confirm this interpretation, but possibility that the interglacial immediately prior to the Vashon extended beyond 40,000 yr cannot yet be disproven.

I-1194. Polnell Point, Washington **>35,000**

Peat from a bed which is part of a sand unit exposed in sea cliffs along Saratoga Passage, 1 mi E of Polnell Point (48° 17' N Lat, 122° 32' W Long), Whidbey Island, Washington. *Comment* (D.J.E.): peat bed is overlain by glaciomarine drift and date indicates that sand unit probably belongs to Whidbey Formation and confirms interpretation that an unconformity exists between the unit and the overlying glaciomarine drift.

I-1445. Swantown, Washington **>35,000**

Wood from log ca. 5 ft above sealevel in peat bed interbedded with sand and silt on N end of bluffs, S of Swantown (48° 17' N Lat, 122° 44' W Long), Whidbey Island, Washington. *Comment* (D.J.E.): date correlates with other material from this formation.

I-1446. Penn Cove, Washington **>33,200**

Peat from bed a few ft above sealevel overlain by 10 to 20 ft gravel and glaciomarine drift at Penn Cove (48° 14' N Lat, 122° 43' W Long), E of Juan de Fuca, Whidbey Island, Washington. *Comment* (D.J.E.): this peat was previously dated $11,060 \pm 185$ (UW-33, unpub.). This date (I-1446) appears to be correct since stratigraphically the unit belongs to Whidbey Formation.

I-1528. Elger Bay, Washington **>35,000**

Peat from bed overlain by Vashon till at Elger Bay (48° 08' N Lat, 122° 28' W Long), Camano Island, Washington. *Comment* (D.J.E.): dates minimum age of Whidbey Formation on Camano Island.

Puget Lowland series, Washington

Samples of glaciomarine sediments deposited from floating ice in the Northern and Central Puget Lowland, Washington. They have been included in Everson Interstade of Fraser Glaciation, the last major glaciation of the lowland (Easterbrook, 1963a). Coll. and subm. 1963 to 1965 by D. J. Easterbrook.

I-969. Orcas Island, Washington, No. 2 **$12,350 \pm 400$
10,400 B.C.**

Shells (mostly *Saxidomus*) from fossiliferous glaciomarine drift 100 to 125 ft above sealevel on N end of East Sound (48° 41' N Lat, 122° 56' W Long), 1.5 mi SW of town of East Sound. *Comment* (D.J.E.): shells occur in pebbly-clay till-like deposit containing pebbles transported by Canadian ice and deposited in marine water. Deposits correlate with glaciomarine drift younger than Vashon till in lowland near Bellingham.

I-1079. Whidbey Island, Washington, No. 2 **$12,535 \pm 300$
10,585 B.C.**

Marine pelecypod shells from fossiliferous glaciomarine drift exposed in sea cliff 0 to 15 ft above mean sealevel on West Beach (48° 14'

N Lat, 122° 46' W Long), Whidbey Island, Washington. No overlying or underlying sediments exposed at site, but sample drift overlies Vashon till 0.5 mi N. *Comment* (D.J.E.): date establishes age of glaciomarine drift on Whidbey Island. Deposition was during a submergence occurring shortly after Vashon glaciation and correlates with similar deposits in N Puget and Fraser Lowlands (Easterbrook, 1962; 1963).

10,370 ± 300

I-1035. Bellingham, Washington

8420 B.C.

Wood from tree branch in small sand lens enclosed by fossiliferous glaciomarine drift at Bellingham (48° 46' N Lat, 122° 28' W Long), Washington. *Comment* (D.J.E.): sample is from Bellingham glaciomarine drift overlying a sand unit and another glaciomarine drift in sea cliff exposures 2 mi W. Date establishes age of submergence and deposition of Canadian-derived material by floating ice during latest phases of last major glaciation.

11,800 ± 400

I-1037. Nooksack Valley, Washington, No. 1

9850 B.C.

Wood from SW bank of Nooksack River, 1¼ mi S of Mt. Baker Highway Bridge (46° 52' N Lat, 123° 17' W Long), Washington. Taken from near middle of Bellingham glaciomarine drift overlying ca. 30 ft of Deming sand and 30 ft of Kulshan glaciomarine drift. *Comment* (D.J.E.): date establishes age of Bellingham glaciomarine drift and indicates that a very short time elapsed between deposition of Kulshan drift (W-996, 11,600 ± 350, USGS VII), Deming sand (W-940, 11,640 ± 275, USGS VII), and Bellingham glaciomarine drift.

12,970 ± 280

I-1447. Nooksack Valley, Washington, No. 2

11,020 B.C.

Marine shells overlain by several feet of sand in glaciomarine drift 1 mi SE of Deming (48° 48' N Lat, 122° 12' W Long), Washington. *Comment* (D.J.E.): dates extension of Kulshan glaciomarine conditions into Nooksack Valley.

11,850 ± 240

I-1448. Penn Cove Park, Washington

9900 B.C.

Shells in glaciomarine drift ca. 10 ft above sealevel at Penn Cove Park (48° 14' N Lat, 122° 40' W Long), Washington, (Easterbrook, 1965). *Comment* (D.J.E.): dates glaciomarine of Everson age on Whidbey Island.

12,350 ± 330

I-1469. Cattle Point, Washington

10,400 B.C.

Shells in glaciomarine drift overlying sand and gravel 1 mi W of Cattle Point (48° 14' N Lat, 122° 59' W Long), San Juan Island, Washington.

- 12,160 \pm 290**
- I-1470. Davidson Head, Washington** **10,210 B.C.**
 Shells in glaciomarine drift lying on Triassic bedrock at Davidson Head (48° 37' N Lat, 123° 08' W Long), San Juan Island, Washington.
- 12,000 \pm 450**
- I-1471. Little Sucia, Washington** **10,050 B.C.**
 Shells from glaciomarine drift and associated sediments lying on Upper Cretaceous bedrock on Little Sucia Island (48° 46' N Lat, 122° 55' W Long), Washington.
- 26,850 \pm 1700**
- I-1111. Strawberry Point, Washington** **24,900 B.C.**
 Peat and wood from sea cliff, ¼ mi N of Strawberry Point (48° 18' N Lat, 122° 30' W Long), Whidbey Island, Washington. Taken from peat bed lying on till ca. 5 ft above sealevel. Peat marks base of sand unit ca. 80 to 100 ft thick which is capped by Vashon drift.. Coll. and subm. 1963 by D. J. Easterbrook. *Comment* (D.J.E.): date indicates that till beneath peat is pre-Vashon and sets limiting age for overlying sand unit which is interpreted as early Vashon.
- >35,000**
- I-1385. Pt. Roberts, Washington**
 Wood from above unconformity at base of thick sand sequence capped by Vashon till at Point Roberts (48° 59' N Lat, 123° 01' W Long), 1 mi S of Maple Beach, Washington. Coll. and subm. 1964 by D. J. Easterbrook. *Comment* (D.J.E.): deposits correlate with Quadra Formation stratigraphically, but age of this sample makes the correlation uncertain.
- >40,000**
- I-1203. Useless Bay, Washington**
 Wood from sea cliff at E side Useless Bay (47° 58' N Lat, 122° 27' W Long), 1½ mi S of Sunlight Beach, Whidbey Island, Washington. Taken from till-like drift ca. 80 ft above sealevel, overlain by sand and Vashon till. Coll. and subm. 1963 by D. J. Easterbrook. *Comment* (D.J.E.): date confirms interpretation of till as pre-Vashon and indicates that a glaciation of Puget Lowland occurred between deposition of underlying Whidbey Formation and last interglaciation. Site is one of few places where till occurs between Whidbey Formation and overlying sand unit.
- 200 \pm 75**
- I-649. Heins Creek site, Wisconsin** **A.D. 1750**
 Burned wood fragments from Heins Creek site in sand dune area (45° 01' N Lat, 87° 09' W Long), on coast of Lake Michigan, 4¼ mi S of Bailey's Harbor, Door County, Wisconsin. Coll. from buried humus zone, 1 to 2 ft thick ca. 4½ ft beneath aeolian sand and ca. 10½ ft above level of lake in a sand dune stabilized by heavy vegetation. Coll. 1961 and subm. 1962 by R. J. and C. I. Mason, Lawrence College,

Appleton, Wisconsin. *Comment* (R.J.M.): found in same stratum with triangular projectile points and pottery of early Late Woodland Heins Creek Complex, but date is too recent to provide age for archaeological material. Sample is likely from a much later intrusion and may provide maximum age for deposition and stabilization of overlying dune cap. I-678, 1230 ± 150 (Isotopes IV) which dates the archaeological material is considered reliable.

$34,700 \pm 2200$

I-418. Gooseberry Anticline, Wyoming

$32,750$ B.C.

Wood altered to coal(?) from small gray clay lens 12 ft below surface inside of gully within old alluvium, in Gooseberry Anticline area, W $\frac{1}{2}$, SW $\frac{1}{4}$, SE $\frac{1}{4}$, NE $\frac{1}{4}$ sec. 33, T47 N, R100 W, 6th P.M., (44° N Lat, $108^\circ 51' 40''$ W Long), Park County, Wyoming. Coll. and subm. 1960 by W. L. Rohrer, U. S. Geol. Survey, Washington.

7200 ± 200

I-473. Dent Mammoth, Colorado, No. 1

5250 B.C.

$11,200 \pm 500$

I-622. Dent Mammoth, Colorado, No. 2

9350 B.C.

Bone and tusk fragments from a young mammoth from Lindenmeier site ($40^\circ 19'$ N Lat, $104^\circ 49'$ W Long), 2 mi SE of Milliken, Colorado. Removed and preserved with shellac during 1933 archaeological excavations. Sample provided by H. M. Wormington, Denver Mus. of Nat. His.; subm. 1961 by George Agogino and C. V. Haynes, Univ. of Arizona, Tucson, Arizona. *Comment* (C.V.H., G.A.): age on I-473 is inconsistent with geological and archaeological evidence which suggest age of 11,000 to 12,000 B.P. Sample was charred in an inert atmosphere prior to leaching with HCl. Indications are that all of shellac preservative was not removed by this pretreatment. A second aliquot of the sample (I-622) was ground to a fine powder, leached with alcohol and acetone, pyrolyzed, and leached with HCl prior to radiocarbon analysis. Date obtained on I-622 is consistent with geological estimate of age of Kersey terrace fill and with radiocarbon dating of Llano (Clovis) complex at Lehner site, Arizona. If terrace remnant at Dent is correlative with Corral Creek moraine, this date marks end of Corral Creek stade of Rock Mountain glaciation (Haynes and Agogino, 1960).

$11,280 \pm 350$

I-449. U. P. Mammoth site, Wyoming

9330 B.C.

Mammoth tusk from U. P. Mammoth site ($40^\circ 31'$ N Lat, $107^\circ 39'$ W Long), 27 mi SW of Rawlins, Wyoming. Partially articulated mammoth skeleton with associated artifacts occurred in clay and gravel channel fill overlain by fine grained alluvium. Tusks were only slightly mineralized. Coll. 1961 by George Agogino; subm. 1961 by Agogino, C. V. Haynes, Cynthia Irwin and Henry Irwin. *Comment* (G.A.): select interior portions of tusks were charred in an inert atmosphere and leached

for 24 hr in HCl prior to radiocarbon analysis. Sample dates the kill of a mammoth by man and suggests a Two Creeks age for lowest part of channel fill (Irwin *et al.*, 1962).

4975 \pm 180

I-474. U. P. Mammoth site, Wyoming

3025 B.C.

Wood fragments from U. P. Mammoth site (40° 31' N Lat, 107° 39' W Long), 27 mi SW of Rawlings, Wyoming. Sample from gravels containing mammoth bones and artifacts in channel fill and overlain by fine grained alluvium. Coll. 1961 by Cynthia and Henry Irwin; subm. 1961 by Henry Irwin, Cynthia Irwin, George Agogino and C. V. Haynes. *Comment* (G.A.): age of sample suggests reworking of upper parts of channel fill and incorporation of the wood possibly during the Alti-thermal (Irwin *et al.*, 1962).

10,375 \pm 700

I-472. Brewster site, Wyoming

8425 B.C.

Wood charcoal from Brewster site (43° 22' N Lat, 104° 04' W Long), 3 mi NE of Mule Creek Oil field, Wyoming. Coll. from basal portions of an alluvial fill and associated with *Bison antiquus* remains and Folsom artifacts. Coll. and subm. 1961 by C. V. Haynes and George Agogino. *Comment* (C.V.H.): dates time of Folsom occupation contemporaneous with *Bison antiquus* and is consistent with dating of overlying Agate Basin occupation (M-1131, 9990 \pm 450, Michigan VIII; O-1252, 9350 \pm 450, unpub.). Dates confirm geologic interpretation of post Two Creeks—pre-Alti-thermal channel fill and loess accumulations.

C. Eastern United States

34,000 \pm 2000

I-749. Frankford, Delaware

22,050 B.C.

Shell (*Crassostrea virginica*) in blue-black silt and fine sand of the outcrop of Omar Formation in Pepper Creek Ditch, 100 ft E of Rt. 113 N of Frankford (38° 32' N Lat, 75° 15' W Long), Delaware. Coll. 1962 and subm. 1963 by R. R. Jordan, Delaware Geol. Survey.

23,300 \pm 850

I-854. Indian River Inlet, Delaware

21,350 B.C.

Wood from core sample 126 to 127 ft below land surface in well Pj 32-3, 60 ft S of S bank of inlet, 110 ft E of Rt. 14, Indian River Inlet (38° 36' N Lat, 75° 04' W Long), Sussex Co., Delaware. Coll. 1962 and subm. 1963 by R. R. Jordan.

I-747. Omar, Delaware

\geq 32,000

Wood from 0.8 mi E of Omar, Sussex Co., Delaware on Rt. 54 (38° 32' N Lat, 75° 12' W Long). Core sample from 24 ft below land surface (elev 22 ft) in well Qh 44-1, in quartz sand, fine, silty and clayey. Omar Formation. Coll. 1958 and subm. 1963 by J. J. Groot and R. R. Jordan, Delaware Geol. Survey.

I-284. Panama City, Florida **36,500 ± 2000**
34,550 B.C.

Wood from submerged forest in 60 ft of water on continental shelf off (30° 09' N Lat, 85° 48' W Long) Panama City, Florida. Trees stand vertical in a coarse, shelly, relict sand, but have been abraded off level with sea floor. Coll. and subm. 1961 by George Shumway, U. S. Navy Electronics Lab., San Diego, California.

I-1747. Cape Fear River, N Carolina **14,000 ± 250**
12,050 B.C.

Peat from along N bank of Cape Fear River at Big Sugar Loaf Bluff (34° 37' N Lat, 78° 31' W Long), Bladen County, N Carolina. 2.60 to 2.70 m from top of section in horizon intercalated in sands. Coll. and subm. 1965 by D. R. Whitehead, Biology Dept., Williams College, Williamstown, Mass. *Comment* (D.R.W.): pollen study of peat, correlated with this date, should contribute much to understanding of full-glacial conditions in SE N Carolina.

I-1746 Intracoastal Waterway, N Carolina, 6.00 m **35,800 -3000**
+4200
33,850 B.C.

Peat from along S bank of Intracoastal Waterway, W of Long Beach (33° 55' N Lat, 78° 09' W Long), Brunswick County, N Carolina. Upper of two peat horizons intercalated in fluvial sands. 6.00 to 6.40 m from top of section. Coll. and subm. 1965 by D. R. Whitehead. *Comment* (D.R.W.): see comment on I-1745, this list.

I-1745. Intracoastal Waterway, N Carolina, 7.20 m **36,000 -2600**
+3700
34,050 B.C.

Peat from along S bank of Intracoastal waterway, same locality as I-1746 (this list), but lower of two peat horizons, 7.20 to 7.40 m from top of section. Coll. and subm. 1965 by D. R. Whitehead. *Comment* (D.R.W.): peats at this locality are from deposits formerly considered interglacial and marine. Date is much too young to permit assignment to the Sangamon; and pollen evidence indicates fresh water conditions and a flora consisting of boreal and austral elements. Correlation with Port Talbot Interstadial seems likely.

D. Canada

I-939. Saanich Inlet, British Columbia, Core No. 4 **3100 ± 200**
1150 B.C.

Organic content of core No. 4 from E end of Squally Reach, Saanich Inlet (48° 35' N Lat, 123° 30' W Long), British Columbia. From 1940 cm below sediment interface in recent marine sediments. No fossils except for remains of planktonic diatoms. Coll. and subm. 1962 by S. M. Gucluer, J. S. Creager, M. G. Gross, Univ. of Washington, Seattle.

Comment (M.G.G.): demonstrated sedimentation rate of ca. 6 mm/yr is consistent with sedimentation rate obtained from average varve thickness (Gross *et al.*, 1963).

22,900 ± 1500

I-773. Wood River, British Columbia

20,950 B.C.

Wood from 475 ft above Columbia River and 10 ft below ground surface in lens of blue-grey organic silt in glacial till near confluence of Columbia and Wood rivers (52° 07' N Lat, 118° 24' W Long), E central British Columbia. Coll. 1962 and subm. 1963 by F. Mylrea, CASECO Consultants, Ltd., Vancouver, British Columbia. *Comment* (F.M.): glacial till above sample horizon was probably deposited at end of Pleistocene.

North Greenland series

Samples from raised beaches in N Greenland. Coll. and subm. 1960 to 1961 by W. E. Davies and D. B. Krinsley, U. S. Geol. Survey, Washington.

4860 ± 150

I-306. Kap Trend, N Greenland

2910 B.C.

Wood from raised marine beach alt 89 ft at Kap Trend, Danmark Fjord (80° 45' N Lat, 23° 45' W Long). Sampled from driftwood log on beach consisting of thin gravel deposit on marine clay-silt.

2580 ± 150

I-307. Kap Wyckoff, N Greenland

630 B.C.

Wood from small driftwood log on storm ridge formed of angular limestone rubble 25 ft above sealevel at Kap Wyckoff (82° 53' N Lat, 24° 05' W Long), Peary Land.

4830 ± 150

I-308. Danmark Fjord, N Greenland, No. 1

2880 B.C.

Shells, *Mya truncata* and *Hiatella arctica* from marine clay-silt terrace 25 ft above sealevel at head of Danmark Fjord (80° 31' N Lat, 23° 30' W Long). Picked by hand from top 4 in. of clay-silt which is covered by thin veneer of gravel.

4925 ± 150

I-309. Brønlund Fjord, N Greenland

2975 B.C.

Shells, *Mya truncata*, from marine silt and clay, 25 ft above sealevel (82° 08' N Lat, 29° 45' W Long), 2 mi NE of Kap Moltke, Brønlund Fjord. Site is ca. 20 mi within limit of former extent of continental ice cap. Sample is from bottom deposits.

7900 ± 200

I-310. Skagen, N Greenland

5950 B.C.

Shells, *Mya truncata* and *Hiatella arctica* imbedded in clay-silt of marine terrace 6 mi S (83° 02' N Lat, 25° 00' W Long) of Skagen, Peary Land.

I-311. Kølén, N Greenland**8550 ± 250****6600 B.C.**

Shells, *Hiatella arctica* from marine clay-silt beds 255 ft above sea-level at Kølén (82° 08' N Lat, 29° 15' W Long), 6 mi E of Brønlund Fjord. Site is on N flank of Kølén at highest point on marine clay-silt beds. *Comment* (W.E.D.): date represents maximum marine transgression in the area and compares well with data of maximum marine transgression in northern Canada (I-215, 8360 ± 175, I-179, 8370 ± 200, Isotopes II; Craig, 1961).

I-312. Kap Viborg, N Greenland**4975 ± 150****3025 B.C.**

Wood from small log resting in coarse marine beach gravel 125 ft above sealevel at Kap Viborg (80° 55' N Lat, 23° 30' W Long).

I-313. Danmark Fjord, N Greenland, No. 2**3375 ± 150****1425 B.C.**

Wood from driftwood log from same site as I-308. *Comment* (W.E.D.): date is compatible with other driftwood dates along Danmark Fjord (I-312, I-306, this list), but contrasts slightly with date on marine shells (I-308, 4830 ± 150) from same site.

I-314. Mudder Bugt, N Greenland**>32,000**

Wood (willow?) from top of terminal moraine of continental glacier, 450 ft above sealevel (82° 28' N Lat, 22° 45' W Long), 8 mi N of Mudder Bugt, Peary Land. *Comment* (W.E.D.): moraine marks maximum Wisconsin advance of continental ice sheet in N Greenland.

I-371. Ingolfs Fjord, N Greenland**7580 ± 200****5630 B.C.**

Shells, *Mya truncata* and *Hiatella arctica*, from marine clay-silt deposits 220 ft above sealevel (80° 27' N Lat, 20° 45' W Long), 3 mi S of Naesen, Ingolfs Fjord.

*E. Europe***N Karelia series, Finland**

Samples from 3 pollen-analytically investigated sediments from N Karelia, Finland, dated to determine ages of sediments and initial phases of local vegetational history. Coll. and subm. 1963 by Hunnu Hyvärinen, Univ. of Helsinki, Helsinki.

I-1173. Inari, Finland, 225 cm**8550 ± 300****6600 B.C.**

Detritus mud from Inari (63° 18' N Lat, 30° 55' E Long), N Karelia, Finland. Pond bottom sediment from depth of 225 cm below pond surface. Alt 200 m above sealevel. Pollen stratigraphic position is *Betula maximum*.

I-1172. Inari, Finland, 245 cm**9540 ± 300****7590 B.C.**

Silty fine detritus mud from same site as I-1173, but at depth of 245 cm below pond surface. Underlain by 20 cm silty mud and 30 cm silt and sand. Pollen stratigraphic position; NAP rich phase preceding *Betula* maximum.

Happalahti, N Karelia, Finland, sub-series

Peat samples from peat bog in Haapalahti, N Karelia (63° 01' N Lat, 30° 08' E Long), Finland. Ca. 110 m above sealevel.

I-1177. Haapalahti, Finland, 275 cm**5025 ± 220****3075 B.C.**

Sphagnum-Carex peat from depth of 275 cm below bog surface. Pollen stratigraphic position: rise of *Picea* and *Pinus* after climatic optimum.

I-1176. Haapalahti, Finland, 545 cm**9155 ± 300****7205 B.C.**

Bryales-Carex peat from depth of 545 cm below bog surface. Pollen stratigraphic position: *Pinus* maximum.

I-1175. Haapalahti, Finland, 570 cm**9410 ± 300****7460 B.C.**

Bryales-Carex peat from 570 cm below bog surface. Pollen stratigraphic position: end of *Betula* maximum.

I-1174. Haapalahti, Finland, 600 cm**8900 ± 300****6950 B.C.**

Basal *Bryales* peat from 600 cm below surface of bog. Pollen stratigraphic position: beginning of *Betula* maximum.

I-1178. Koli, Finland**9155 ± 350****7205 B.C.**

Silty fine-detritus mud from pond sediment at Koli (63° 04' N Lat, 29° 06' E Long), N Karelia, Finland. From 505 cm below pond surface at ca. 220 m above sealevel. Underlain by 5 cm silty mud and 10 cm silt and sand. Pollen stratigraphic position: transition from NAP phase to *Betula* maximum.

General Comment (H.H.): ages for I-1172, I-1173 and I-1178 are in agreement and thus the NAP/*Betula* phase transition would be more than 9000 B.P. and less than 9500 B.P. Internal inconsistency of dates for I-1174, I-1175, and I-1176 may be due to mixing by water in the raw and partly sand-mixed peat. These latter dates do, however, yield evidence that basal part of the bog, formed during *Betula* phase, is ca. 9000 yr old, which is in accord with former dates.

I-680. Ilomantsi, Finland **5350 ± 190**
3400 B.C.

Peat from depth of 1.9 m in bog at Puohtiinsuo, Ilomantsi (62° 44' N Lat, 31° 05' E Long), Finland. Bog is at 150 m alt and sample underlies *Sphagnum-Carex* peat. Coll. and subm. 1962 by Kimmo Tolonen, Botanical Inst., Univ. of Helsinki, Helsinki. *Comment* (K.T.): pollen analysis indicates that sample dates beginning of the spruce (*Picea abies*) migration in Ilomantsi (Tolonen, 1963).

Kuusamo series, Finland

Samples from Kuusamo district, Finland to check tentative dating of phases of vegetational development in the area (Vasari, 1962). Coll. 1959 and subm. 1963 by Yrjö Vasari, Dept. of Botany, Univ. of Oulu, Oulu, Finland.

I-774. Meskusjärvi, Finland **9150 ± 300**
7200 B.C.

Coarse organic mud from Meskusjärvi (66° 00' N Lat, 28° 56' E Long). From depth of 230 to 240 cm in transition zone overlying *Carex* peat to fine gyttja. *Comment* (Y.V.): age is ca. 1000 yr greater than expected, but seems to confirm correlation of the spread of pine forest in this area with late pre-Boreal, early Boreal period (Vasari, 1962).

I-775. Tollakkolampi, Finland, 380 cm **8430 ± 300**
6480 B.C.

Coarse gyttja and brown peat from Tollakkolampi, Maanselkä (65° 50' N Lat, 29° 05' E Long). From depth of 380 to 390 cm at boundary between coarse gyttja and brown moss peat. *Comment* (Y.V.): date corresponds closely to the supposed age, early Boreal period (Vasari, 1962, 1963; I-774, this series).

I-777. Tollakkolampi, Finland, 420 cm **8435 ± 300**
6485 B.C.

Clay gyttja from Tollakkolampi, Maanselkä (65° 50' N Lat, 29° 05' E Long). From layer of clay gyttja, 10 cm thick at depth of 420 to 430 cm between underlying minerogenic sediments and overlying fine gyttja. *Comment* (Y.V.): sample was expected to yield date for time of spread of birch forests to this area corresponding to Younger Dryas/pre-Boreal (Vasari, 1963). Age is, however, ca. 1500 yr younger than expected, probably due to contamination with younger material.

I-776. Säynäjälampi, Finland **3450 ± 170**
1500 B.C.

Peat from Säynäjälampi, Teerisuo (66° 11' N Lat, 28° 56' E Long), Kuusamo district, Finland. From uppermost 10 cm of telmatic *Sphagnum-Carex-Bryales* peat, at depth of 90 to 100 cm, overlain by transgressive gyttja. Coll. 1959 and subm. 1963 by Yrjö Vasari. *Comment* (Y.V.): sample was expected to confirm correlation of the start of the last phase

in the local vegetational development with the opening of the Subatlantic period (Vasari, 1962, 1963). Age obtained is ca. 700 yr older than expected.

Woodgrange series, N Ireland

Samples of highly humified, dark brown, fine organic detritus from an organic layer underlying marine sand of postglacial age in a raised beach deposit at Woodgrange (54° 19' N Lat, 05° 47' W Long), County Down, N Ireland. Coll. and subm. 1963 by Gurdip Singh, Birbal Sahni Inst. of Paleobotany, Lucknow, India.

7220 ± 175

I-1198. Woodgrange, N Ireland, No. 1

5270 B.C.

Top of layer of organic detritus, apparently from Transgression contact.

3125 ± 150

I-1199. Woodgrange, N Ireland, No. 2

1175 B.C.

Bottom of layer of organic detritus, apparently from Regression contact.

Comment (G.S.): ages corroborate conclusions obtained from pollen analysis (Singh, 1964; Singh, 1965), and other C¹⁴ data (LJ-903, LJ-908, LaJolla IV), that there was massive marine incursion in late Boreal period during which the major part of postglacial relative sealevel rise was completed and that the maximum occurred shortly before 3000 B.P.

F. Africa

I-1094. Upper Diamond Terrace, Africa

>28,000

Barnacles adhering to smooth surface of pothole in schist (discovered during removal of diamantiferous gravels) now ca. 10 m above sealevel (28° 30' S Lat, 16° 20' E Long). Coll. and subm. 1963 by Willard Bascom, Ocean Science and Engineering, Inc., Washington, D. C. *Comment* (W.B.): first dating of this raised sea-terrace which extends 30 mi along coast of SW Africa.

11,650 ± 300

I-532. Akasha, Sudan

9700 B.C.

Pelecypod shells (*Corbicula artini*) from Khor Kidingkong (21° 12' N Lat, 30° 41' E Long), in Akasha district, 200 m E of Nile, 100 km SW of Wadi Halfa, Sudan. Site is 15 m above Nile flood level, and 195 m above mean sealevel in soft pale gray Sebilian silt, stratigraphically the younger part, 20 m below top. There are no associated fossils. Coll. 1961 and subm. 1962 by R. W. Fairbridge, Columbia Univ., New York. *Comment* (R.W.F.): most shells of sample are articulated, minimizing possibility of reworking or transportation by currents. They occupy a rich horizon in a former backwater of the river in a thick sequence of silts otherwise barren. Since overlying 20 m of silt is uninterrupted, date re-

flects youngest high oscillation of the Nile when siltation built the valley to 35 m above present flood level. Time corresponds to warm (Alleröd) interstadial of Europe and N America.

G. Brazil

I-695. Bay of Paranagua, Brazil

2675 ± 150

725 B.C.

Wood from ilmenite layer under 1.8 m of old beach deposits at Bay of Paranagua, Parana (25° S Lat, 48° W Long), Brazil. Layer is 0.8 m above present maximum high tide level. Coll. 1962 by J. J. Bigarella; subm. 1962 by W. R. Hurt, Univ. of Indiana, Bloomington, Indiana. *Comment* (W.R.H.): beach deposits overlying specimen may correspond with worldwide rise in sealevel designated the *Abrolhos* (ca. 2400-2000 B.P.) by Fairbridge (1960).

II. PHYSICAL GEOGRAPHY SAMPLES

A. Canadian North West Territories

North Baffin Island series

Samples from various locations on Baffin Island, NW Territories. Coll. and subm. during 1962 and 1965 by members of the Geographical Branch, Dept. of Mines and Tech. Surveys, Ottawa, Canada.

I-1245. Tay Sound

4875 ± 350

2925 B.C.

Shells (*Pelecypoda*) from deltaic beds ca. 127 ft above sealevel on Tay Sound (71° 56' N Lat, 78° 35' W Long). Coll. 1963 by G. Falconer; subm. 1964 by J. D. Ives. *Comment* (G.F.): sample alt is 133 ft below local postglacial marine limit.

I-1316. Tay Sound

8250 ± 750

6300 B.C.

Shells of *Mytilus edulis* Linné occurring *in situ* in deltaic deposit (71° 56' N Lat, 78° 34' W Long). Shell-bearing bed exposed at 193 ft above sealevel whereas marine limit is estimated at 260 ft. *Mytilus edulis* was found in association with *Macoma balthica* (Linné) and *Mya* sp. but only *Mytilus* used for dating. Coll. 1963 by G. Falconer; subm by J. T. Andrews.

I-1317. Tay Sound

3660 ± 480

1710 B.C.

Marine shells of *Macoma balthica* (Linné) occurring with *Mytilus edulis* at 50 ft above sealevel (71° 52' N Lat, 78° 23' W Long). Coll. by G. Falconer 1965; subm. by J. T. Andrews.

I-724. Tay Sound

8350 ± 300

6400 B.C.

Pelecypod shells from SW arm of Tay Sound (72° 00' N Lat, 79° 15' W Long). From 248 ft above sealevel in raised beach deposits. The

upper limit of postglacial marine submergence has been identified at 287 ft above sealevel in this locality. Coll. and subm. by G. Falconer. *Comment* (G.F.): date suggests association with higher sealevels prevailing during latter part of Cockburn I glacial phase (Ives, 1963).

I-1318. Tay Sound

4400 ± 490

2450 B.C.

Marine shells *Mya* sp., probably *Mya truncata* Linné, found broken in clay beds at 44 ft above sealevel and 6 ft below I-1317 (71° 52' N Lat, 78° 23' W Long). Coll. by G. Falconer; subm. by J. T. Andrews.

I-1319. Koluktoo Bay

5710 ± 200

3760 B.C.

Marine shells, *Mytilus edulis* Linné, *Astarte montagui* var. *warhami* Hancock, *Macoma calcaria* (Gmelin), *Macoma balthica* (Linné), *Mya truncata* (Linné), *Hiatella arctica* (Linné). Coll. from surface of raised marine shoreline 55 ft above sealevel (80° 03' N Lat, 81° 07' W Long). Coll. by G. Falconer; subm. by J. T. Andrews.

I-1246. Koluktoo Bay

7930 ± 300

5980 B.C.

Shell fragments from Koluktoo Bay (72° 03' N Lat, 81° 10' W Long), Milne Inlet. Coll. from clay deposits within moraine loop ca. 197 ft above sealevel. Coll. 1963 by G. Falconer; subm. 1964 by J. D. Ives. *Comment* (G.F.): date provides probable minimum date of formation of Cockburn moraine system in N Baffin Island (Ives, 1964).

I-1320. Milne Inlet

4010 ± 440

2060 B.C.

Marine shells *Macoma balthica* *Mya truncata* *Hiatella arctica* *in situ* 59 feet above sealevel in sandy deltaic beds (71° 53' N Lat, 80° 55' W Long). Shell-bearing layer sloped upwards to surface beach ridges at ca. 68 ft. Coll. by G. Falconer; subm. by J. T. Andrews.

I-1315. Arctic Bay

9360 ± 230

7410 B.C.

Peat from 20-ft thick bed in stream bank on slopes of King George V Mountain at 150 ft above sealevel (73° 02' N Lat, 85° 11' W Long). Ref. G. Falconer, J. D. Ives, O. H. Løken, and J. T. Andrews, 1965. Coll. by G. Falconer; subm. by J. T. Andrews.

I-1204. "Tiger" Ice Patch

330 ± 75

A.D. 1620

Dead moss (*Polytrichum juniperum*) from area exposed by ice retreat since summer 1961, on N Baffin Island (71° 20' N Lat, 78° 50' W Long), NW Territory. Coll. 1963 by G. Falconer; subm. by R. Beschel and G. Falconer. *Comment* (G.F.): recent rapid recession of thin stagnant ice cover in this locality reveals undisturbed patterned ground features and dead moss mats. Sample may date a climatic deterioration

and significantly more snowy period beginning ca. A.D. 1620. This agrees with Ives' (Ives, 1962) findings based on geomorphic evidence from N margin of Barnes Ice Cap.

Sam Ford Fiord series

The following samples were all from the same deposit ($70^{\circ} 01' \text{ N Lat}$, $71^{\circ} 33' \text{ W Long}$) at Sam Ford Fiord, Baffin Island, from sand and silt beds in stratified beach deposit. Coll. and subm. by O. H. Løken.

I-1668. Sam Ford Fiord **3830 ± 140**
1880 B.C.

Shells of *Serripes groenlandicus* (Bruguere), *Mya truncata* and *Hiatella arctica*. *Comment* (O.H.L.): sample dates a relative sealevel 18.5 m above present sealevel.

I-1669. Sam Ford Fiord **4770 ± 140**
2820 B.C.

Shells of *Mya truncata* found 435 m SW of head of Fiord. *Comment* (O.H.L.): sample dates a relative sealevel 21.5 m above present sealevel.

I-1670. Sam Ford Fiord **4770 ± 140**
2820 B.C.

Shells of *Mya truncata* found 395 m SW of head of Fiord. *Comment* (O.H.L.): sample dates a relative sealevel 20 m above present level although there appears to be an unexplained discrepancy between this date and the others in the series.

I-1671. Sam Ford Fiord **4270 ± 140**
1320 B.C.

Shells of *Mya truncata* and *Hiatella arctica* found 455 m SW of head of Fiord. *Comment* (O.H.L.): sample dates a relative sealevel 23.5 m above present sealevel.

I-1321. Sam Ford Fiord **5390 ± 150**
3440 B.C.

Shells of *Macoma calcarea*, *Mya* sp., and *Hiatella arctica* from crest of bank ca. 70 ft below marine limit. Ref. Falconer *et al.*, 1965. Coll. by J. D. Ives; subm. by J. T. Andrews. *Comment* (J.T.A.): date provides a minimum estimate on age of the Cockburn moraines and provides information on the isostatic recovery of the area.

I-1243. Walker Arm **5560 ± 250**
3610 B.C.

Shells from crest of a bank of marine silt on Walker Arm ($70^{\circ} 16' \text{ N Lat}$, $71^{\circ} 43' \text{ W Long}$). Coll. 1963 and subm. 1964 by J. D. Ives. *Comment* (J.D.I.): sample is from 100 ft below marine limit. Age indicates that maximum marine transgression occurred >5600 yr B.P. and that outer Cockburn moraines, which terminate far to seaward of locality, must be appreciably older than 5600 B.P.

I-1553. Sam Ford Fiord**7500 \pm 200****5550 B.C.**

Shells of *Macoma* sp. found on E side of Sam Ford Fiord (70° 13' N Lat, 71° 18' W Long), on a delta associated with terminal position of outlet glacier. Coll. and subm. by O. H. Løken. *Comment* (O.H.L.): date gives maximum age of adjacent terminal moraine.

I-1556. Sam Ford Fiord**6240 \pm 140****4290 B.C.**

Shells of *Macoma* sp. from a site 2.5 km W of head of Fiord in clay on edge of a fluvial deposit. Coll. and subm. by O. H. Løken. *Comment* (O.H.L.): sample gives minimum date for deglaciation of the inner part of the Fiord.

Inugsuin Fiord series

Shells from sand and silt beds in stratified beach deposit (69° 37' N Lat, 70° 01' W Long). Coll. by O. H. Løken; subm. by J. D. Ives. Ref. Løken, O. H., 1965.

I-1554. Inugsuin Fiord**7030 \pm 190****5080 B.C.**

Shells of *Chlamys islandicus* (Muller) *Clinocardium ciliatum* (Fabricius), *Mytilus edulis*, *Mya truncata*, *Hiatella arctica* found 920 m S of head of fiord. *Comment* (O.H.L.): date gives age of relative sealevel more than 44.5 m above present sealevel.

I-1555. Inugsuin Fiord**2800 \pm 140****850 B.C.**

Shells of *Mytilus edulis*, *Hiatella arctica*, *Macoma balthica* from 250 m S of head of fiord. Dating relative sealevel 8.0 m above present sealevel (O.H.L.).

I-1596. Inugsuin Fiord**6150 \pm 170****4200 B.C.**

Shells of *Mytilus edulis* from 830 m S of head of fiord dating a relative sealevel 37.0 m above present sealevel (O.H.L.).

I-1597. Inugsuin Fiord**4090 \pm 150****2140 B.C.**

Shells of *Mytilus edulis*, *Mya truncata*, *Macoma balthica*, *Hiatella arctica* from 480 m S of head of fiord dating sealevel 1915 m above present sealevel (O.H.L.).

I-1598. Inugsuin Fiord**7200 \pm 150****5250 B.C.**

Shells of *Clinocardium ciliatum*, *Hiatella arctica*, *Mya truncata* from 925 m S of head of fiord and dating a relative sealevel 44.5 m above present level (O.H.L.).

2990 \pm 140
1040 B.C.

I-1599. Inugsuin Fiord

Shells of *Macoma balthica*, *Hiatella arctica*, and *Mya truncata* from 320 m S of head of fiord dating a relative sealevel 9.0 m above present level (O.H.L.).

3520 \pm 230
1570 B.C.

I-1600. Inugsuin Fiord

Shells of *Mya pseudoarenaria* (Schlesh.) and *Mya truncata* found 380 m S of head of fiord and dating a relative sealevel 14.5 m above present level (O.H.L.).

3530 \pm 130
1580 B.C.

I-1601. Inugsuin Fiord

Shells of *Mytilus edulis*, *Mya truncata*, *Macoma balthica*, *Mya pseudoarenaria* and *Hiatella arctica* from 420 m above head of fiord and dating a relative sealevel of more than 12.8 m above the present. (O.H.L.).

7900 \pm 210
5950 B.C.

I-1602. Inugsuin Fiord

Shells of *Chlamys islandicus* from head of fiord (69° 38' N Lat, 70° 02' W Long) at alt of 32 m above sealevel, from folded bed of sand and silt. Coll. by D. M. Barnett; subm. by O. H. Løken. *Comment* (O.H.L.): sample dates the minimum age.

7080 \pm 170
5030 B.C.

I-1672. Inugsuin Fiord

Shells of Pelecypoda and Gastropoda from head of fiord (69° 38' N Lat, 70° 02' W Long). Coll. and subm. by O. H. Løken. Coll. in sand bed above I-1602. The difference in age between the two samples gives an indication of deposition time for the intervening sediment.

7970 \pm 340
6020 B.C.

I-1673.

Marine mollusc shells from head of fiord (69° 38' N Lat, 70° 02' W Long). Sample found in contorted silt bed. Coll by D. M. Barnett; subm. by O. H. Løken. *Comment* (O.H.L.): coll. in same deposit as I-1602 but stratigraphically slightly above it.

McBeth Fiord series

170 \pm 105
A.D. 1780

I-1603. Thanes Lake

Stem and root of Arctic Willow (*Salix herbacea*) (69° 41' N Lat, 68° 44' W Long). Coll. by D. A. Harrison; subm. by O. H. Løken. The material was covered by lacustrine deposit from an ice dammed lake for which it gives a maximum age.

I-1674. Cawdor Glacier

<200

Mosses and lichens collected from rocks that were covered by a glacier until 5-7 yr ago. Collected to see if vegetation could survive a readvance of a glacier. Result inconclusive (O.H.L.).

West Coast series**I-1242. Felside Lake****19,000 \pm 1000****17,050 B.C.**

Shells, (Pelecypoda, Cirripedia) from S end of Felside Lake, Steensby Inlet (70° 03' N Lat, 77° 30' W Long). Sample from frost boils at elev of 115 \pm 7 m above sealevel or ca. 25 m above marine limit. Coll. 1963 by D. A. Harrison; subm. 1964 by J. D. Ives. *Comment* (J.T.A.): shell fragments are from surface of a calcareous till containing dolomite fragments from an area W of Felside Lake. Both dolomite fragments and shells were probably transported from the W by ice. Date possibly indicates a period of open water in Foxe Basin at ca. 19,000 B.P. Date compares with I-725, 17,800 \pm 500 (unpub.) and I-1314, 18,700 \pm 1200 (unpub.) from a locality 45 mi N of the head of Steensby Inlet.

I-725. Foxe Basin**17,800 \pm 500****15,850 B.C.****I-1314. Foxe Basin****18,700 \pm 1200****17,750 B.C.**

Shells of *Mya* sp. and *Astarte* sp. coll. by G. Falconer 45 mi N of head of Steensby Inlet (71° 08' N Lat, 78° 38' W Long). Ref. J. T. Andrews and G. Falconer (in preparation). *Comment* (G.F.): site is 170 ft above limit of postglacial marine incursion on E coast of Steensby Inlet. Two dates were obtained from a single sample. The first (I-725) was obtained after removal of the outer 10 percent, the second (I-1314) after removal of the outer 50 percent. There is good agreement between the dates obtained from I-725 and I-1314 with I-1242 (19,000 \pm 1,000) coll. by J. T. Andrews at a locality further south, and it is possible that the molluscs lived in open Foxe Basin sea ca. 19,000 yr ago.

Isortoq Detrital Bed series**I-731. Isortoq River****24,600 \pm 500****22,650 B.C.**

Woody peat from bank of Isortoq River (75° 05' N Lat, 70° 16' W Long), 16 mi W of present margin of Barnes Ice Cap. Site is a river bank exposure of 7 m of contorted peat; sample from 4 m above river level. Coll. 1962 and subm. 1963 by J. T. Andrews. *Comment* (J.T.A.): date need not represent maximum age of deposit because of inclination of bedding. Alder and dwarf birch remains suggest a slightly warmer climate than today. Taken in conjunction with I-839 there is a strong implication that during the period 24,000 to 30,000 B.P., the large pro-

portion of N-central Baffin Island was ice-free or at least carried less glacier ice than today (Andrews, 1963; Ives, 1964).

I-1233. Isortoq River

14,400 ± 400

12,450 B.C.

Peat from horizontal plant teaming beds truncating folded peat beds at approx. 690 ft above sealevel (75° 05' N Lat, 70° 16' W Long). Coll. and subm. by J. T. Andrews, 1963.

I-1234. Isortoq River

>35,000

Peat from youngest of exposed beds (75° 05' N Lat, 70° 16' W Long). Coll. and subm. 1963 by J. T. Andrews.

I-1235. Isortoq River

>40,000

Peat from under horizontal river sand, the oldest peat exposed (75° 05' N Lat, 70° 16' W Long). Coll. and subm. by J. T. Andrews, 1963.

I-1244. Isortoq Fiord

5070 ± 450

3120 B.C.

Shells from frost boil on gently sloping clay flat 140 ft above sealevel at Isortoq Fiord (69° 56' N Lat, 76° 54' W Long). Coll. and subm. 1963 by J. D. Ives. *Comment* (J.D.I.): coll. 150 ft below marine limit of this vicinity; provides evidence of area's progressive isostatic recovery and minimum date for withdrawal eastwards of Isortoq Valley glacier.

I-1247. Isortoq Fiord

3550 ± 200

1600 B.C.

Leaves and twigs of willow and mosses from Delta Valley, Isortoq Fiord (69° 56' N Lat, 77° 02' W Long). From a sporadic layer between coarse and fine sands of a delta at 17.93 m above sealevel. Coll. 1963 by D. A. Harrison; subm. 1964 by J. T. Andrews. *Comment* (J.D.I.): sampled from same vicinity as I-1244 and provides further data on post-glacial relationship between land and sea levels.

I-839. Isortoq River

30,000 ± 1200

28,050 B.C.

Leafy peat, partially carbonized, from same site as I-731, but immediately above river level. Coll. 1962 and subm. 1963 by J. T. Andrews. *Comment*: see I-731.

I-1240. Lewis Glacier

>35,000

Root or stem (*Salix* sp.) incorporated into ground moraine and uncovered, after 1948, by Lewis Glacier (70° 26' N Lat, 74° 44' W Long), NW margin of Barnes Ice Cap. Sample alt is 1300 ft above sealevel. Coll. by M. Church; subm. 1963 by J. T. Andrews. *Comment* (J.T.A.): date is surprisingly old in view of appearance of sample which had been assumed to date from the period prior to the 17th century advance of the Lewis Glacier. Date compares, however, to dates on plant fragments from Flitaway Lake (I-1241, this list), and Isortoq Valley (I-1234, I-1235, this

list). These samples contained plant remnants indicative of a warmer climate than exists today and may be evidence for an interglacial period.

I-1241. Flitaway Lake **> 30,000**

Organic plant remains including scales of *Betula nana* from Flitaway lake (70° 29' N Lat, 74° 40' W Long). Plant fragments occurred as a loosely compact cover over an ice-covered mound 1 km from present NW margin of Barnes Ice Cap. Remains were also incorporated into till layer above ice core. Coll. and subm. 1963 by J. T. Andrews. *Comment* (J.T.A.): date for this site may be compared to similar dates on plant remains from other localities in N-central Baffin Island (cf. I-1240, I-1234, I-1235, this list). Pollen and macro-fossil studies by J. Terasmae of Geol. Survey of Canada, and P. J. Webber of Queens Univ., indicate an assemblage of plants not found in the area today, but which do occur further S. Deposit may be tentatively referred to as from an interglacial period.

I-1238. Duart Bay **5070 ± 200**
3120 B.C.

Shells coll. from bedded sands of a delta 54 ft above sealevel, Duart Bay (71° 21' N Lat, 72° 54' W Long), Dexterity Fiord, Bruce Mts. Coll. by D. A. Harrison; subm. 1964 by J. D. Ives. *Comment* (J.T.A.): date adds to small number of dates available for the E coast of Baffin Island (cf. I-1243). The dates provide minimum dates for the withdrawal of main outlet glaciers from the fiords, and give indications of the post-glacial relationship between land and sealevels (Harrison, 1964).

B. Labrador, Newfoundland, Canada

Churchill River (formerly Hamilton River) series, Labrador

Peat samples from along the Churchill River, Labrador. Coll. 1962 by A. Morrison, Geog. Dept., McGill Univ., Montreal; subm. 1963 by J. D. Ives.

I-728. Sona Lake **5575 ± 250**
3625 B.C.

Sandy peat from bog in a kettle on isthmus between Sona Lake and Whitefish Lake (53° 35' N Lat, 63° 57' W Long), Labrador. From lowest predominantly organic material from deepest part of the bog, at depth of 260 to 270 cm below surface. Overlain by peat, underlain by silty sand to a depth of 300 cm. *Comment* (A.M.): age based on single count only, but checks well with I-880 and I-853, this series.

I-853. Churchill Falls (formerly Grand Falls) **5450 ± 220**
3500 B.C.

Silty peat and woody fragments from bog on SW rim of Churchill Falls (53° 36' N Lat, 64° 19' W Long), of Churchill River, Labrador. Obtained by Hiller corer from 370 to 380 cm below surface of bog lo-

cated in a kettle apparently truncated by retreat of the Falls. Sample was lowest predominantly organic material in core, and probably lowest in the bog. Overlain by peat and underlain by silt to depth of 427 cm.

5255 ± 200

I-880. Churchill Falls, Labrador, N

3305 B.C.

Peat from bog in a kettle close to NE bank of Churchill River, 1/2 mi N (53° 36' N Lat, 64° 19' W Long) of Churchill Falls, Labrador. Obtained by Hiller corer from 220 to 230 cm below surface. Lowest predominantly organic material in core, and probably lowest in the bog. Overlain by peat, underlain by silt to depth of >305 cm. Corer did not reach bottom of basin of deposition. *Comment* (A.M.): based on three dates of the series, allowing time for deposition of the small layers of silt below samples and for formation of the first peat, best estimate of date of deglaciation of Churchill Falls area is ca. 5750 B.P. (Morrison, 1963). Dates compare with those obtained by Grayson (Grayson, 1956) on SM-354, SM-355, SM-356 (Socony Mobil I).

8190 ± 710

I-1322. Eclipse Channel

6240 B.C.

Shells of *Mya truncata* from silty clay (59° 48' N Lat, 64° 16' W Long). *Comment* (O.H.L.): sample was collected immediately below the SL4 strandline and was expected to give a minimum age for this. The age is unexpectedly high and redeposition of the shells is suspected, particularly as shell was mainly fragments.

C. Other Provinces

585 ± 205

I-1393. South Saskatchewan River

A.D. 1365

Carbonized wood from halfway up an 8-m cutback along South Saskatchewan River (50° 57' N Lat, 108° 41' W Long), in conjunction with numerous bison bones. Coll. 1964 by D. A. St. Onge; subm. by J. T. Andrews. *Comment* (J.T.A.): purpose of date was to determine recent history of South Saskatchewan River. Date implies that river has for the past 500 yr been in a state of dynamic equilibrium.

I-1127. Kingston, Ontario

>18,000

Shells from W side Division Street (44° 16' N Lat, 76° 30' W Long), Kingston, Ontario. Found in silty clay, 2 m below crest of "small moraine." Coll. and subm. 1963 by O. H. Løken, Queens Univ., Dept. of Geog., Kingston, Ontario. *Comment* (O.H.L.): the small moraines were formed during a late readvance of the ice sheet in the region. Since shells were imbedded in a moraine, they must predate the moraine, thus giving a maximum age for the readvance (Løken, 1964).

10,450 ± 250

I-488. Deception Bay, Quebec

8500 B.C.

Marine molluscs, (*Mya truncata*, *Hiatella arctica*) from W side Deception Bay (62° 09' N Lat, 72° 45' W Long), Quebec. Coll. from raised

marine beach material 281 ft above sealevel in area where marine limit is ca. 400 ft. Coll. 1961 by B. Matthews, McGill Univ., Montreal; subm. 1962 by J. D. Ives, Geog. Branch, Dept. of Mines and Tech. Surveys, Ottawa. *Comment* (J.D.I.): age is greatest obtained for marine molluscs from raised shore features in the Hudson Bay-Hudson Straits-Foxe Basin area. It indicates open water conditions at ca. the time of Valders Re-advance of more southern lats. Marine level is >200 ft above height of this sample and higher samples may yield older dates.

III. ARCHAEOLOGIC SAMPLES

A. United States

Iron Gate Reservoir series, California

Charcoal and charred wood from House-Pit 4, near S bank of Klamath River, ca. 200 ft upstream from Jenny Creek ($41^{\circ} 58' N$ Lat, $122^{\circ} 22' W$ Long), California. Site is village on small terrace in an area now flooded by Iron Gate Reservoir of Pacific Power and Light Co. A succession of houses had been built in the pit originally dug for the first house (Cressman *et al.*, 1956). Floors are numbered from the bottom in order of use. Coll. 1960 by D. L. Cole; subm. 1961 by L. S. Cressman, Univ. of Oregon, Eugene.

I-230. Iron Gate, Floors 2, 3

510 ± 75

A.D. 1440

Charred wood from fill varying from 5 to 10 cm deep between Floors 2 and 3.

I-231. Iron Gate, Floor 1

400 ± 75

A.D. 1550

Charred wood from beam on Floor 1, earliest in series.

General Comment (L.S.C.): difference between levels between the two samples is very small (5 to 10 cm), and fill could have accumulated quickly. Difference in dates is not statistically significant, and results do not represent a reversal of stratigraphy.

I-502. Salt Caves Dam, California

1280 ± 125

A.D. 670

Charcoal from midden associated with village at Salt Caves Dam ($42^{\circ} 01' N$ Lat, $122^{\circ} 10' W$ Long), in Klamath River Canyon, ca. 12 mi from Dorris, California. Site has three geological strata reading from bottom to top: I) large well-rounded river cobbles larger than ferry transported by river now; II) cemented gravels, less rounded and smaller than in I; III) midden. Artifacts tentatively grouped into three levels. Sample is from near bottom of Geological Stratum III, Cultural Level 1 (Cressman, 1942). Coll. 1961 by John Wells; subm. 1962 by L. S. Cressman.

2250 ± 150**I-681. Leslie mound, W Virginia****300 B.C.**

Charred wood from Leslie mound, 4 mi upstream (38° 30' N Lat, 81° 51' W Long) from Winfield, W Virginia, on SW bank of Kanawha River. From postmound under mound which also contained an Armstrong Plain pottery sherd. Coll. and subm. 1962 by E. V. McMichael, W Virginia Geol. Survey. *Comment* (E.V.McM.): expected to date Hopewellian Armstrong culture of central W Virginia, but appears to be too early. Proper assessment must, however, await additional dates on this culture (McMichael and Mairs, 1963).

*B. Sudan***7300 ± 350****I-530. Khor Khageras, Sudan****5350 B.C.**

Charcoal from 200 m NE of junction of Khor Khageras and Nile, between Ukma and Akasha (21° 07' N Lat, 30° 42' E Long), Sudan. From lenticular depression (fireplace?), 40 cm in diam, 60 cm below surface in a sequence of Mid-Holocene silts, 13 m above present high flood level of Nile. Coll. 1961 and subm. 1962 by R. W. Fairbridge. *Comment* (R.W.F.): silts containing sample clearly abut the middle and older (Sebilian-Wisconsin) silts. Date compares with M-804, 8260 ± 400 (Michigan V) on shells in Jebel Maktub pothole 100 km N of Akasha. Fireplace clearly shows a seasonal emergence of the flood-deposited silts. No diagnostic artifacts were discovered during excavation but terrace surface is strewn with microlithic tools of broadly Mesolithic character.

Wadi Halfa series, Sudan

Charcoal and charred grain samples from two sites W of Nile River (21° 57' N Lat, 31° 20' E Long), N of main mosque in Wadi Halfa, Northern Province, Republic of Sudan. Coll. 1962 and 1963 by J. B. Wheat, Duane Quiatt, Minor Van Arsdale; subm. 1963 by G. W. Hewes, Univ. of Colorado, Boulder, Colorado.

18,100 ± 1200**I-863. Wadi Halfa, Sudan, Site 6B27, No. A 16,150 B.C.**

Wood (?) charcoal from exposed face of ancient soil horizon, an erosional remnant of laminated silt deposited by ancient Nile, at Site 6D27, 1100 m W of Nile River and 2.4 km N of main mosque in Wadi Halfa. Site is in Western Desert, 142 m above mean sealevel and 20 m above present mean level of Nile. Soil is extremely hard, has traces of hearth lenses, scattered fossil mammal bone fragments and flint chips. Fossil bones of large extinct bovids present. Charcoal apparently washed into place. *Comment* (G.W.H.): carbon content of sample was low and possibly subject to contamination with older material. Associated lithic artifacts, mainly flint and chert flakes apparently belonging to Epi-Levalloisian (Upper Palaeolithic) tradition, would be expected to fit

this 16,000 B.C. date (Butzer, 1962). Age is closer to expectations than I-864, from same site (Hewes, 1963).

1845 \pm 190

I-866. Wadi Halfa, Sudan, Site 6G9, No. D A.D. 105

Wood charcoal from roofing poles which had fallen on to fill of sand and ash above room floor. *Comment* (G.W.H.): slightly younger date on this sample is reasonable if roofing material had been replaced during life of structure. This practice is still followed in modern Nubia. See also comments on I-865.

2750 \pm 170

I-867. Wadi Halfa, Sudan, Site 6G9, No. E 800 B.C.

Charcoal from ash deposit in a line of burned rubble running N to S in Room 20 at same site as I-865, but on E side of principal rooms. Rubble is ca. 50 cm from present sand surface and contained mudbricks and a few sherds identified as of Pharaonic type (Hewes, 1963). *Comment* (G.W.H.): date seems to confirm supposition that the feature antedated by some time the main part of the structure. Sherds and other finds fall into Napatan period, prior to removal of the Kushite capital from Napata to Meroe. Date in conjunction with other evidence, suggests that Site 6G9 had an earlier transitory occupancy, of which clearcut building remains had disappeared (or were used for later construction) by the time main part of site was used as a habitation.

6150 \pm 300

I-864. Wadi Halfa, Sudan, Site 6B27, No. B 4200 B.C.

Charcoal from Hearth A, at same site as I-863. *Comment* (G.W.H.): date seems too recent for nature of associated artifacts. Pottery was in use in area by 4200 B.C., but no ceramic remains whatever were found at this, or adjacent camp sites (Hewes, 1963). Sample was perhaps contaminated by rootlets during the Subpluvial (Butzer, 1962).

2100 \pm 220

I-865. Wadi Halfa, Sudan, Site 6G9, No. C 150 B.C.

Charcoal from fire lens beneath stone house wall in main section of dwelling area in Gezira Dabarosa village, 600 m W of Nile River, 1100 m N of main mosque in Wadi Halfa. Hearth presumably antedates laying of the rough mortar-less stone wall Nordström, 1962). *Comment* (G.W.H.): this date, along with I-866 and I-868 from same site, agrees with estimates based on pottery and other indications that Site 6G9 was occupied for a brief period in earlier part of Meroitic period (Nordström, 1962; Hewes, 1963).

2250 \pm 175

I-868. Wadi Halfa, Sudan, Site 6G9, No. F 300 B.C.

Carbonized grain (wheat?) from Room 15 at same site as I-866. Grain was spread fairly widely at floor level between Floors 1 and 2 (Hewes, 1963). *Comment*: see I-865.

C. Italy

Veii series, Italy

Charcoal from banks of streams N (42° N Lat, 12° 30' E Long) of Rome, Italy. Obtained during archaeological investigations in vicinity of Etruscan city of Veii. Coll. and subm. 1962 by Sheldon Judson, Princeton Univ., Princeton, New Jersey.

1140 \pm 160

I-881. Valchetta, Italy, No. 1

A.D. 810

Charcoal from zone marking destruction of a late Roman bath and related structures on banks of La Valchetta stream, 15 mi N of Rome. *Comment* (S.J.): date is somewhat young, but in general agrees with geological and archaeological evidence (Judson, 1963).

1400 \pm 100

I-882. Crescenza, Italy, No. 11

A.D. 550

From banks of La Crescenza stream 10 mi N of Rome at point where ancient road from Rome to Veii crosses the stream. *Comment* (S.J.): date is supported by archaeological evidence from rubble zone which provides an age of post 3rd century A.D. (Judson, 1963).

3648 \pm 250

I-883. Crescenza, Italy, No. 9

1698 B.C.

From same site as I-882, but from level dated by archaeological evidence as from ca. A.D. 50. *Comment* (S.J.): date differs greatly from expected age. No explanation for anomaly is known and age based upon cultural and geologic evidence seems acceptable (Judson, 1963).

D. South Pacific

Mangareva series, French Polynesia

Charcoal samples obtained during archaeological excavations on Mangareva (23° 08' S Lat, 134° 56' W Long). Coll. 1959 by R. C. Green; subm. 1960 by H. L. Shapiro, Am. Mus. of Nat. Hist., New York.

520 \pm 80

I-193. Site GA-1, Mangareva

A.D. 1430

From Square B-1, Cultural Layer C, at Te Ana Puta Rua, Aukena, in a charcoal lens just above underlying sterile sand floor of cave. *Comment* (R.C.G.): dates time of initial occupation of cave and from comparisons with artifacts recovered agrees with sequence established by other dates in series.

330 \pm 80

I-191. Kitchen Cave, Layer G, Mangareva

A.D. 1620

From fire pit in Square Z-2, Cultural Layer G, in Kitchen Cave, Kamaka, Site GK-1. *Comment* (R.C.G.): Square Z-2 has best stratified sequence and was adopted as standard of sequence for other squares. Dates in sequence seem to agree with cultural evidence.

760 ± 80**I-190. Kitchen Cave, Layer J, Mangareva A.D. 1190**

From firepit in sterile floor in Square A-1, Cultural Layer J, Kitchen Cave, Kamaka. *Comment* (R.C.G.): dates earliest occupation of site.

≤100**I-192. Sancho's Cave, Mangareva Modern**

From cultural Layer C, directly under a stone religious structure at Sancho's Cave, Kamaka, Site GK-3. *Comment*: sample was expected to date artifacts from beneath pavement of structure which dates to just before European contact ca. 150 B.P. Validity of the age is uncertain, but should not be far off.

Moorea series, French Polynesia

Charcoal samples collected during archaeological investigations on Moorea (17° 30' S Lat, 149° 50' W Long), in Society Islands. Stratigraphy at most sites along coast has been obliterated or obscured by burrowing land crabs. Coll. 1960 by R. C. Green; subm. 1960 by H. L. Shapiro.

700 ± 80**I-204. Amehiti, Moorea A.D. 1250**

From small oven lying under stone curbing of W wall of large round ended assembly house at Site ScMo-4, Amehiti. *Comment* (R.C.G.): oven correlates with a set of earlier post-holes on storage pits from a similar house on same site as that now marked by stone curbing and provides date for earlier house.

760 ± 80**I-188. Te Ama Ama, Moorea A.D. 1190**

From oven dug into sand at base of overlying cultural deposits and ca. 37 in. below surface at Site ScMf-4, Te Ama Ama, Papetoai. Associated with other cultural deposits including an adze, shell chisels, and a coconut grater. Overlying deposits are disturbed by burrowing land crabs, but oven and sample level appears intact. *Comment* (R.C.G.): sample level was below sealevel and immersed in brackish water. Date agrees with cultural evidence.

540 ± 75**I-189. Vai Ohu'a, Moorea A.D. 1420**

From small oven at base of cultural deposits, ca. 41 in. below site is one of few undisturbed by land crabs; cultural stratification can be determined. This date and I-188 are from the only two sites where an indication of age of artifacts associated with cultural layers may be given.

*E. Peru***Chilca series, Peru**

Samples from several sites along the Chilca, an intermittent river on central coast (12° 26' S Lat, 76° 46' W Long) of Peru. Coll. and

subm. 1963 to 1964 by Frederic Engel, Universidad Nacional Agraria, Lima, Peru (Engel, 1964).

5650 \pm 220
3700 B.C.

I-835. Village 1, v-806, Peru

Charcoal from bottom strata at Village 1 (12° 29' 48" S. Lat, 76° 44' 48" W Long). *Comment* (F.E.): date fits well for early pre-cotton, preceramic phase of the period on central coast of Peru (cf. NZ-1053, 5700 \pm 136).

5250 \pm 220
3350 B.C.

I-811. Village 1, v-800, Peru

Charcoal from Village 1, on left bank of the Chilca, ca. 3 km E of Pacific Ocean. Coll. from Level 2A which contains some pottery fragments. *Comment* (F.E.): age is inconsistent with stratigraphic interpretation. Stratigraphy may have been disturbed by the Chavinoid who resettled the site or by their burning of earlier wood posts. I-812, 2420 \pm 175, from same level yields expected age for Chavin reoccupation. Other samples from same level yield ages consistent with I-811 (cf. I-818, I-800, I-817, I-813). A disturbed stratigraphy, therefore, seems likely.

4525 \pm 220
2575 B.C.

I-818. Village 1, v-798, Peru

Charcoal from Level 2 at Village 1. Level contains some pottery fragments. *Comment* (F.E.): age inconsistent with stratigraphic interpretations. See comments for I-811.

5250 \pm 220
3300 B.C.

I-817. Village 1, v-795, Peru

Charcoal from Level 2 at Village 1. *Comment* (F.E.): age not consistent with stratigraphic interpretations. See comments for I-811.

5650 \pm 190
3700 B.C.

I-813. Village 1, v-794, Peru

Charcoal from Level 2C which contains some pottery fragments. *Comment* (F.E.): age inconsistent with stratigraphic interpretation, but fairly consistent with other samples from similar levels. See comments for I-811.

5025 \pm 200
3075 B.C.

I-815. Village 1, v-793, Peru

Charcoal from Level 2 which contains some pottery fragments. *Comment* (F.E.): see I-811.

4850 \pm 170
2900 B.C.

I-746. Village 1, v-778, Peru

Charcoal from Level 2B in Village 1. *Comment* (F.E.): age not consistent with stratigraphic estimates. See I-811.

I-745. Village 1, v-777, Peru **4975 ± 160**
3025 B.C.

Reed mat wrapping funeral bundle in Grave 42 in W cemetery of middle level of Village 1. *Comment* (F.E.): gives age of cemetery belonging to intermediate period of village which lasted to ca. 4500 B.P. See also I-814.

I-814. Village 1, v-796, Peru **4950 ± 220**
3000 B.C.

Charcoal from middle level of Village 1. *Comment* (F.E.): date sets age for middle level of village and is consistent with age for I-745 from equivalent level.

I-812. Village 1, v-797, Peru **2420 ± 175**
470 B.C.

Charcoal from Level 2A in Village 1. Level contains Chavinoid pottery. *Comment* (F.E.): age is consistent with expected age for Chavinoid level.

I-892. Village 1, v-829, Peru **5410 ± 275**
3460 B.C.

Charcoal from deepest natural level encountered during a stratigraphic control cut at Village 1. *Comment* (F.E.): age is in correct range and compares with other dates from equivalent levels (NZ-1053, 5700 ± 136; I-835, 5650 ± 220; I-813, 5650 ± 190).

I-816. Village 1, v-799, Peru **4500 ± 190**
2550 B.C.

Charcoal from dark, ashy, preceramic level of Village 1. *Comment* (F.E.): dark ashy levels usually indicate a site belonging to final pre-cotton period on central coast of Peru. Date fits well with this estimate.

I-1229. Village 1, v-1131, Peru **3625 ± 200**
1675 B.C.

Vegetable matter from stratigraphic cut in mound overlying preceramic Village 1. Found in stratigraphic position in natural Level 5 with pottery and corn. *Comment* (F.E.): date indicates level is pre-Chavin or early Chavinoid.

I-956. Site 4, v-1032, Peru **4300 ± 500**
2350 B.C.

Charcoal from small refuse mound at Site 4. Site is on southern bluff overhanging bed of river, close to Village 1.

I-1290. Village 6, v-1176, Peru **3235 ± 175**
1285 B.C.

Charcoal from deepest natural level in stratigraphic test cut. *Comment* (F.E.): probably one of last preceramic, cotton-yielding sites.

I-1192. Village 20, v-1162, Peru **6970 ± 300**
5020 B.C.

Reed mat from funeral bundle at Village 20 in northern range of hills closing Chilca canyon (12° 28' S Lat, 76° 45' 48" W Long). *Comment* (F.E.): age is normal for "Lomas" settlers.

I-1091. Village 74, v-1134, Peru **4310 ± 275**
2360 B.C.

Charcoal from refuse at cotton-yielding site of what had been a village of reed huts built over low rectangular stone walls. *Comment* (F.E.): date indicates site may be one of oldest cotton-yielding villages in Chilca area.

I-980. Village 85, v-1065, Peru **585 ± 100**
A.D. 1365

Corn (cob) from Village 85 in Chilca canyon. *Comment* (F.E.): level is expected to be post-Tiahuanacoid and pre-Inca. Date fits well with this interpretation. Grave had been looted and stratigraphic position of sample is uncertain. *Comment* (F.E.): patterns on fabric are typical "Huaca Malena" period, Style II, rather than Tiahuanacoid.

I-1444. Site 156, v-1213, Peru **3600 ± 140**
1650 B.C.

Charcoal from black ashy refuse level in test pit at Site 156 (12° 27' 36" S Lat, 76° 43' 18" W Long). Site is preceramic and yielded twined cotton fabric. *Comment* (F.E.): age obtained, together with black ashy refuse, indicates a site of final preceramic period.

I-1435. Site 156, v-1217, Peru **3520 ± 125**
1570 B.C.

Vegetable matter from inside small refuse mound at Site 166, a preceramic site yielding twined cotton fabrics. Site is located on lateral branch of Chilca on the way to a pass leading to Quebrada de los Peridos, 40 km inland.

I-1476. Village 219, v-1168, Peru **400 ± 100**
A.D. 1550

Charcoal from inside stone house at Village 219 (12° 16' 30" S Lat, 76° 24' 18" W Long). No stratigraphy was evidenced, but brown circle-impressed pottery was associated with sample. *Comment* (F.E.): pottery style is usually contemporary with Cusquenian influences. Date obtained supports this assumption.

I-1124. Village 93, v-1156, Peru **4515 ± 220**
2565 B.C.

Charcoal from test pit at Village 93. Reed twined fabrics, but no cotton, were recovered. Pit revealed black ashy refuse similar to that found at similar sites. *Comment* (F.E.): date indicates that site may be one of the last pre-cotton sites in Chilca area.

I-1185. Village 107, v-1158, Peru **370 ± 120**
A.D. 1580
Vegetable matter from inside one of the houses of Village 107, large village near beach at foot of Cerro Santa Maria (12° 26' 24" S Lat, 76° 46' 36" W Long). *Comment* (F.E.): sample may date a refuge village. A large group of people apparently lived for a short time at the site. Water is available, but very deep. Site is possibly early Hispanic.

I-1479. Village 137, v-1235, Peru **700 ± 120**
A.D. 1250
Charcoal from Natural Level 2 in Village 137. *Comment* (F.E.): typical age for late Central Coast culture which lasts during Inca influence.

I-1480. Village 143, v-1234, Peru **1005 ± 125**
A.D. 945
Woven fabric from grave within adobe house at Village 143.

I-1248. Village 224, v-1167, Peru **635 ± 150**
A.D. 1315
Charcoal from refuse inside house of Village 224 (12° 19' 36" S Lat, 76° 31' 12" W Long). Site is high upstream (alt 1130 m), but still within coastal climate area. Sample was associated with brown pottery with impressed circles and black and red post-fired painted pottery typical of pre-Inca style on central coast.

I-1397. Village 235, v-1196, Peru **1830 ± 120**
A.D. 120
Charcoal from inside house containing Llapa Llapa pre-fired painted pottery at village 235, halfway up Chilca canyon (12° 24' 48" S Lat, 76° 30' 54" W Long). *Comment* (F.E.): age may indicate a final phase for Central Coast culture which used Llapa Llapa pottery, post-fired, painted in the early phase and later pre-fired.

I-1560. Village 519, v-1272, Peru **950 ± 110**
A.D. 1000
Vegetable matter from refuse mound at Village 519, a Tiahuanacoid pottery-yielding site in Chilca canyon (12° 32' 58" S Lat, 76° 42' 56" W Long).

I-1184. Site 105-2, V-1159, Peru **3040 ± 200**
1090 B.C.
Charcoal from deepest level inside refuse mound at Site 105-2, a cliff overhanging the ocean (12° 26' 42" S Lat, 76° 46' 42" W Long) in Chilca area. No cotton, pottery, or corn was visible in test pit.

I-810. Las Colinas, Peru **3775 ± 220**
1825 B.C.
Charcoal from deepest Chavinoid level at interface with preceramic refuse, at Village 9, "Las Colinas", on slope of hill overlooking Ancon

(11° 46' 45" S Lat, 76° 11' 00" W Long), on central coast of Peru. Twined fabrics are present in level sampled. Coll. by Ramiro Matos, Univ. of Huancayo, Peru; subm. 1963 by Frederic Engel. *Comment* (F.E.): twined fabrics are not found in Chavinoid refuse and sample may have been slightly contaminated by preceramic refuse. Age is not far from Chilca 24 (GX-203, 3610 ± 80, GX-275, 3510 ± 70, Geochron., unpub.).

1500 ± 120

I-1562. Chillon River, Peru**A.D. 450**

Mixture of charcoal, corn, and fabric, from Village 28 on N bluff of Chillon River, 1 km E of the sea (11° 56' 40" S Lat, 77° 06' 44" W Long), ca. 10 km N of Lima International Airport, on central coast of Peru. Found in stratigraphic position and in association with interlocking pottery of Playa Grande type. Coll. and subm. 1964 by Frederic Engel. *Comment* (F.E.): provides date for this pottery and also for period of some wall paintings associated with similar pottery at nearby Cerro Culebras.

Omas series, Peru

Samples from drainage area of the Omas, an intermittent river, on central coast of Peru (Engel, 1963a). Coll. and subm. 1964 by Frederic Engel.

2890 ± 210

I-1230. Village 5, v-1164, Peru**940 B.C.**

Vegetable material from Refuse Level 2 in an adobe house in Village 5 (12° 45' 02" S Lat, 76° 33' 58" W Long). House from which sample was taken contained Chavinoid pottery. *Comment* (F.E.): fairly typical Chavin age.

2940 ± 140

I-1389. Site 25, v-130, Peru**990 B.C.**

2925 ± 140

I-1381. Site 25, 0-3008, Peru**975 B.C.**

Fabric from bundle in Grave 1 at Site 25, a small adobe structure close to the Omas (12° 45' 18" S Lat, 76° 24' 33" W Long), ca. 3 km E of the sea. *Comment* (F.E.): checker pattern of fabric is typical of Chavin horizon on central coast of Peru. Sample was submitted in two separate sections as "blind split." Dates on two fractions show good agreement.

5440 ± 250

I-1231. Mound 302, v-657, Peru**3490 B.C.**

Vegetable matter from Grave 6, same grave in same mound as I-1382. *Comment* (F.E.): age seems too old for corn and pottery. Contamination may have occurred from underlying preceramic mound.

I-1380. Mound 302, 0-6475, Peru**3050 \pm 140****1100 B.C.**

Fabric from Grave 7, in Mound 302, described in I-1382. Grave contained corn and Chavinoid pottery. *Comment* (F.E.): dates early phase of Chavin horizon. Probably a more reliable age than those on I-1231 and I-1382 from same mound.

I-1382. Mound 302, 0-5577, Peru**4320 \pm 120****2370 B.C.**

Fabric from Grave 6, an adobe structure with rooms, earth columns and a staircase, in Mound 302 ($12^{\circ} 46' 29''$ S Lat, $76^{\circ} 34' 45''$ W Long), ca. 3 km E of the sea. Grave contained corn and pottery. Floor plan resembles that of temple of Punkuri Bajo in Napana Valley on N coast of Peru. *Comment* (F.E.): age seems somewhat old for corn and pottery. Mound was built over a preceramic refuse mound which may have caused some contamination. See also I-1380, I-1231 from same mound.

Paracas series, Peru

Samples from sites on Paracas Peninsula on S coast of Peru. Coll. and subm. 1963 to 1964 by Frederic Engel (Engel, 1963a).

I-1311. Village 96, v-1178, Peru**8830 \pm 190****6880 B.C.**

Reed mat from burial near house at Village 96 on eastern shore of Paracas Bay ($13^{\circ} 51' 18''$ S Lat, $76^{\circ} 15' 00''$ W Long). *Comment* (F.E.): village contains gourds and a tuber, possibly a kind of yuca. Date should establish arrival of incipient agriculture on S coast of Peru.

I-957. Cabezas Largas, v-817, Peru**1695 \pm 130****A.D. 255**

Vegetable matter from Stratigraphic Cut VI in Cabezas Largas on peninsula of Paracas ($13^{\circ} 52' 39''$ S Lat, $76^{\circ} 16' 00''$ W Long). From Level 1E, inside house built on top of older structures. *Comment* (F.E.): dates the Nazca 2 or 3 reoccupation of proto-Nazca stone village of Cabezas Largas.

I-1340. Cabezas Largas, v-1174, Peru**2360 \pm 215****410 B.C.**

Algal material cementing walls of proto-Nazca stone compounds of Cabezas Largas. From same site and stratigraphic cut as I-957. Buildings contain quantities of proto-Nazca pottery. *Comment* (F.E.): age seems slightly old for proto-Nazca structures.

IV. MISCELLANEOUS SAMPLES

Gas "seep" series, SE U.S.A.

Samples of marsh gas, mostly methane, from gas "seeps" in ponds in Georgia and Alabama. Samples were obtained by agitating bottom sedi-

ments in the ponds and collecting the released gas bubbles by water displacement in a 5 gallon glass jug. Sediments are presumably of recent age. Coll. 1963 by J. C. Wilson; subm. 1964 by D. R. Baker, Marathon Oil Co., Littleton, Colorado.

<100

I-1146. Cobb Creek, Georgia**Modern**

From pond on Cobb Creek, 5 mi S of Vidalia on State Highway 15 and 1¼ mi W at Cobb Creek crossing (32° 10' N Lat, 82° 25' W Long), Toombs County, Georgia. *Comment* (D.R.B.): methane fraction was separated from other minor components in collected gas prior to analysis on this and other samples of the series. Age suggests that methane was formed by bacterial decomposition of recent plant material which accumulated in bottom sediments.

<10

I-1148. Rocky Creek, Georgia**Modern**

From a pond on Rocky Creek at Rocky Creek Crossing, 1 mi SE of Vidalia, Toombs County, Georgia (32° 10' N Lat, 82° 25' W. Long). *Comment* (D.R.B.): see I-1146 for sample treatment. δC^{14} was +250 indicating that methane was formed by bacterial activity probably utilizing plant and other carbonaceous material formed since the increase in atmospheric C^{14} content due to atmospheric nuclear explosions.

715 ± 120

I-1147. Swift Creek, Georgia**A.D. 1235**

From pond on Swift Creek 1¾ mi NE of Higgston, Montgomery County, Georgia. *Comment* (D.R.B.): see I-1146 for sample treatment. Date suggests that methane was formed by bacterial decomposition of recent plant material, although the significantly older age than that observed for I-1146 suggests that some ancient carbonaceous material may also have been used.

I-1149. Sealy Springs well, Alabama

>34,000

From Sealy Springs Well, Cottonwood, Houston County, Alabama. Well yielding salt water and natural gas, probably from Upper Cretaceous Eutaw sandstone. *Comment* (D.R.B.): sample submitted as control. Infinite age as expected.

I-1150. Maxie Gas Field, Mississippi

>30,000

From Lower and Upper Cretaceous, and Eocene formations in Maxie Gas Field, Forrest County, Mississippi. *Comment* (D.R.B.): control sample yielding infinite age as expected.

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**INSTITUTO VENEZOLANO DE INVESTIGACIONES CIENTIFICAS
NATURAL RADIOCARBON MEASUREMENTS II**

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The dates reported in this list were measured from December, 1964 to November, 1965. The laboratory continues to employ liquid scintillation techniques with synthesized benzene; however, the chemical yield has been improved to the point where it is now between 80 and 100%. For most of the measurements listed here, a 4 cc counting vial was used with 3 cc benzene and 1 cc commercial toluene containing PPO and dimethyl-POPOP scintillators. The counting efficiency is 72%, which gives a net modern count of 23.5 cpm, and the background is 8.2 cpm. The detection limit (48 hours counting, 2σ statistics) with ordinary size samples is 43,000 yr using the 4 cc vial and 52,000 yr with a 20 cc vial. Errors introduced by the laboratory procedure are less than $\frac{1}{2}\%$ (Tamers and Pearson, 1965a). A detailed review of the methods being used has been published recently (Tamers, 1965b).

All calculations of the dates were made on the basis of a C^{14} half-life of 5568 yr with the modern reference taken as 95% of the activity of the NBS oxalic-acid standard. The standard errors in the measurements are given with the dates.

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SAMPLE DESCRIPTIONS

I. GROUND WATER SAMPLES

A program of dating ground water extracted from wells of various aquifers, similar to that undertaken at the Univ. of Texas (Texas II and Texas III), is the principal research effort of the I.V.I.C. laboratory. Water deposits in four arid or semi-arid regions of Venezuela are under study—the unconfined sand aquifer of Maracaibo, the confined limestone formation near Coro, the unconfined sand aquifer of the Peninsula of Paraguaná, and the water basin of the Lake of Valencia. The radio-carbon study of the Maracaibo aquifer is now complete and the interpretation of these results, as well as a description of experimental methods, are given elsewhere (Tamers, 1966). The δC^{13} values are based on

the Craig PDB limestone standard and were done by Isotopes, Inc. The radiocarbon contents are reported as percent of modern without correction for limestone dilution. The corrected ages are given in the detailed report to be published in another journal. Samples coll. 1965 by Juan Navarro (I.V.I.C.), Epifanio Rondón (Instituto Nacional de Obras Sanitarias, Caracas) and Murry Tamers (I.V.I.C.); subm. by Murry Tamers.

Maracaibo Aquifer Wells

		δC^{13} (‰)	C^{14} (% of modern)
IVIC-195	Campo 2, pozo 6 (10° 30' N Lat, 71° 48' W Long)	-17.8 ± 0.1	29.4 ± 1.4
IVIC-196	La Cañada (10° 25' N Lat, 71° 41' W Long)	-17.6 ± 0.1	0.98 ± 0.24
IVIC-197	Hacienda Veritas (10° 25.5' N Lat, 71° 45' W Long)	-16.2 ± 0.1	5.1 ± 0.34
IVIC-198	Hacienda La Palma (10° 22' N Lat, 71° 49' W Long)	-18.7 ± 0.1	2.4 ± 0.3
IVIC-201	Campo 2, pozo 8 (10° 29' N Lat, 71° 48' W Long)	-16.0 ± 0.1	24.2 ± 0.3
IVIC-202	Hacienda Los Palmares (10° 22' N Lat, 71° 47' W Long)	-20.7 ± 0.1	6.85 ± 0.46
IVIC-203	Hacienda Mandalay (10° 15' N Lat, 71° 54' W Long)	----	9.3 ± 0.36
IVIC-205	Potrerito (10° 20' N Lat, 71° 47' W Long)	-18.6 ± 0.1	9.3 ± 0.33
IVIC-207	Caujarito Shell (10° 36' N Lat, 71° 48' W Long)	-19.7 ± 0.1	20.9 ± 0.35
IVIC-208	Campo 1, pozo 21 (10° 32' N Lat, 71° 43' W Long)	-16.6 ± 0.1	26.5 ± 0.3
IVIC-209	Hato Grande (10° 42' N Lat, 71° 43' W Long)	-19.6 ± 0.1	45.4 ± 0.5
IVIC-213	La Rinconada (10° 43' N Lat, 71° 41' W Long)	-17.8 ± 0.1	51.2 ± 0.5
IVIC-215	Campo 1, pozo 28 (10° 33' N Lat, 71° 42.5' W Long)	-17.1 ± 0.1	20.6 ± 0.4
IVIC-216	Campo 3A, pozo 1 (10° 30' N Lat, 71° 43' W Long)	-15.8 ± 0.1	18.9 ± 0.35
IVIC-217	Pozo Viejo, El Rincón (10° 28' N Lat, 71° 41' W Long)	-19.6 ± 0.1	7.5 ± 0.3

Palmar River and Adjacent Wells

IVIC-212	Palmar River Water (10° 17' N Lat, 71° 58.5' W Long)	-15.0 ± 0.1	124.8 ± 0.8
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IVIC-211	Hacienda Alto Viento (10° 14' N Lat, 71° 57' W Long)	-20.0 ± 0.1	69.2 ± 0.6
IVIC-214	Matera Santa Lucia (10° 18' N Lat, 71° 42.5' W Long)	-13.5 ± 0.1	85.6 ± 0.7

Coro Aquifer Wells and Spring

IVIC-218	Meachiche No. 1 (11° 20' N Lat, 69° 34' W Long)	-13.1 ± 0.1	26.3 ± 0.4
IVIC-219	Meachiche No. 2 (11° 20' N Lat, 69° 33' W Long)	-19.4 ± 0.1	25.4 ± 0.4
IVIC-220	Meachiche Spring (11° 19' N Lat, 69° 34' W Long)	-13.0 ± 0.1	109.4 ± 0.74
IVIC-221	Rio Coro Pozo No. 5 (11° 25' N Lat, 69° 38' W Long)	-20.3 ± 0.1	57.1 ± 0.5
IVIC-222	Rio Coro Pozo No. 8 (11° 25' N Lat, 69° 38' W Long)	-14.4 ± 0.1	57.3 ± 0.5
IVIC-223	Rio Coro Pozo No. 10 (11° 25' N Lat, 69° 38' W Long)	-16.8 ± 0.1	59.5 ± 0.4
IVIC-224	Hacienda Los Perozos (11° 24' N Lat, 69° 38' W Long)	-13.1 ± 0.1	70.9 ± 0.4

Peninsula of Paraguaná Well

IVIC-225	Buena Vista, Pozo El Milagro (11° 53' N Lat, 69° 57' W Long)	-8.4 ± 0.1	29.9 ± 0.4
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II. ARCHAEOLOGIC SAMPLES

*A. Venezuela***1300 ± 170****IVIC-179. Miquimú, Carache Area****A.D. 650**

Charcoal from trench M, 1.3 m below surface, in bank of Miquimú Creek at Miquimú (9° 35.6' N Lat, 70° 15.2' W Long), ca. 8 km SSW from Carache, state of Trujillo, Venezuela. Associated with crude, plain, and modeled pottery of Miquimú Style and bat wing pendants of metamorphosized chert. Pottery seems to be Dabajuroid. Sample very small, hence large error in date. Coll. 1964 and subm. by Erika Wagner, I.V.I.C. *Comment* (E.W.): date falls within Period III of Cruxent-Rouse chronology (Cruxent and Rouse, 1961), and correlates with tentative date for Guasare style of Rancho Peludo area. It is older than dates for Mirinday and El Chao material of Carache area (IVIC I) and gives an acceptable sequence for region.

13,010 ± 280**IVIC-191-1. Taima-taima A****11,060 B.C.****14,440 ± 435****IVIC-191-2. Taima-taima C****12,490 B.C.**

Bones from a kill site W of Vela de Coro, state of Falcón, Venezuela (11° 30' N Lat, 69° 30' W Long). Region is presently arid; how-

ever, bones came from animals, now extinct in the country, that could only have lived under much more humid conditions. Main excavations were done by the late Dr. José Royo y Gómez and J. M. Cruxent in 1962. Associated artifacts are primitive stone instruments of a very special type, an industry of "pebble-tools." Taima-taima site is 8 km W of excavation of Muaco, which had a fauna similar in many respects to Taima-taima. A bone date for Muaco gave $14,300 \pm 500$ B.P. (M-1068, Michigan VII). A charcoal (?) date for Taima-taima gave $>41,000$ B.P. (Y-1199, written comm. from I. Rouse to J. M. Cruxent), but it was later decided that material dated could very well have been coal and, therefore, date is not usable (Rouse and Cruxent, 1963). Coll. 1963 and subm. by J. M. Cruxent, I.V.I.C. IVIC-191-1 and IVIC-191-2 dates were obtained on two separate batches of bone, both of which were given a pre-treatment that completely removed carbonate portion. Results of a previous study (Tamers and Pearson, 1965b) suggest that dates be taken as lower limits and that oldest date is probably more correct. *Comment* (J.C.): we would have thought that Taima-taima was older than Muaco. Present results pose a difficult problem as to coexistence of two different complexes in same area. However, material must be studied in more detail and excavations will be continued on the site.

B. Jamaica

IVIC-189. Brazilletto

1920 \pm 100

A.D. 30

Charcoal sample taken 50 cm from surface of Brazilletto site, SW of mouth of Cockpit River, in Portland Bight, Jamaica ($17^{\circ} 52' N$ Lat, $77^{\circ} 10' W$ Long). Tentatively considered to be one of oldest archaeological sites of Jamaica, but within Period IV of the Neo-Indian epoch. Coll. 1964 by Daniel Bruce and J. M. Cruxent, I.V.I.C.; subm. by Cruxent. *Comment* (J.C.): archaeologists of Jamaica consider date too old for island, but we are not of that opinion. Sample age seems to us to be logical and in agreement with our prediction.

IVIC-190. Rio Nuevo

770 \pm 100

A.D. 1180

Charcoal sample excavated 50 cm from surface at mouth of Rio Nueva (right bank), north coast, Jamaica ($18^{\circ} 25' N$ Lat, $76^{\circ} 04' W$ Long). Site is similar to others in Cuba and Dominican Republic, especially with respect to weights used on fishing nets. However, this is first time the artifact has been discovered in Jamaica, despite being very typical for sites in Dominican Republic and other islands. Coll. 1964 by Luis Chanlatte and J. M. Cruxent, I.V.I.C.; subm. by Cruxent. *Comment* (J.C.): we can say nothing against date since we think that site was occupied by Arawaks and that they could have lasted up to time of Spanish Conquistadores.

*C. Chile***IVIC-170. Pisagua Viejo 3****5220 ± 170****3270 B.C.**

Wood forming part of stuffing of thorax cavity of mummy of Tomb No. 2, of Indian cemetery "Pisagua Viejo" (19° 33' S Lat, 70° 14' W Long), N of port of Pisagua, province of Tarapaca, Chile. Mummy corresponds to period that Max Uhle called "Aborigines of Arica," based on a complicated preparation consisting of removing interior organs of body and filling with materials such as straw, pieces of wood, cord, etc. Position is always extended. Coll. 1963 and subm. by Lautaro Nuñez Atencio, Museo Arqueológico de la Universidad de Chile, Calama. *Comment* (L.N.A.): date in perfect concordance with cultural content of site.

IVIC-171. Dupont 4**460 ± 100****A.D. 1490**

Cloth from Tomb No. 1 of Dupont site (22° 31' S Lat, 68° 58' W Long), Province of Antofagasta, Chile. Excavated cemetery is placed between period of expansion of Tiahuanaco to the Inca. Cultural contents were defined by flexed mummies, Dupont ceramic (black with polished interior), and other artifacts from Valley of the Loa. Coll. 1964 and subm. by Lautaro Nuñez Atencio. *Comment* (L.N.A.): early part of date is in agreement with pre-Inca situation of Dupont.

IVIC-172. Pica 5**310 ± 110****A.D. 1640****IVIC-173. Pica 6****930 ± 90****A.D. 1020****IVIC-174. Pica 7****220 ± 80****A.D. 1730**

Three samples from Tomb No. 6, sec. A of Pica cemetery (20° 31' S Lat, 69° 23' W Long) in Province of Tarapacá, Chile. These are first dates for cultural complex Pica, which is intermediate between cultures Arica and San Pedro de Atacama. Latter culture was dated at 1650 ± 150 (Sa-109, Saclay I) and 1700 ± 150 (Sa-226, Saclay II). Tomb contained cloth of the type Gentilar and modeled ceramic with human faces. No evidence that site had been previously disturbed. Sample IVIC-173 was cloth and samples IVIC-172 and 174 were maize cobs and other unidentified plants. Coll. 1963 and subm. by Lautaro Nuñez Atencio. *Comment* (L.N.A.): two early dates of maize cobs are not reasonable; however, cloth sample date, IVIC-173, is correct. Field evidence requires that three samples should be contemporary.

IVIC-175. Conanoxa 1**3740 ± 130****1790 B.C.**

Dried excrements of unidentified herbivorous animal located at Level 2 of pre-agricultural site Cxa W,a. Excavation was at Conanoxa, Valley of Camarones, Province of Tarapacá, Chile (19° 02' S Lat, 69° 59' W Long). Cultural materials associated with sample were placed in

Second Pre-agricultural period of N coast of Chile, as defined by Bird (Bird, 1946). Excavation has been described in a previous article (Niemeyer and Schiappacasse, 1963). Coll. and subm. by Hans Niemeyer and Virgilio Schiappacasse, Santiago, Chile. *Comment* (H.N. and V.S.): date obtained is in agreement with archaeologic evidence which suggested that sample should be placed in ca. 2000 B.C.

1150 \pm 95

IVIC-176. Conanoxa 2

A.D. 800

Charcoal from bottom of small underground silo of House A of the excavation Cxa E.I (I) (19° 02' S Lat, 69° 59' W Long). Associated ceramic artifacts place site in first part of Agricultural period, with non-decorated pottery or Pichalo II of Bird (Bird, 1946). Coll. 1962 and subm. by Hans Niemeyer and Virgilio Schiappacasse.

D. Colombia

530 \pm 100

IVIC-158. Boyacá

A.D. 1420

Shavings from wooden statue now in Museo Nacional, Bogotá. From cave near Boyacá, Department of Cundinamarca, Colombia (4° 44' N Lat, 74° 19' W Long). Piece is very characteristic for late phase of Chibcha culture. Coll. ca. 1900 by person now unknown; subm. by Gerardo Reichel-Dolmatoff, Universidad de Los Andes, Bogotá. Colombia. *Comment* (G.R-D.): date coincides with present theories suggesting recent age of Chibcha artifacts in this zone.

765 \pm 85

IVIC-159. Los Santos

A.D. 1185

Cotton cloth covering a mummy (Museo Nacional, Bogotá No. 41-III-2493-2509) from "Cueva de los Indios," Municipality of Los Santos, Dept. of Santander del Sur, Colombia (6° 46' N Lat, 73° 06' W Long). Complex of burials in caves is very typical for this region of Chibcha territory. Cloth was associated with series of other cultural elements, both of ceramic and wood. Coll. 1941 by the late Justus Wolfram Schottelius; subm. by Gerardo Reichel-Dolmatoff. *Comment* (G.R-D.): discoverer of this material had tentatively attributed to it very recent, protohistoric age. C¹⁴ determination puts this hypothesis in doubt. Possibly, it belongs to culture preceding that of Guane and Chibcha del Altiplano.

715 \pm 60

IVIC-160. Restrepo

A.D. 1235

Wood from a canoe (Museo Nacional, Bogotá No. A-62-VIII-1810), associated with Calima culture, found at bottom of dry lake (3° 51' N Lat, 76° 32' W Long). Lake is near town of Darian, Department del Valle, Colombia. Calima culture is one of most advanced of Colombia, but is little known. Many of its characteristics appear to be related to Quimbaya and San Agustín cultures and also to Mesoamerican cultures. Coll. 1962 by Warwick Bray, Cambridge Archaeol. Exped.; subm. by

Gerardo Reichel-Dolmatoff. *Comment* (G.R-D.): a charcoal sample, found by Bray in a burial in same zone, gave date of 700 ± 85 B.P. (NPL-60, NPL II). The two dates determine a late phase of Calima culture.

F. Argentina

IVIC-177. Ampajango **670 \pm 85**
A.D. 1280

Charcoal from Ampajango site, Valley of Santa María, Province of Catamarca, Argentina ($26^{\circ} 55'$ S Lat, $66^{\circ} 05'$ W Long), taken 38 cm below surface of Structure A, Unit I. Associated artifacts include pottery of Santa María and San José styles. Archaeologic investigations of Valley of Santa María have been described in detail in a previous publication (Cigliano *et al.*, 1960). Coll. 1961 and subm. by Eduardo Cigliano, Museo de la Plata, La Plata, Argentina. *Comment* (E.C.): date coincides perfectly with archaeologic evidence.

IVIC-178. Cerro Mendocino **610 \pm 85**
A.D. 1340

Charcoal from Punta de Balasto, Valley of Santa María, Province of Catamarca, Argentina ($27^{\circ} 00'$ S Lat, $66^{\circ} 15'$ W Long), taken 1 m below surface of structure of Núcleo C. Pottery of Santa María style was found on surface. Sample should date the Santamariana culture, typical of Valley of Santa María. Coll. 1959 and subm. by Eduardo Cigliano. *Comment* (E.C.): date is in agreement with archaeologic findings.

IVIC-184. Barranca Larga **1460 \pm 90**
A.D. 490

Cloth, from vicuña wool, in bad condition and intimately mixed with dry earth, from Valley of Abaucán, 7 km NE of town of Tinogasta, Province of Catamarca, Argentina ($28^{\circ} 02'$ S Lat, $67^{\circ} 32'$ W Long). Taken from funeral urn in which was also found a trephined skull. This dates horizon of burial urns of types Sanagasta, San José, Haulfín, and Jachal. Coll. 1963 and subm. by Eduardo Cigliano. *Comment*: in agreement with estimated date.

IVIC-186. Jüella **1320 \pm 90**
A.D. 630

Fragment of a wooden object found in House No. 18 of site Quebrada de Jüella, ca. 4 km W of Humahuaca, Province of Jujuy, Argentina ($23^{\circ} 30'$ S Lat, $65^{\circ} 22'$ W Long). Site corresponds to late pre-Inca period of the black on red horizon of Quebrada de Humahuaca. Ceramic type is Tilcara. Coll. 1958 and subm. by Eduardo Cigliano. *Comment* (E.C.): we would have thought that age was a little greater.

IVIC-187. Punta de Balasto **1300 \pm 60**
A.D. 650

Charcoal from roof of Structure No. 1, Punta de Balasto, Cerro Mendocino, at extreme S of Valley of Santa María, Province of Cata-

marca, Argentina (26° 55' S Lat, 66° 07' W Long). Sample located 60 cm above floor of house, on which were recovered ceramic fragments of a crude type and Santa María Bicolor. Coll. 1959 and subm. by Eduardo Cigliano. *Comment*: in agreement with estimated date.

4760 ± 120

IVIC-188. Palo Blanco 9

2810 B.C.

Mollusk shells from a natural formation at Palo Blanco, Province of Buenos Aires, Argentina, 1 km from present day coast (34° 55' S Lat, 57° 50' W Long). At base of mound was found a rough type of pottery that would predate formation of mound. Coll. 1962 and subm. by Eduardo Cigliano. *Comment* (E.C.): date, on geologic evidence, is more than reasonable. Archaeologically, it is revolutionary and suggests that site merits an intensive investigation.

F. Perú

IVIC-182-A. Pachacamac wood

Modern

1280 ± 85

IVIC-182-B. Pachacamac cloth net

A.D. 670

Two samples, wood from a portal and a fragment of a cloth net (which could have been used as a hair net) from ruins of Pachacamac, Perú (12° 13' S Lat, 76° 53' W Long). Coll. 1964 and subm. by Raimundo Villegas, I.V.I.C. *Comment*: wooden portal is evidently not part of original fortress. Cloth date is reasonable and comparable to another cloth date for Pachacamac, 990 ± 40 B.P. (Hv-351, Hannover III).

G. United States of America

IVIC-151. Ready Bullion Creek

9470 ± 180

7520 B.C.

Wood coll. 1963 by R. E. Becker and L. R. Mayo, U. S. Geol. Survey, 25 ft above base of Wisconsin age frozen silt, 1/2 mi NW of Ester, Alaska (64° 51' N Lat, 148° 02' W Long). Wood was part of sample previously dated Univ. of Texas at 9410 ± 130 B.P. (Tx-158, Texas II) and Packard Instrument Co. at 10,450 ± 150 B.P. (PIC-6, Packard I). Subm. by F. J. Pearson, Univ. of Texas, as check sample. *Comment*: in complete agreement with Texas date and approximate agreement with Packard value.

8800 ± 220

IVIC-180. Eagle Cave A

6850 B.C.

Charcoal from Eagle Cave site (41 VV 167) in Mile Canyon, near Langtry, Texas (29° 49' N Lat, 101° 33' W Long). From Stratum V, Hearth 1, which was earliest occupation of site and contained "Early Barbed" points. Charcoal was part of a sample previously dated by Univ. of Texas at 8760 ± 150 B.P. (Tx-107, Texas III). Coll. 1963 by R. E. Ross, M. L. Parsons, and C. D. Tunnell, Univ. of Texas; subm. by F. J. Pearson as check sample. *Comment*: I.V.I.C. date in complete agreement with Texas measurement.

III. MISCELLANEOUS SAMPLE

IVIC-206. Hojas de Guama 1965 $171 \pm 1\%$ modern

Growing leaves from same Guama tree (*Inga fastuosa*) in Altos de Pipe ($10^{\circ} 23' N$ Lat, $66^{\circ} 58' W$ Long) as IVIC-147 (IVIC I). Sample used to monitor nuclear weapon contamination in area. Coll. May 26, 1965. *Comment*: contamination has increased 9% over the period of exactly 1 yr.

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COPENHAGEN RADIOCARBON DATES VII

HENRIK TAUBER

Carbon-14 Dating Laboratory

Department of Natural Sciences, National Museum, Copenhagen

The following list comprises a selected number of measurements made up to November, 1965. Age calculations are based on a contemporary value equal to 95% of the activity of the NBS oxalic-acid standard, and on a half life for C^{14} of 5570 yr. Results are reported in years before 1950, and in the A.D./B.C. scale. Errors quoted include the standard deviations of the count rates for the unknown sample, the contemporary value, and the background. Because possible errors arising from isotopic fractionation in the plants, or from the de Vries effect, have not been included, calculated errors smaller than 100 yr have been increased by rounding to that figure as a minimum.

Sample descriptions have been prepared in collaboration with collectors and submitters.

ACKNOWLEDGMENTS

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SAMPLE DESCRIPTIONS

I. GEOLOGIC AND POLLEN-DATED SAMPLES

A. Denmark

K-931. Eiby, interglacial >35,000

Shells (*Mytilus edulis*) from a cliff formed in till, N of Eiby Bro (55° 42' N Lat, 11° 50' E Long), at Isefjord, Zealand. Found in 50-cm thick layer of stones, 10.5 m above sealevel, in a 22-m high cliff. At foot of cliff flint material of possible Palaeolithic character was found (Madsen, 1963). Coll. 1964 by E. Madsen; subm. by J. Troels-Smith, Natl. Mus., Copenhagen.

Nørre Lyngby profile, Older Dryas period

Late-glacial samples from open profile in cliff at Nørre Lyngby (57° 25' N Lat, 9° 45' E Long), North Jutland. Profile contains well-known Allerød series described and pollen-analyzed by Iversen (1942). Samples collected in fresh water deposit at level a little below beginning of Allerød period, belonging to end of Older Dryas, Pollen-zone Ic. Coll. 1949 and subm. by H. Krog, Geol. Survey of Denmark. *Comment:* Older Dryas period has previously been dated on samples from Usselo, Netherlands (Copenhagen IV), and Witow, Poland (Copenhagen V); dates agree closely.

K-962. Nørre Lyngby, D.G.U. 251**11,680 ± 140****9730 B.C.**

Strongly compressed, sandy peat with remains of wood and a few bands of moss peat. From upper part (163 to 167.5 cm below surface) of uppermost of two peat layers placed at base of the fresh water series. Date is average of two measurements: $11,650 \pm 180$ and $11,710 \pm 180$.

K-963. Nørre Lyngby, D.G.U. 252**11,780 ± 180****9830 B.C.**

Strongly compressed, sandy peat with remains of wood. From lower part (167.5 to 170 cm below surface) of same peat layer as K-962.

Sydfynske Øhav, immigration of hazel

Samples from boring (No. 268) through former fresh water bed in Sydfynske Øhav ($54^{\circ} 60' N$ Lat, $10^{\circ} 19' E$ Long), S of Funen, Denmark, at water depth of 19.2 m. Pollen-analytically dated to pollen-zone border IV/V, where the hazel curve rises, and to first half of Zone V. Coll. 1963 and subm. by H. Krog. *Comment:* compare dates for immigration of hazel at the Great Belt, and at Draved (this date list).

K-852. Sydfynske Øhav, D.G.U. 197**9550 ± 140****7600 B.C.**

Peat with small amounts of wood and a few fragments of mollusc shells, which were removed by acid before dating. Sample was overlying calcareous gyttja and was covered by peat. Position in core: 165 to 171 cm below sea bottom. Lower edge of sample marks the pollen-zone border IV/V.

K-1028. Sydfynske Øhav, D.G.U. 196**8990 ± 140****7040 B.C.**

Peat with small amounts of wood and fragments of mollusc shells, which were removed by acid before dating. Taken immediately above K-852, covered by peat. Position in core: 158 to 165 cm. Beginning of Pollen-zone V.

K-857. Sydfynske Øhav, D.G.U. 198a**8910 ± 140****6960 B.C.**

Wood, presumably exclusively *Salix* sp., resting on peat and covered by 5 cm of peat with some gyttja. Position in core: 132 to 148 cm. Pollen-zone V, presumably shortly before middle of zone.

Great Belt, immigration of hazel

Samples from boring (No. 271) through former fresh water bed in Great Belt ($55^{\circ} 21' N$ Lat, $10^{\circ} 55' E$ Long), at water depth of 27 m. Pollen analytically dated to Zone IV and beginning of Zone V. Immediately above uppermost sample (K-922) a rise in water level is indicated by the sediments. It is interpreted as the result of a transgression of the sea (Krog, 1960, 1965). This transgression has previously been dated

(Copenhagen V). Coll. 1964 and subm. by H. Krog. *Comment:* compare dates for immigration of hazel at Sydfynske Øhav and in Draved (this date list).

K-942. Great Belt, D.G.U. 227 **9730 ± 130**
7780 B.C.

Peat from Pollen-zone IV. Position in core: 278 to 281 cm below sea bottom.

K-926. Great Belt, D.G.U. 228 **9300 ± 150**
7350 B.C.

Peat from beginning of Pollen-zone V. Frequency of hazel pollen rises from 0.5% to 10% of AP. Position in core: 260 to 265 cm below sea bottom.

K-922. Great Belt, D.G.U. 229 **9060 ± 120**
7110 B.C.

Peat from beginning of Pollen-zone V. Hazel curve is still rising strongly. Position in core: 256 to 260 cm, i.e., immediately above K-926, covered by calcareous gyttja. Date is average of two measurements: 8990 ± 150 and 9130 ± 150.

Draved Mose, Profile H 1312, immigration of hazel

Samples from profile (H 1312) in a drainage ditch in the bog Draved Mose (55° 1' N Lat, 8° 57' E Long), South Jutland; near shore of prehistoric "Draved Lake". A peat monolith, 20 by 20 cm, was cut into contiguous slices, each 1 cm thick, from which a pollen and a C¹⁴ sample was taken (see the following series from Draved Mose). Peat overlies sand; the position in the monolith is indicated in cm above the sand. Samples date the immigration of hazel, pollen-zone border IV/V. This and the following series from Draved Mose are parts of a project to date pollen-zone borders and characteristic horizons in the total pollen sequence in Draved Mose. Coll. 1963 by Alfred Andersen; subm. by Johs. Iversen, Geol. Survey of Denmark. *Comment:* the corresponding pollen-zone border IV/V in Süderlügum, only 20 km S of Draved Mose, has been dated as H-363/343, 8720 ± 140 B.P. (Kubitzki and Münnich, 1960). Compare also dates for immigration of hazel at Sydfynske Øhav and at Great Belt (this date list).

K-909. Draved Mose, D.G.U. 222 **8730 ± 160**
6780 B.C.

Sandy gyttja, 18 to 19 cm above sand. Pollen-zone border IV/V, the hazel curve rises strongly.

K-910. Draved Mose, D.G.U. 223 **8740 ± 160**
6790 B.C.

Sandy gyttja, 17 to 18 cm above sand, i.e. immediately below K-909. Hazel percentage is very low and probably due to long distance transport.

K-911. Draved Mose, D.G.U. 224 **8630 ± 160**
6680 B.C.

Peaty, sandy gyttja, 16 to 17 cm above sand, i.e. immediately below K-910.

K-913. Draved Mose, D.G.U. 225 **8660 ± 160**
6710 B.C.

Peaty, sandy gyttja, 15 to 16 cm above sand, i.e. immediately below K-911.

Draved Mose, Profile H 1312, Pollen-zones V to VII

Samples from same profile, H 1312, in drainage ditch in the bog Draved Mose (55° 1' N Lat, 8° 57' E Long), South Jutland, as mentioned in the previous series. Samples date from Pollen-zones V, VI, and VII. Coll. 1963 by Alfred Andersen; subm. by Johs. Iversen.

K-950. Draved Mose, D.G.U. 250 **8330 ± 140**
6380 B.C.

Peat from 51 to 52 cm above sand. Taken in layer of birch forest peat which formed after the filling-up of the former lake and before the occurrence of more swampy conditions. Close to a charred layer. Last part of Pollen-zone V.

K-949. Draved Mose, D.G.U. 249 **8190 ± 140**
6240 B.C.

Peat from 57 to 58 cm above sand. Taken just below a charred layer and close to level where swamping begins. Pollen-zone border V/VI.

K-948. Draved Mose, D.G.U. 248 **8140 ± 140**
6190 B.C.

Peat from 58 to 59 cm above sand, i.e. immediately above K-949. Taken in a charred layer placed closely above level where swamping begins. Pollen-zone border V/VI.

K-947. Draved Mose, D.G.U. 247 **7720 ± 140**
5770 B.C.

Peat from 68 to 69 cm above sand. Taken immediately above a charred layer. Pollen-zone border VI/VII ex Knud Jessen; Pollen-zone VI ex Svend Jørgensen.

K-946. Draved Mose, D.G.U. 246 **7650 ± 140**
5700 B.C.

Peat from 77 to 78 cm above sand. Taken above a charred layer (perhaps from the same fire as in K-947). Pollen-zone border VI/VII ex Knud Jessen; Pollen-zone VI ex Svend Jørgensen.

K-945. Draved Mose, D.G.U. 245 **7510 ± 140**
5560 B.C.

Peat from 82 to 83 cm above sand. Taken immediately below a distinct charred layer. Pollen-zone VII ex Knud Jessen; Pollen-zone VI ex Svend Jørgensen.

K-944. Draved Mose, D.G.U. 244**7180 ± 120****5230 B.C.**

Peat from 83 to 84 cm above sand. Taken in charred layer mentioned in K-945. It is possible that part of the peat layer had disappeared in this fire. Pollen-zone VII ex Knud Jessen; Pollen-zone VI ex Svend Jørgensen. Date is average of two measurements: 7200 ± 140 and 7160 ± 140 .

Draved Mose, charred pine stumps

Samples from charred stumps and stems of pine trees from profile H 1312, and from a locality 900 m S of H 1312, in bog Draved Mose ($55^{\circ} 1' \text{ N Lat, } 8^{\circ} 57' \text{ E Long}$), South Jutland. Found at transition from forest peat to sphagnum peat. At this level several charred stumps have been found, and it looks as if forest was destroyed in one big forest fire or in a number of consecutive fires. Samples K-783, K-943, and K-1018 have been dated pollen analytically to the zone border VI/VII ex Knud Jessen. Coll. 1958 to 1965 by Alfred Andersen; subm. by Johs. Iversen.

K-783. Draved Mose, D.G.U. 126**7810 ± 140****5860 B.C.**

Outer year-rings from a charred pine stump found in Profile H 1312.

K-943. Draved Mose, D.G.U. 125**7840 ± 140****5890 B.C.**

Charcoal (*Pinus* sp.) from a charred layer found in Profile H 1312 in connection with K-783.

K-786. Draved Mose, D.G.U. 138**7790 ± 140****5840 B.C.**

Outer year-rings from a charred pine stump found in southern part of the bog, 900 m from K-783, in Trench P I at dwelling place No. 332 (see Draved Mose, Mesolithic dwelling places, this date list).

K-1018. Draved Mose, D.G.U. 278**7590 ± 150****5640 B.C.**

Outer year-rings from a charred pine stump found in Profile H 1312. Stump was partly burned and had been overgrown by the bog when a new pine tree grew up on same spot. Second pine tree had also burned (see K-1019).

K-1019. Draved Mose, D.G.U. 279**7370 ± 150****5420 B.C.**

Outer year-rings from younger of two connected pine stumps (see K-1018).

Draved Mose, Profile 1959, Pollen-zones VII to IX

Samples from open profile (1959) 30 m long, in central part of bog Draved Mose ($55^{\circ} 1' \text{ N Lat, } 8^{\circ} 57' \text{ E Long}$), South Jutland. Profile exposes peat from early Atlantic time to present, overlies sand. A peat

monolith, 20 to 20 cm, was cut into slices 1 cm thick, from which samples for pollen analysis and for C^{14} dating were taken. Position of slices in monolith is indicated in cm above sand. Samples date pollen-zone borders and characteristic horizons in the sequence, among these the land occupation phase (Iversen, 1941). Samples from this monolith representing the pollen-zone border VII/VIII and the elm fall have previously been published (Copenhagen VI). Coll. 1960 by Alfred Andersen; subm. by Johs. Iversen.

6500 \pm 140
K-787. Draved Mose, D.G.U. 177 4550 B.C.

Strongly humified peat (or mor) from 4 to 5 cm above sand. Pollen-zone VII ex Knud Jessen; Pollen-zone VI ex Svend Jørgensen.

6280 \pm 140
K-788. Draved Mose, D.G.U. 178 4330 B.C.

Strongly humified sphagnum peat from 6 to 7 cm above sand. Pollen-zone VII ex Knud Jessen; Pollen-zone VI ex Svend Jørgensen.

5810 \pm 130
K-830. Draved Mose, D.G.U. 181 3860 B.C.

Strongly humified sphagnum peat from 12 to 13 cm above sand. From level where curve for the mixed-oak forest becomes constant. Pollen-zone VII ex Knud Jessen; Pollen-zone border VI/VII ex Svend Jørgensen.

5710 \pm 130
K-831. Draved Mose, D.G.U. 182 3760 B.C.

Strongly humified sphagnum peat from 14 to 15 cm above sand. Pollen-zone VII, just above level where curve for the mixed-oak forest becomes constant. *Comment:* higher samples in same sequence were K-737, 29 to 30 cm, K-738, 30 to 31 cm, K-739, 33 to 34 cm, and K-741, 35 to 36 cm above the sand, representing the elm fall and the pollen-zone border VII/VIII; see Copenhagen VI.

4480 \pm 120
K-840. Draved Mose, D.G.U. 183 2530 B.C.

Strongly humified sphagnum peat from 41 to 42 cm above sand. Dates land occupation phase and first occurrence of *Plantago lanceolata*. Pollen-zone VIII.

4500 \pm 120
K-843. Draved Mose, D.G.U. 184 2550 B.C.

Strongly humified sphagnum peat from 43 to 44 cm above sand. Like K-840, sample dates the land occupation phase and the first occurrence of *Plantago lanceolata*. Pollen-zone VIII.

2990 \pm 100
K-742. Draved Mose, D.G.U. 160 1040 B.C.

Sphagnum peat from 121 to 123 cm above sand. Taken 1 to 3 cm below a charred layer found a little below level where beech curve begins.

Pollen-zone VIII. Date is average of two measurements: 3080 ± 110 and 2910 ± 110 .

K-743. Draved Mose, D.G.U. 161 **2660 ± 110**
710 B.C.

Sphagnum peat from 123 to 124 cm above sand. Taken immediately below charred layer mentioned in K-742. Pollen-zone VIII.

K-744. Draved Mose, D.G.U. 162 **2690 ± 110**
740 B.C.

Sphagnum peat from 125 to 126 cm above sand. Taken 1 cm above charred layer mentioned in K-742, and 2 cm below level where beech curve begins. Pollen-zone VIII.

K-773. Draved Mose, D.G.U. 169 **2730 ± 110**
780 B.C.

Sphagnum peat from 128 to 130 cm above sand. Dates beginning of beech curve. Pollen-zone border VIII/IX.

K-774. Draved Mose, D.G.U. 170 **2650 ± 100**
700 B.C.

Sphagnum peat from 131 to 133 cm above sand. Dates beginning of beech curve. Pollen-zone IX.

K-778. Draved Mose, D.G.U. 171 **1760 ± 100**
A.D. 190

Sphagnum peat from 178 to 180 cm above sand. Dates a characteristic rise in the curves for beech and hornbeam. Pollen-zone IX.

K-779. Draved Mose, D.G.U. 172 **1730 ± 100**
A.D. 220

Sphagnum peat from 180 to 182 cm above sand. Dates a characteristic rise in curves for beech and hornbeam. Pollen-zone IX.

K-780. Draved Mose, D.G.U. 173 **1660 ± 100**
A.D. 290

Sphagnum peat from 182 to 184 cm above sand. Dates a characteristic rise in curves for beech and hornbeam. Pollen-zone IX.

K-745. Draved Mose, D.G.U. 163 **1420 ± 100**
A.D. 530

Sphagnum peat from 206 to 208 cm above sand. Taken just below lower edge of a characteristic layer of *Sphagnum imbricatum* peat. Pollen-zone IX.

K-746. Draved Mose, D.G.U. 164 **1360 ± 100**
A.D. 590

Sphagnum peat from 208 to 210 cm above sand. Represents lower edge of characteristic layer of *Sphagnum imbricatum* peat mentioned in K-745. Pollen-zone IX.

K-747. Draved Mose, D.G.U. 165 **1320 ± 100**
A.D. 630

Sphagnum peat from 211 to 213 cm above sand. Taken 3 cm above lower edge of layer of *Sphagnum imbricatum* peat mentioned in K-745. Pollen-zone IX.

K-781. Draved Mose, D.G.U. 174 **750 ± 100**
A.D. 1200

Sphagnum peat from 244 to 246 cm above sand. Taken in uppermost part of *imbricatum* peat layer mentioned in K-745. Pollen-zone IX.

K-782. Draved Mose, D.G.U. 175 **780 ± 100**
A.D. 1170

Sphagnum peat from 246 to 248 cm above sand. Taken immediately above *imbricatum* peat mentioned in K-745. Pollen-zone IX.

Draved Mose, profile at dwelling place No. 329

Samples from a profile at dwelling place No. 329 (see Draved Mose, Mesolithic dwelling places, this date list) at shore of the prehistoric "Draved Lake" in the bog Draved Mose (55° 1' N Lat, 8° 57' E Long), South Jutland. Profile exposes peat layers overlying a sand dune, on which dwelling place No. 329 was found. Samples indicate time when peat formation began on the dune, and date two charred layers in the peat. Coll. 1963 by Alfred Andersen; subm. by Johs. Iversen.

K-918. Draved Mose, D.G.U. 210b **2410 ± 120**
460 B.C.

Strongly humified peat (or mor) from a 1-cm thick layer just above sand. Sample indicates time when peat formation began. Pollen-zone IX.

K-917. Draved Mose, D.G.U. 209 **2190 ± 120**
240 B.C.

Sandy sphagnum peat, 1 to 1.5 cm thick, from charred layer placed closely above sand. Pollen-zone IX.

K-915. Draved Mose, D.G.U. 208 **2040 ± 120**
90 B.C.

Sandy sphagnum peat, 1 to 1.5 cm thick, from charred layer placed 25 to 30 cm above sand. Pollen-zone IX.

K-723. Draved Forest, Mor-profile 1, D.G.U. 135 **1210 ± 100**
A.D. 740

Charcoal of oak from a mor-profile in Draved Forest (55° 1' N Lat, 8° 59' E Long), at Løgumkloster, South Jutland. Profile exposed an unusually thick layer of fossil mor overlying eolian sand. The profile is described and pollen-analyzed by Iversen (1960, 1964). The charcoal was taken 41 to 45 cm above sand at border between oak-mor (below) and *Callunamor*. Pollen-zone IX, shortly before rise of beech curve. Coll. 1959 and subm. by Johs. Iversen. *Comment*: two lower lying samples from same profile have previously been dated (Copenhagen IV).

K-794. Lundergaards Mose, D.G.U. 179**3240 ± 120
1290 B.C.**

Outer year-rings from oak stump found in Lundergaards Mose (57° 12' N Lat, 9° 37' E Long) Vendsyssel, North Jutland. Remains of a whole forest have been found in the bog. Trees had been killed, and stumps have been preserved, due to swamping. Sample is from one of the stumps in this forest. Coll. 1962 by J. Jørgensen; subm. by Johs. Iversen.

North Jutland, late-and post-glacial shells

A series of samples of mollusc shells from late-glacial and post-glacial marine deposits in Vendsyssel and Himmerland, North Jutland, and on the island Læsø, Kattegat. Samples date various stages in the late- and post-glacial marine development in Skagerak and Kattegat (see Hansen, 1965). Three samples of recent shells (K-892, 433, 893) from same area have been included as a control. K-900 coll. ca. 1900 by V. Nordman; K-433 coll. 1952; K-902 and K-903 coll. 1961 by S. A. Andersen; all others coll. 1962-1963 and subm. by H. Krog and Sigurd Hansen, Geol. Survey of Denmark. *Comment:* before dating, shells were cleaned and the surface layers (approx. 10% of the total carbonate) were removed with acid.

K-858. Lønstrup Klint, D.G.U. 200**13,900 ± 220
11,950 B.C.**

Shells (*Saxicava arctica*) from layer of Lower Saxicava sand in the cliff Lønstrup Klint (57° 29' N Lat, 9° 48' E Long), Vendsyssel.

K-887. Dybvad Teglvaerk, D.G.U. 211**13,180 ± 200
11,230 B.C.**

Shells (*Saxicava arctica*) from clay pit at the brick-works Dybvad Teglværk (57° 16' N Lat, 10° 21' E Long), Vendsyssel. Found in late-glacial Yoldia clay, 1 to 2½ m below present surface.

K-903. Dybvad Teglvaerk, Andersen No. 2**13,010 ± 190
11,060 B.C.**

Shells (*Saxicava arctica*) from clay pit at the brick-works Dybvad Teglværk, Vendsyssel. Found in layer of late-glacial Yoldia clay.

K-894. Læsø Nordmark, D.G.U. 216**12,910 ± 180
10,960 B.C.**

Shells (*Saxicava arctica*) from boring (No. 7) through late-glacial Yoldia clay at Læsø Nordmark (57° 17' N Lat, 10° 0' E Long), Læsø.

K-891. Bindslev Teglvaerk, D.G.U. 213**12,650 ± 180
10,700 B.C.**

Shells (*Mya truncata*, *Saxicava arctica*, and *Macoma calcarea*) from Bindslev Teglværk (57° 32' N Lat, 10° 12' E Long), Vendsyssel. Found in late-glacial Yoldia clay in open profile, covered by late-glacial marine sand.

- 12,770 \pm 160**
10,820 B.C.
- K-898. Skeenmøllebaek, D.G.U. 218c**
- Shells (*Mya truncata*) from Skeenmøllebæk, Loc. A, (57° 33' N Lat, 10° 7' E Long), Vendsyssel. Found in transitional layer of marine clay and gravel at border between late-glacial Yoldia clay and lower part of Zirphaea bed. Date is average of two measurements: 12,850 \pm 200 and 12,690 \pm 200.
- 12,520 \pm 180**
10,570 B.C.
- K-897. Skeenmøllebaek, D.G.U. 218b**
- Shells (*Mytilus edulis*) from Skeenmøllebæk, Loc. A, Vendsyssel. Found in transitional layer of marine clay and gravel at border between late-glacial Yoldia clay and lower part of Zirphaea bed.
- 12,230 \pm 170**
10,280 B.C.
- K-860. Skeenmøllebaek, D.G.U. 202a**
- Shells (*Mya truncata*) from Skeenmøllebæk, Loc. A, Vendsyssel. Found in transitional layer of marine clay and gravel at border between late-glacial Yoldia clay and lower part of Zirphaea bed.
- 12,240 \pm 180**
10,290 B.C.
- K-899. Skeenmøllebaek, D.G.U. 219b**
- Shells (*Mytilus edulis*) from Skeenmøllebæk, Loc. B, Vendsyssel. Found in marine sand belonging to Zirphaea bed, exposed in a cleft cut by a brook, 3 to 4 m below surface.
- 12,360 \pm 150**
10,410 B.C.
- K-862. Skeenmøllebaek, D.G.U. 203b**
- Shells (*Macoma calcarea*) from Skeenmøllebæk, Loc. C, Vendsyssel. Found in marine sand belonging to Zirphaea bed, in a cliff, ca. 3 m below surface. Date is average of two measurements: 12,460 \pm 170 and 12,260 \pm 170.
- 12,190 \pm 170**
10,240 B.C.
- K-861. Skeenmøllebaek, D.G.U. 203a**
- Shells (*Mya truncata*) from Skeenmøllebæk, Loc. C, Vendsyssel. From same layer in Zirphaea bed as K-862.
- 12,030 \pm 130**
10,080 B.C.
- K-859. Borgbakke, D.G.U. 201**
- Shells (*Mytilus edulis*) from Borgbakke (57° 27' N Lat, 10° 31' E Long), Frederikshavn, Vendsyssel. From layer of shell fragments and marine gravel in Upper Saxicava sand. Date is average of two measurements: 11,840 \pm 170 and 12,170 \pm 150.
- 8280 \pm 140**
6330 B.C.
- K-895. Tvaersted Å, D.G.U. 217**
- Shells (*Cardium edule*) from cliff at the river Tværsted Å (57° 35' N Lat, 10° 11' E Long), Vendsyssel. Found in layer of post-glacial marine sand below Cardium clay, 1 to 2½ m above water level in river.

- K-906. Melholt, D.G.U. 212d** **6110 \pm 120**
4160 B.C.
Shells (*Ostrea edulis*) from gravel pit S of Melholt (57° 6' N Lat, 10° 21' E Long), Vendsyssel. Found in layer of post-glacial gravel, 0.9 to 1.9 m above water level of river Gerå. Tapes (Littorina) time. Date is average of two measurements: 6100 \pm 140 and 6120 \pm 140.
- K-890. Melholt, D.G.U. 212c** **6090 \pm 120**
4140 B.C.
Shells (*Cardium edule*, *Ostrea edulis*, and *Cyprina islandica*) from same layer as K-906. Tapes (Littorina) time. Date is average of two measurements: 6050 \pm 140 and 6130 \pm 140.
- K-907. Melholt, D.G.U. 212e** **5940 \pm 140**
3990 B.C.
Shells (*Cardium edule*) from same layer as K-906. Tapes (Littorina) time.
- K-888. Melholt, D.G.U. 212a** **5620 \pm 140**
3670 B.C.
Shells (*Ostrea edulis*) from same layer as K-906. Tapes (Littorina) time.
- K-889. Melholt, D.G.U. 212b** **5560 \pm 140**
3610 B.C.
Shells (*Cardium edule*) from same layer as K-906. Tapes (Littorina) time.
- K-902. Melholt, Andersen No. 1** **5550 \pm 140**
3600 B.C.
Unsorted shells from same layer as K-906. Tapes (Littorina) time.
- K-866. Lille Vildmose, D.G.U. 205** **5580 \pm 150**
3630 B.C.
Shells (*Ostrea edulis*) from a digging in Lille Vildmose (56° 53' N Lat, 10° 13' E Long), Himmerland. From layer of post-glacial marine sandy gyttja, 2 to 2½ m below surface. Tapes (Littorina) time.
- K-900. Strandby, D.G.U. 220** **4470 \pm 140**
2520 B.C.
Shells (*Dosinia exoleta*) from beach ridge at Strandby (57° 29' N Lat, 10° 30' E Long), Vendsyssel.
- K-864. Gettrup Bro, D.G.U. 204a** **4150 \pm 140**
2200 B.C.
Shells (*Ostrea edulis*, *Mytilus edulis*, *Cardium edule*, and *Tapes aureus*) from layer of clayey marine sand with gyttja in river bed of Gerå at Gettrup Bro (57° 7' N Lat, 10° 17' E Long), Vendsyssel, 1½ m below surface. Tapes (Littorina) time.

4010 \pm 120
2060 B.C.

K-865. Gettrup Bro, D.G.U. 204b

Shells (*Littorina littorea*) from same layer as K-864. Tapes (*Littorina*) time. Date is average of two measurements: 3960 ± 140 and 4050 ± 140 .

560 \pm 100
A.D. 1390

K-867. Frederikshavn, D.G.U. 206

Shells (*Cardium edule*) from layer of shells and gravel N of Frederikshavn ($57^{\circ} 28' \text{ N Lat}$, $10^{\circ} 32' \text{ E Long}$), Vendsyssel. Found in uncovered surface layer, ca. 2 m above sealevel. Recent or almost recent.

100.8 \pm 0.5%
of modern

K-892. Kuje Grund, D.G.U. 214

Shells (*Cardium edule*) from Kuje Grund ($56^{\circ} 57' \text{ N Lat}$, $10^{\circ} 17' \text{ E Long}$), in Kattegat. Found below surface of Kattegat, $\frac{1}{2}$ to 1 km from shore, covered by ca. 25 cm of marine sand. Recent.

100.7 \pm 0.5%
of modern

K-433. Østerskompagniet

Shells (*Ostrea edulis*) from oyster bed in western part of Limfjorden (57° N Lat , 9° E Long). Living oysters taken 1952.

101.9 \pm 0.5%
of modern

K-893. Sæby, D.G.U. 215

Shells (*Mya arenaria*) from beach S of Sæby ($57^{\circ} 16' \text{ N Lat}$, $10^{\circ} 33' \text{ E Long}$), Vendsyssel. Recent shells collected on the beach in 1962. *Comment:* it is not known when the clams were living; the high activity, however, is probably due to an uptake of bomb-produced C^{14} in the sea.

Faellesvaerre, North Sea transgression

Samples from salt-marsh sediments found below an artificial mound, Fællesværrer ($54^{\circ} 54' \text{ N Lat}$, $8^{\circ} 50' \text{ E Long}$), South Jutland. The sediments are overlying a sand geest lying 65 to 116 cm below present sea-level. Samples date latest transgression of the North Sea in the Tønder area, South Jutland (Jacobsen, 1964). Coll. 1962 and subm. by N. Kingo Jacobsen, Geog. Inst., Univ. of Copenhagen.

3400 \pm 120
1450 B.C.

K-795. Faellesvaerre NØ 1

Stems and leaves of Phragmites from Phragmites peat formed immediately above the sand geest, 65 to 50 cm below sealevel.

3650 \pm 120
1700 B.C.

K-796. Faellesvaerre NØ 2

Piece of wood lying horizontally in red fen peat. Found 45 cm below sealevel. Immediately below the red fen peat was a charred layer, and below this Phragmites peat overlying the sand geest.

K-797. Faellesvaerre SV 2 **1180 ± 100**
A.D. 770

Phragmites washed out of a layer of Phragmites clay formed in brackish water. Found 30 to 40 cm below sealevel.

K-941. Hollerup, ZMK 31 **3060 ± 260**
1110 B.C.

Bones of amphibians found at Hollerup (56° 24' N Lat, 9° 51' E Long), Viborg, Jutland. Supposed to originate from a deposit of kiselguhr formed during the last interglacial, parts of kiselguhr were sticking to the bones. Coll. 1907 by N. Hartz and kept in Zool. Mus. till now; subm. 1964 by U. Møhl, Zool. Mus., Copenhagen. *Comment:* may originate from a burrow of fox or badger dug into the deposit.

B. Greenland

K-802. Kapisigdlit, "lake 8 m s.m." **4340 ± 120**
2390 B.C.

Lake sediments from boring in the first lake ("lake 8 m s.m.", Iversen, 1954) inland from the mouth, on river Kapisigdlit (64° 26' N Lat, 50° 12' W Long), Godthaabsfjord, West Greenland. The sediments consist of gyttja overlying marine clay. Sample taken in lowermost part of gyttja, 0 to 9 cm above clay. Represents upper part of Pollen Period III (Iversen, 1964). Coll. 1960 and subm. by Bent Fredskild, Natl. Mus., Copenhagen.

Qagssiarssuk, "Comarum Mose"

Samples from boring in "Comarum Mose" (61° 8' N Lat, 45° 32' W Long), Julianehåb District, West Greenland. Samples date two pollen horizons in a pollen series from a 445-cm thick organic sediment overlying stratified clay. A pollen diagram from the sediment series is being prepared. Coll. 1960 and subm. by Bent Fredskild.

K-804. "Comarum Mose", Hg 6070 **7200 ± 140**
5250 B.C.

Noncalcareous, slightly clayey gyttja from the lowermost 10 cm of the gyttja deposit, overlying stratified clay. Depth below surface 435 to 445 cm. Dates the time when formation of gyttja began.

K-803. "Comarum Mose", Hg 6066 **2510 ± 100**
560 B.C.

Noncalcareous gyttja with a slight content of swamp peat, taken 0 to 5 cm below the border between gyttja and overlying swamp peat. Depth below surface 166 to 171 cm. Dates a characteristic horizon in the filling-up of the basin.

C. England

Blea Tarn, the elm fall

Samples from boring (No. 3) in lake sediments in Blea Tarn, (54° 25' N Lat, 3° 5' W Long), Westmorland, England. Sediments have been

pollen-analyzed and show a very distinct fall in elm pollen percentages in connection with an inwash of mineral matter (Pennington, 1964 and 1965). Coll. 1964 and subm. by W. Pennington (Mrs. T. G. Tutin), Univ. of Leicester, England. *Comment:* dates agree closely with other dates for the post-glacial elm fall in NW Europe (Godwin, 1960; Copenhagen VI).

K-959. Blea Tarn, No. 6-7

5530 \pm 120

3580 B.C.

Noncalcareous gyttja from layers Nos. 6 and 7, 190 to 200 cm in the core. Before the elm fall, elm pollen frequencies fall from 20% to 14% of AP.

K-958. Blea Tarn, No. 4-5

5320 \pm 120

3370 B.C.

Noncalcareous gyttja from layers Nos. 4 and 5, 180 to 190 cm in the core, i.e., immediately above K-959. Before the elm fall, elm pollen frequencies rise from 14% to 16% of AP.

K-957. Blea Tarn, No. 2-3

5100 \pm 120

3150 B.C.

Noncalcareous gyttja from layers Nos. 2 and 3, 170 to 180 cm in the core, i.e., immediately above K-958. Represents the true elm fall, elm pollen frequencies fall from 16% to 6% of AP.

II. ARCHAEOLOGIC SAMPLES

A. Denmark

Draved Mose, Mesolithic dwelling places

Samples from 4 Mesolithic dwelling places found at shores of the prehistoric "Draved Lake" in Draved Mose (55° 1' N Lat, 8° 57' E Long), South Jutland. Dwelling places have been found on former sand dunes, now covered by peat. Flint implements found are from Klosterlund and younger cultures (Kapel, 1959, 1964). Coll. 1958-1965 and subm. by Alfred Andersen and H. Kapel, Geol. Survey of Denmark. *Comment:* a sample from dwelling place No. 604 has previously been dated to K-582, 9060 \pm 130 (Copenhagen V). Dates support the archaeological assumption that remains from two different cultures are left on these places.

K-829. Draved Mose, D.G.U. 112 and 114

8390 \pm 150

6440 B.C.

Charcoal from thin culture layer (4 to 6 cm in thickness) on dwelling place No. 604, found together with flint implements from Klosterlund culture. The implements may originate from two different cultures (see K-582, Copenhagen V), which have not yet been properly separated. Found in Squares H I and H II.

K-790. Draved Mose, D.G.U. 141**8990 ± 140****7040 B.C.**

Charcoal of pine and birch from culture layer on dwelling place No. 611. Core axes, trimmed blades and microliths from Klosterlund culture were found in the culture layer. Sample found in pit, Trench Ø-V, Squares 11 to 12.

K-791. Draved Mose, D.G.U. 148**8430 ± 140****6480 B.C.**

Charcoal of pine and birch from culture layer on dwelling place No. 332. Found together with flint implements, e.g., core axes, scrapers, and microliths, and with larger worked stones. Implements are supposed to be somewhat younger than Klosterlund culture. Sample collected from a number of squares.

K-914. Draved Mose, D.G.U. 188**9050 ± 160****7100 B.C.**

Charcoal from culture layer on dwelling place No. 329. Flint implements from two different cultures have been found in the culture layer, partly from Klosterlund culture, partly from another probably younger culture with small and finely worked microliths. Sample collected in Square 24/3 W.

K-841. Draved Mose, D.G.U. 187**8470 ± 150****6520 B.C.**

Charcoal from culture layer on dwelling place No. 329. Found in Square 25/3 W in same culture layer as K-914.

K-1017. Draved Mose, D.G.U. 282**8250 ± 170****6300 B.C.**

Charcoal of pine from culture layer on dwelling place No. 329. Found on Square 32/8 W.

K-1016. Draved Mose, D.G.U. 281**8180 ± 190****6230 B.C.**

Charcoal of pine from dwelling place No. 329. Found in pit in southern slope of sand dune, on top of which the dwelling place was situated. Pit also contained pieces of worked flint. From Square 32/3 W.

Kongemose culture, Åmosen

Samples of charred wood from culture layer on dwelling place Kongemosen (55° 35' N Lat, 11° 30' E Long), in bog Åmosen, West Zealand. Found in a 5 to 17-cm thick refuse layer embedded in gyttja in a former lake, on the shore of which the dwelling place was situated. A very large amount of flint implements were found on the dwelling place, among these rhombic arrow heads and large flint picks. Kongemose culture is an inland phase of the Mesolithic Old Coastal culture (Jørgensen, 1956 and 1961). A preliminary pollen investigation has dated the refuse layer to the transition Pollen-zone V/VI. Coll. 1955 and subm. by Svend Jørgensen, Natl. Mus., Copenhagen.

8830 ± 110**K-571. Kongemosen, No. 3571****6880 B.C.**

Charred wood of pine from refuse layer in calcareous gyttja. Found in lowermost part of refuse layer, which here was 17 cm thick. Date is average of two measurements: 8980 ± 150 and 8720 ± 130 .

8400 ± 150**K-570. Kongemosen, No. 20181****6450 B.C.**

Charred wood from same refuse layer as in K-571. Found at a place where refuse layer was only 5 to 8 cm thick.

4490 ± 120**K-978. Katbjerg, Early Passage Grave period****2540 B.C.**

Bark (*Betula* sp.) from a passage grave, Jordhøj, at Katbjerg ($56^{\circ} 38' \text{ N Lat.}, 9^{\circ} 55' \text{ E Long.}$), Jutland. Found jammed in between stones in wall of grave, which had remained untouched from the Stone age until the opening in 1890. The passage grave belongs to Middle Neolithic time, Period I b. Coll. 1890 by W. Boye; subm. by P. Kjærsum, Prehist. Mus., Aarhus. *Comment:* two samples from Early Passage Grave period in Jutland have previously been dated (Copenhagen VI). Dates agree closely. The bark had not been treated with preservatives.

3460 ± 100**K-989. Fårup, disc wheel****1510 B.C.**

Wood (*Quercus* sp.) from disc wheel found in 1875 in bog at Fårup ($56^{\circ} 22' \text{ N Lat.}, 9^{\circ} 33' \text{ E Long.}$), Jutland. Wheel is of the one-piece type, which in the Netherlands has been dated to ca. 2100 B.C. (van der Waals, 1964). Coll. 1875; subm. by H. Norling-Christensen, Natl. Mus., Copenhagen. *Comment:* sample had been treated with preservatives, presumably varnish and kerosene. Prior to dating preservatives were extracted with ether, and the sample material separated in cellulose and lignin fractions as described in K-599 (Copenhagen V). The two fractions were dated separately: K-989A (lignin), 3410 ± 110 ; and K-989B (cellulose), 3510 ± 110 . Date is average of these two measurements.

2420 ± 110**K-823. Dystrup Mose, disc wheel****470 B.C.**

Wood (*Alnus* sp.) from disc wheel found in 1904 in Dystrup Mose ($56^{\circ} 27' \text{ N Lat.}, 10^{\circ} 38' \text{ E Long.}$), Jutland. Wheel is of tripartite type with lunate openings and separate inserted nave (Müller, 1907). In the Netherlands this type of disc wheel has been dated to the Iron age (van der Waals, 1964). Coll. 1904; subm. by Elna Møller, Natl. Mus., Copenhagen. *Comment:* sample had been treated with paraffin as a preservative. Prior to dating the paraffin was carefully extracted by repeated leaching with ether, which in turn was extracted by several boilings with water. After drying no smell of paraffin or ether was left. Date is average of two measurements on the thus pretreated material: 2410 ± 120 and 2430 ± 120 . As a control a wood sample previously dated to K-101,

10,970 \pm 120 (Copenhagen VI) was given the same treatment with ether and water. After this pretreatment the date became 10,990 \pm 180.

Viking ships, Roskilde Fjord

Samples from Viking ships and artificial blockings found in natural channels at Skuldelev (55° 48' N Lat, 12° 4' E Long), in Roskilde Fjord, Zealand. Five wrecks of old Viking ships were found in a submarine excavation. The ships had been sunk deliberately in order to block the narrow natural channel, Peberrenden, to the town Roskilde, probably for defense (Olsen and Crumlin-Pedersen, 1958; Olsen, 1964). Blockings of piles driven into the bottom were also found in the channel Peberrenden, and in three other narrow channels: Vesterrenden, Vimmelskiftet, and Jydedybet. Coll. 1962 and subm. by Oluf Olsen and O. Crumlin-Pedersen, Natl. Mus., Copenhagen. *Comment*: two samples from wreck No. 2 have previously been dated with similar results (Copenhagen IV).

940 \pm 100

K-876. Skuldelev, wreck No. 1

A.D. 1010

Animal hair and wood-tar used as caulking between the planks in wreck No. 1. Dates time of construction of the ship.

960 \pm 100

K-908. Skuldelev, wreck No. 2

A.D. 990

Wooden pins (*Salix* sp.) used in construction of wreck No. 2. Wedges of hard wood (oak) were driven into the pins to make them stick in the holes; wedges were removed before dating. Dates time of construction of the ship.

920 \pm 100

K-877. Skuldelev, wreck No. 3

A.D. 1030

Wooden pin (*Salix* sp.) used in construction of wreck No. 3. Dates time of construction of the ship.

990 \pm 100

K-875. Skuldelev, wreck No. 5

A.D. 960

Animal hair and wood-tar used as caulking between the planks in wreck No. 5. Dates time of construction of the ship.

970 \pm 100

K-878. Skuldelev, Peberrenden

A.D. 980

Branches (*Corylus avellana*) used in pile blocking in the channel Peberrenden, found immediately E of wreck No. 3.

940 \pm 100

K-873. Skuldelev, Vesterrenden

A.D. 1010

Piece of pile (*Fagus sylvatica*) used in blocking in the channel Vesterrenden.

880 ± 100**K-871. Skuldelev, Vimmelskiftet****A.D. 1070**

Wood from piles (*Fagus sylvatica*) used in blocking in the southern end of the channel Vimmelshaflet.

870 ± 100**K-872. Skuldelev, Jydedybet****A.D. 1080**

Piece of worked wood (*Quercus* sp.), perhaps from a ship, used as blocking in the channel Jydedybet. Date is average of two measurements: 860 ± 100 and 880 ± 100.

*B. Greenland***Jørgen Brønlund Fjord, Vandfaldnaes**

Samples of charcoal from terraces at Vandfaldnaes (82° 9' N Lat, 30° 13' W Long), Jørgen Brønlund Fjord, Peary Land. Two raised beaches at levels of 11 m and 6.4 m above sealevel, respectively, are found at the locality. The charcoal originates from Palaeo-Eskimo ruins on these terraces. The ruin on the 11 m terrace contained implements of Independence I culture, while the ruin on the lower terrace represents Independence II culture (Knuth, 1965). Coll. 1963 and subm. by Eigil Knuth, Natl. Mus., Copenhagen. *Comment:* ruins from Independence I culture have previously been dated on samples of drift wood (Copenhagen III, IV, and VI). This (K-932) and the following samples from Portfjældet and from Pearylandville are the first dates of Independence I culture made on local plant material (*Salix arctica*). Dates agree closely with those previously made on driftwood. Dates for Independence II culture agree with those previously published (Copenhagen III and IV).

3780 ± 120**K-932. Vandfaldnaes, 11 m terrace****1830 B.C.**

Charcoal (*Salix* sp.) from ruin No. 15 on the 11 m terrace, found together with a large number of implements of Independence I culture.

3180 ± 110**K-933. Vandfaldnaes, 6.4 m terrace, No. 1****1230 B.C.**

Charcoal from drift wood (*Larix* sp.) from a large circular ruin, No. 9, with mid-passage hearth, situated on the 6.4 m terrace. Found together with implements of Independence II culture.

2740 ± 100**K-934. Vandfaldnaes, 6.4 m terrace, No. 2****790 B.C.**

Charcoal from drift wood (*Picea* sp.) from same ruin as K-933. Dated in order to trace a possible difference between different pieces of drift wood from the same ruin. Date is average of two measurements: 2720 ± 110 and 2760 ± 120.

Midsommerelven, Portfjældet

Charcoal from local willow found in Palaeo-Eskimo ruins on a terrace 9 m above bed of the river Midsommerelven at Portfjældet (82° 12'

N Lat, 32° 20' W Long), Peary Land. Two of the ruins contained implements of Independence I culture (Knuth, 1965). Coll. 1963 and subm. by Eigil Knuth. *Comment:* see comment to samples from Jørgen Brønlund Fjord, Vandfaldnæs (this date list).

K-928. Portfjaeldet, ruin No. 1

3890 ± 120

1940 B.C.

Charcoal (*Salix* sp.) found in ruin No. 1. Ruin contained no implements.

K-929. Portfjaeldet, ruin No. 2

3860 ± 120

1910 B.C.

Charcoal (*Salix* sp.) found in ruin No. 2, an elliptic camp site with mid-passage hearth. Found together with implements of Independence I culture.

K-930. Portfjaeldet, ruin No. 3

3790 ± 120

1840 B.C.

Charcoal (*Salix* sp.) found in ruin No. 3, which was situated 20 m W of ruin No. 2. Found together with implements of Independence I culture.

Nedre Midsommersø, Pearylandville

Charcoal from local willow found in ruins on a large ruin place Pearylandville (82° 14' N Lat, 33° 31' W Long), at the lake Nedre Midsommersø, Peary Land. Implements of Independence I culture were found in the ruins (Knuth, 1965). Coll. 1964 and subm. by Eigil Knuth. *Comment:* see comment to samples from Jørgen Brønlund Fjord, Vandfaldnæs (this date list).

K-938. Pearylandville, ruin No. 24

3950 ± 120

2000 B.C.

Charcoal (*Salix* sp.) from ruin No. 24. A large number of implements of Independence I culture was found in the ruin, together with bones of musk-ox, hare, and trout.

K-939. Pearylandville, ruin No. 10

3840 ± 120

1890 B.C.

Charcoal (*Salix* sp.) from ruin No. 10. Found together with implements of Independence I culture and bones of musk-ox, hare, and trout.

K-1004. Nedre Midsommersø Teltnæs

770 ± 100

A.D. 1180

Charcoal (*Salix* sp.) from hearth in front of a ruin at Teltnæs (82° 14' N Lat, 33° 0' W Long), at the lake Nedre Midsommersø, Peary Land. The ruin (No. 2), a tent ring, was situated on a gravel terrace 3.4 m above water level of the lake. Form of the ruin is different from all other ruins in the area. Supposed to represent an immigration younger than Independence II culture. Coll. 1964 and subm. by Eigil Knuth.

3360 ± 120**1410 B.C.****K-855. Ika, Sarqaq culture**

Charcoal (*Picea* sp.) from driftwood found in campsite at Ika, Ikamiut (65° 38' N Lat, 52° 48' W Long), Sukkertoppen, West Greenland. Collected from 5 hearths within the campsite, situated 10 to 20 cm below the present surface. Found together with implements of Sarqaq culture. Coll. 1963 and subm. by Robert Petersen, Natl. Mus., Copenhagen. *Comment:* samples from Sarqaq culture have previously been dated (Copenhagen III, IV, V; Pennsylvania IV).

*C. Iceland***1340 ± 100****A.D. 610****K-940. Ingolfur Arnarson's farm**

Charcoal powder (probably of birch) mixed with clay, from culture layer found at the supposed site of Ingolfur Arnarson's farm, Reykjavik (64° 8' N Lat, 21° 56' W Long), Iceland. Culture layer (perhaps a floor) was found 1.85 m below present surface, and 1.3 m below a level, which with great probability dates from the earliest days of the town Reykjavik, A.D. 1750 to 1760. The farm of Ingolfur Arnarson, one of the founders of the Norse settlement on Iceland, dates from A.D. 874. Coll. 1963 and subm. by K. Eldjarn, Natl. Mus. Reykjavik. *Comment:* date is somewhat older than expected, but it is not incompatible with assumption that the culture layer dates from the time of Ingolfur Arnarson.

*D. Poland***Witow series**

Charcoal from culture layers found in profile through sand dunes and a bog at Witow (52° 4' N Lat, 19° 11' E Long), Province of Lodz, Poland. Profile exposed a number of culture layers separated by sand. Culture layers date from Allerød time and till Neolithic (Chmielewska and Chmielewski, 1960). Coll. 1961 and subm. by M. Chmielewska, Archaeol. Mus., Lodz.

11,020 ± 170**K-952. Witow, 1-P****9070 B.C.**

Charcoal (*Pinus* sp.) from layer No. 4a, presumably a deflated culture layer, in Horizon B which is separating sand dunes from Older Dryas and Younger Dryas. Probably of Allerød age. *Comment:* date agrees well with an Allerød age.

8180 ± 140**K-954. Witow, 6-P****6230 B.C.**

Charcoal (*Pinus* sp.) from layer No. 21, a sandy culture layer on slope of a dune in marginal zone between dune and bog. Mesolithic culture layer with flint implements of Tardenoisian type.

K-953. Witow, 3-P**3410 ± 110
1460 B.C.**

Charcoal (*Quercus* sp.) from layer No. 13, a sandy culture layer on slope of a dune in marginal zone between dune and bog. Neolithic layer from Pre-Finno-Ongrian time.

*E. Qatar***K-967. Bir Uwainat Ali****4100 ± 110
2150 B.C.**

Shells (*Cerithium* sp.) from layer of shells of *Cerithium* sp. and *Columbella* sp. found immediately below dwelling place Q 62/10 at Bir Uwainat Ali (25° 28' N Lat, 50° 45' E Long), Qatar. Sample antedates the dwelling place. Coll. 1964 and subm. by Svend Jørgensen and H. Kapel, Natl. Mus., Copenhagen.

K-971. Shaqah**6970 ± 130
5020 B.C.**

Sand with slight amount of charcoal powder from fireplace in a culture layer found 6 km SE of Shaqah (24° 45' N Lat, 51° 25' E Long), Qatar. Culture layer was covered by 60 cm of sand. Artifacts in layer are presumably of same age as the Mesolithic Al Wusail find (Nielsen, 1962). Coll. 1964 and subm. by Svend Jørgensen and H. Kapel.

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UNIVERSITY OF KIEL RADIOCARBON MEASUREMENTS I

H. WILLKOMM and H. ERLLENKEUSER

 C^{14} Laboratory of the University of Kiel, Germany

The C^{14} Laboratory at Kiel University was established in 1963. It continues measurements, which were made at the Institut für Kernphysik, Kiel, on age determination with Chlorine 36, which is produced by cosmic ray neutrons (Bagge and Willkomm, 1963, 1966). The first C^{14} -counting apparatus was completed in 1964 and dating work started at the end of 1964 after extensive general tests of counter working conditions (Erlenkeuser, 1965). The data reported here have been obtained during the first half of 1965. During this period the dating measurements were interrupted on numerous occasions by measurements of background and the oxalic standard in order to check long-time variations of the apparatus.

The counter in use is built of commercially available copper. Outer dimensions are: length 950 mm, diam 104 mm. The sensitive counter volume is screened by a tube of highly purified quartz material in order to eliminate wall contamination (Scholz, 1961). The background due to wall contamination is less than 1 cpm. The sensitive volume amounts to 4.5 L, its surface is 2270 cm², the wire diam is 0.05 mm. The counter is surrounded by 4.5 cm of selected lead followed by 36 Geiger-Müller anti-coincidence counters arranged in a double ring and finally by 10 cm of old lead.

The counter gas is carbon dioxide usually filled to 500 torr. Pressures up to 3 atm are possible. The high voltage at 500 torr is 3600 v. The sample is counted for at least 48 hours. The background is ca. 20 cpm and gives a plateau slope of 2.5%/100 v for at least 600 v. The barometric pressure coefficient amounts to -1.8%/torr. However, gross counting rates are corrected using the coincidences between the counter and the anticoincidence ring, and not using the atmospheric pressure directly, since the background counting rate shows a closer proportionality to these coincidences than to the atmospheric pressure. The background may be reduced to ca. 10 cpm if some gaps in the anticoincidence ring are closed; these are now due to an unexpected thickness of the glass-walls of the GM-tubes in use (Trondheim I, 1959).

Modern activity is given by 95% of NBS oxalic-acid standard activity. This standard gives a net counting rate (at a pressure of 500 torr) of 22.07 ± 0.05 cpm. A second standard is given by rings of an oak tree, 280 yr old. The rings of the years 1845 to 1850 give an age-corrected activity of $95.2 \pm 1\%$ of oxalic standard (see KI-6, 7, 10).

Organic samples such as wood or peat are usually boiled with dilute HCl, washed with distilled water, boiled with dilute NaOH, carefully washed again and then dried at 150°C. This treatment removes carbonate and most of the humus. The dry substance is then burned to CO₂. When combustion is finished, CO₂ is absorbed in a NH₄OH-CaCl₂

solution. Within ca. 6 hours at 80°C, CaCO_3 is precipitated quantitatively, and after intensive washing, CO_2 is liberated by sulfuric acid. This method, described by Münnich (1957) gives a very pure counting gas free of radon.

Dates given are not corrected for the $\text{C}^{13}/\text{C}^{12}$ ratio. The error quoted here corresponds to 1σ . No account has been taken of the error in the C^{14} half-life and of the de Vries effect. Our dates are based on the Libby half-life and A.D. 1950 as zero B.P.

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I. CHECK SAMPLES

KI-6. Oak-standard

mean: $95.2 \pm 1\%$ of

KI-7.

NBS standard activity

KI-8.

Slice of oak tree grown near Ratzeburg, Schleswig-Holstein, Germany ($53^\circ 42'$ N Lat, $10^\circ 47'$ E Long), felled 1954. The 280 rings of slice cover period from 1674 to 1954. Subm. F. Overbeck, Botanisches Inst., Kiel Univ., Germany. Tree is to give a second standard in addition to NBS standard. Rings grown between 1845 to 1850 give average age-corrected activity of $95.2 \pm 1\%$ of the NBS activity.

2700 ± 200

KI-11. Dätgen A-III/2

750 B.C.

Peat from Grosses Moor near Dätgen ($54^\circ 9.7'$ N Lat, $9^\circ 55.2'$ E Long), 0 to 2 cm below contact between dark and light peat, pollen analyzed by L. Aletsee (1959). Coll. 1963 and subm. 1964 by L. Aletsee. Samples of same stratigraphic position located a few cm away from A-III/2 dated by Heidelberg (A-III/1, subm. 1961 by L. Aletsee, 2965 \pm 60, H-1590b-1257, unpub.) and by Hannover (A-III/3, coll. and subm. 1964, 2935 \pm 80, Hv-678-BV, unpub.).

3090 ± 200

KI-12. Vierthmoor, Gnutz

1240 B.C.

2970 ± 80

KI-18.

1020 B.C.

Wood of *Betula* stump, diam 9 cm, from Vierthmoor near Gnutz,

Germany ($54^{\circ} 6.8' \text{ N Lat}$, $9^{\circ} 49.1' \text{ E Long}$). Subm. 1964 by L. Aletsee. Stump found in basal peat of bog, a few m away from section G-2 (see Aletsee, 1959, for stratigraphical and pollenanalytical comment). Sample dated second time with increased accuracy. Wood of same sample dated by Hannover to 2940 ± 60 (Hv-477, unpub.). Peat of same stratigraphic position as the *Betula* stump (subm. 1961 by L. Aletsee) dated by Heidelberg to 2990 ± 70 (H-1589-1136, unpub.).

II. GEOLOGIC SAMPLES

Nitrogen series, Dätgen

Peat samples D-N/1, D-N/2 from Grosses Moor at Dätgen, Germany ($54^{\circ} 9.7' \text{ N Lat}$, $9^{\circ} 55.7' \text{ E Long}$), are from upper and lower surface of a monolith that was used to estimate nitrogen content of light peat (Aletsee, 1966). Coll. 1961, subm. 1964 by Aletsee. Each sample dated twice within two months. Error includes some technical difficulties and may be too high.

KI-8. Dätgen D-N/1	1530 \pm 200
Sample D-N/1, 29 to 31 cm below surface.	A.D. 420

KI-14.	1506 \pm 200
	A.D. 444

KI-9. Dätgen D-N/2	2340 \pm 200
Sample D-N/2, 121 to 123 cm below surface.	390 B.C.

KI-15.	2330 \pm 200
	380 B.C.

KI-26. Segeberg	5270 \pm 120
	3320 B.C.

Highly humified peat from bottom of Kleiner Segeberger See, Segeberg, Germany ($53^{\circ} 56.2' \text{ N Lat}$, $10^{\circ} 18.9' \text{ E Long}$), 25 to 25.10 m below lake level. *Ulmus* starts decreasing, beginning of *Plantago* just above. Coll. 1963 and subm. 1965 by L. Aletsee. *Comment*: sample also useful for investigation of age of stalactite cavern at Segeberg.

III. DAHLDORF DATES

Dahldorf samples are collected at $53^{\circ} 22.1' \text{ N Lat}$, $8^{\circ} 58.7' \text{ E Long}$. Subm. by F. Overbeck. Series contributes to continuing investigation of younger history of settlement in northern Germany.

KI-23. Dahldorf II-1, 30 cm depth	2160 \pm 80
	210 B.C.

Sphagnum peat from upper part of highly humified peat layer. From this level upward *Carpinus* exceeds 1%, *Fagus* is 5% and more.

KI-24. Dahldorf II-3, 70 cm depth **2550 ± 60**
600 B.C.

Maximum of humification. From this level upward *Corylus* is below 10%. Agricultural activity decreasing.

KI-25. Dahldorf II-5, 100 cm depth **3110 ± 70**
1160 B.C.

0 to 1 cm below contact between dark and light peat (depth of contact: 100 cm), just below first indication of pollen of cereal type. *Comment*: numerous rootlets had to be removed before chemical treatment. They will be dated later.

IV. ARCHAEOLOGIC SAMPLES

KI-17. Dätgen, mummified man's body **2065 ± 90**
115 B.C.

Sphagnum cuspidatum peat, Grosses Moor, Dätgen, Germany (54° 10' N Lat, 9° 56' E Long). Peat from a hollow, 114 to 116 cm below surface; from this level upward *Fagus* exceeds 5%. Coll. 1959 and subm. 1964 by L. Aletsee. Peat gives minimal date for mummified man's body lying in the hollow.

KI-20. Gernsbach **385 ± 80**
A.D. 1565

Wood of coffin found in crypt of Evangelische Stadtkirche, Gernsbach, Germany. Subm. 1964 by U. Schaefer, now of Univ. of Giessen, Germany.

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KÖLN RADIOCARBON MEASUREMENTS I

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INTRODUCTION

After publication of the occurrence of C^{14} in nature and the first successful datings made by the radiocarbon method (Anderson *et al.*, 1947; Arnold and Libby, 1949), a fair number of physicists as well as geologists, paleobotanists, and prehistorians in Germany became interested (e.g., Harteck, 1951; Zeuner, 1951; Firbas, 1953; Schwabedissen, 1949) in studying the applicability of the new method. So, one of us (H.S.) together with F. Firbas tried to stimulate plans by F. Houtermans (later at Bern, Switzerland) to organize a dating laboratory at Göttingen, before 1950. When the Heidelberg laboratory was founded, close contact was kept with O. Haxel and K. O. Münnich by providing them with carefully selected samples covering a variety of prehistoric ages (partly published in Heidelberg I). Samples were also submitted to Washington, D. C. (see USGS III, I, II), Yale (see Yale III), and Copenhagen (unpub.).

Plans for our laboratory were initiated after a meeting of K. Beckhoff** and Schwabedissen at a prehistoric conference held at Münster/W. in April, 1957. During 1957 through 1959, Beckhoff, an electronic engineer and owner of an electroengineering plant, designed and built the equipment (Beckhoff, 1960) which, after showing satisfactory performance, was transferred to Cologne in December, 1959. At the same time, H. Kirchner assumed responsibility for the new-founded C^{14} laboratory; from summer 1960 until he left in summer 1962, he began to build up a complete second counting system of similar design.

From January, 1962, the electronic parts of the Beckhoff equipment have been working dependably. In January, 1963, Freundlich assumed responsibility for the C^{14} laboratory, and was able to undertake routine dating operations by the middle of 1963. In May, 1964, K. Beckhoff's equipment was given as a donation to the University of Cologne. The equipment devised by H. Kirchner has been taken care of by H. H. Eipper from March, 1963; it is intended to begin the dating routine in the near future. A third system is presently being established on funds from the Volkswagenwerkstiftung, mainly in order to date samples of higher ages.

METHODS

After careful manual selection, the sample is boiled with 5% HCl, and then with 10% NaOH solution followed again by 5% HCl; between these steps, the sample is washed with boiling distilled water to the

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neutral point and subsequently dried and weighed, unless stated otherwise in the individual sample description. The purification of the counter-filling gas (CO_2 , gained by controlled ignition similar to De Vries' device, see De Vries and Barendsen, 1953) is done in the "wet" way as described by Haxel (1957, p. 166); for the decomposition of the CaCO_3 , approx. 2N HCl is applied (Calvin *et al.*, 1960, p. 153ff.). The resulting CO_2 then passes high efficiency drying columns held at -80°C and is stored in 6 L bulbs for subsequent measurement. As a control of the CO_2 purity, the plateau rise is routinely determined before and after each single measurement. The purity of the CO_2 gained normally proved to be excellent; in rare cases, when the plateau rise seemed to be detectably "shifted" towards higher counter voltage value (i.e., more than 10 to 20 v), the performance could reliably be improved by passing the gas over hot silver. The electronic amplification, too, is checked at regular intervals.

The CO_2 is filled to a pressure of 710 mm Hg (at 23°C) into the 2-L copper-walled proportional counter (of Heidelberg type). The counter is shielded by 10 cm of selected old lead and by an anti-coincidence shield of 15 commercial Geiger counters of the cosmic-ray type (model HZ-100, Zentralwerkstatt Göttingen). The anti-coincidence background count is 8.5 cpm and is averaged over a "floating" period of 20 days. A barometric effect of $0.08 + 0.024$ cpm per cm Hg was measured during October, 1964, when extreme variations of the atmospheric pressure occurred. In conjunction with a low but reproducibly time-dependent increase of the alpha-count rate found for any CO_2 -filling which is allowed to stay in the counter tube for several days, a concurrent increase of the net beta-count was observed, the ratio of increase, $\Delta\beta/\Delta\alpha$, being close to three (Freundlich, 1965). The net contemporary value (95% NBS oxalic acid) is 11.8 cpm. As a control of the statistical regularity of the background and beta counts, the time elapsing between each 100 anti-coincidence counts is printed out. Each dating gas is measured for at least three 16-hr periods at two or more independent fillings more than 14 days apart.

The dates are based on Libby's half life value, 5570 yr; the standard deviations given with the C^{14} ages are rounded-off values calculated from the statistical uncertainties of the count rates of sample, background, and contemporary standard; a minimum standard deviation of 80 yr is included to take account of the De Vries effect.

From the 50 radiocarbon dates determined so far in this laboratory (all of them by means of the Beckhoff apparatus), only those have been included in this list which can either be checked with radiocarbon dates of other laboratories made on material of exactly the same sample (section II), or those which can be compared with age determinations independently based on historical, archaeological, or geological reasons (section I).

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SAMPLE DESCRIPTIONS

I. GEOLOGIC AND ARCHAEOLOGIC SAMPLES

KN-53. Querenstede **11,070 \pm 320**
9120 B.C.

Wood charcoal found in Alleröd layer, 1.30 m below surface of Circular-Ditch Graves (Kreisgraben-Gräberfeld) site, Querenstede, Gemeinde Zwischenahn, Landkreis Ammerland, Niedersachsen ($53^{\circ} 11' N$ Lat, $7^{\circ} 00' E$ Long), Germany. Geological classification: Alleröd, by A. Bohmers and H. T. Waterbolk (private commun.). Excavated 1961 and subm. by D. Zoller, Staatliches Mus. für Vorgeschichte, Oldenburg (Oldb.), Niedersachsen (see Zoller, 1963). *Comment:* numerous C^{14} dates from Alleröd period have been discussed; they lie consistently between 8800 and 10,000 B.C. (e.g., Gross, 1952, p. 74; 1954, p. 192; 1955, p. 110), in accordance with the Swedish varve chronology.

KN-72. Los Millares **4380 \pm 120**
2430 B.C.

Wood charcoal of mixed composition (*det.* Mrs. Maura Scannell, Natl. Mus. of Antiquities, Dublin), coll. 1956 by A. Arribas from Grave no. 19, during excavation campaign by M. Almagro, Inst. Espanol de Prehistoria, Madrid, and A. Arribas, Museo Arqueologico, Barcelona; of well-known site of Los Millares near Santa Fé de Mondújar, prov. Almeria ($36^{\circ} 59' N$ Lat, $2^{\circ} 28' W$ Long), Spain (Almagro and Arribas, 1963), a place already excavated in 1892 by L. Siret. Sample (by commission of H. Schubart, Deutsches Archäologisches Institut, Madrid) subm. by E. Sangmeister, Univ. of Freiburg/Breisgau. *Comment:* archaeological age was determined (Sangmeister and Do Paço, 1956, p. 229) to be ca. 2400 B.C.; material from same site (sample Sch-45) was dated by Heidelberg lab.: H-204/247, Los Millares, 2345 ± 85 B.C. (see Schwabedissen and Münnich, 1958).

KN-90. Bogazköy **3490 \pm 120**
1540 B.C.

Large sample of wood charcoal from ceiling of a burnt building belonging to castle of Büyükkale, citadel of the ancient Hethitian city at Bogazköy (modern name Bogazkale), villayet Corum ($40^{\circ} 02' N$ Lat, $34^{\circ} 33' E$ Long), Turkey. Taken from 1.20 m below surface, during excavations of the 1959 Bogazköy expedition of German Archaeol. Inst.; subm. by K. Bittel, Deutsches Archäologisches Institut, Berlin (see Bittel *et al.*,

1957). *Comment*: archaeological age, corresponding to Old Assyrian trade settlements in Cappadocia: early second millennium B.C. (K. Bittel).

1990 ± 80

KN-7. Asberg

40 B.C.

Charred cereal grains from excavations of Roman military camp Asciburgium (=Asberg), Kreis Moers, Nordrhein-Westfalen (51° 25' N Lat, 6° 40' E Long), Germany. Position: Trench IV, no. 19 P 54 +30. Coll. 1961 and subm. 1963 by F. Tischler, Niederrheinisches Mus., Duisburg. Sample has only been subjected to acid pretreatment. *Comment*: sample found in Claudian layer, age must be close to A.D. 50 (F. Tischler, to be published).

1900 ± 120

KN-3. Neuss

A.D. 50

Wood charcoal with remains of cremation from incineration hole, Place no. 1202, from excavations of Roman military camp Novaesium (see Petrikovits, 1957), close to modern town of Neuss, Nordrhein-Westfalen (51° 12' N Lat, 6° 41' E Long), Germany. Sample coll. 1958; present leader of excavations, G. Müller, Rheinisches Landesmuseum, Aussenstelle Neuss. Subm. 1959, by Ph. Filtzinger, now Württembergisches Landesmuseum, Stuttgart. *Comment*: archaeological age depending on finds of ceramics (terra sigillata) within the hole: final first century A.D. (Mrs. M. Vegas, Rheinisches Landesmuseum, Bonn, and G. Müller; G. Müller, to be published).

2050 ± 120

KN-50. Oberaden

100 B.C.

Wood (*Picea*, det. Miss I. Peters, Bonn) from the timbering of a barrel-type water well (=Fassbrunnen), Well no. 1, outside the camp area of Roman military camp of Oberaden, Kreis Unna, Nordrhein-Westfalen (51° 36' N Lat, 7° 37' E Long), Germany. Sample coll. and subm. by H. Beck, Landesmuseum für Vor- und Frühgeschichte, Münster/W. (Aschemeyer, 1963; see also Albrecht, 1938/1942). *Comment*: historical date: exactly, 11 to 3 B.C. It is supposed that no spruce trees (*Picea*) were growing at that time within at least 100 km, so that timber must have been brought from a fair distance (R. Schütrumpf).

840 ± 80

KN-40. Peiting

A.D. 1110

Wood charcoal (*Pinus*) from cover of a coffin containing a female corpse found 50 cm below surface in "Schwarzer Laich" bog near Peiting (47° 47' N Lat, 10° 55' E Long), close to Schongau, Bayern, Germany. Coll. 1957 and subm. by K. Schlabow, Textilmuseum, Neumünster. *Comment*: from the clothes and textiles, the find can be attributed to Early Middle Ages (see Schlabow, 1961).

KN-35. Berlin Nr. 45 **640 ± 80**
A.D. 1310

Wood charcoal from the great fire of Berlin in A.D. 1380, found with excavation of the Nikolaikirche, Berlin-Mitte (52° 31' N Lat, 13° 24' E Long), Germany. Excavated 1957, coll. and subm. by E. Reinbacher, Institut für Vor- und Frühgeschichte der Deutschen Akademie der Wissenschaften zu Berlin (Reinbacher, 1963). *Comment*: historical age A.D. 1380 was confirmed by a coin from between A.D. 1370 and 1380, found within charred remains from fire (A. Suhle; see Reinbacher, 1963, p. 52).

II. INTER-LABORATORY CHECKS

KN-10b. Langenlois **26,560 ± 1600**
24,610 B.C.

KN-10c. Langenlois **26,960 ± 1200**
25,010 B.C.

Wood charcoal from Hearth no. X/1961 of a Gravettian encampment found in loess at Langenlois (48° 28' N Lat, 15° 40' E Long), near Krems, Niederösterreich, Austria. Excavated 1961 by F. Felgenhauer, Institut für Ur- und Frühgeschichte, Univ. of Vienna, Austria (see Felgenhauer, 1963). Coll. and subm. 1962 by F. Felgenhauer; final publication in preparation. *Comment*: material of same sample has been dated by Heidelberg lab.: H-2218/1537 (Sch-181), 25,480 ± 880 B.P. (K. O. Münnich, pers. commun.).

KN-51. Coveta del Or **6510 ± 160**
4560 B.C.

Charred cereal grains (*Triticum monococcum*, det. Mrs. M. Hopf, Mainz) from supply-like find in a layer containing Cardial ceramics, in Coveta del Or cave, close to Benniarres near Alcoy, prov. Alicante (38° 42' N Lat, 0° 28' W Long), Spain. Excavated by V. P. Perez, coll. and subm. by H. Schubart, Deutsches Archäologisches Institut, Madrid (Schubart and Perez, 1964; Hopf and Schubart, 1965). *Comment*: sample from same place was dated at Heidelberg: H-1754/1208 (Sch-179), 6265 ± 75 B.P. (K. O. Münnich, pers. commun.).

KN-21. Egolzwil 4 **5370 ± 160**
3420 B.C.

Wood (*Abies*) from small tree found with 1954 excavations of Egolzwil 4, Luzern (47° 11' N Lat, 8° 01' E Long), Switzerland, by E. Vogt, Zürich. Site belongs to Younger Cortaillod culture, lower layer. Tree found in horizontal position in chalky bottom layers of lake. *Comment*: wood of same sample dated at Heidelberg: H-228/276 Egolzwil 4 (Sch-66), 5150 ± 100. Another sample from same site, a board of ash (*Fraxinus*) wood found in upper layer of Younger Cortaillod culture (part of wooden floor of a house), was dated, too, at Heidelberg lab.: H-227/277 Egolzwil 4 (Sch-65), 5040 ± 100 B.P. (K. O. Münnich, pers. commun.). A date of Egolzwil 3 (belonging to Older Cortaillod cul-

ture, see Vogt, 1955) was published by Copenhagen lab. (Copenhagen III, recalculated value; solid carbon technique measurements): K-115, 116, 118, 121 (average), 4890 ± 90 B.P. Another date quoted by Zeuner (1958, p. 344) is F-17 Egozswil 3, 4650 ± 110 B.P.

5310 \pm 160

3360 B.C.

KN-27. Riedschachen 13

Wood of oak beam from below a clay floor layer (threshold beam) of a house of Schussenried culture, find place Riedschachen 13 near Aichbühl/Federsee, Baden-Württemberg ($48^{\circ} 02' N$ Lat, $9^{\circ} 40' E$ Long), Germany. Sample taken 1963 by H. Schwabedissen, together with R. Schütrumpf and E. Wall, upon excavating a test trench near border of earlier excavations by H. Reinerth (e.g., Zimmermann, 1961). *Comment:* another part from exactly the same piece of wood was taken during a trial excavation in 1962 by E. Wall and K. Göttlich (Göttlich, 1964), and submitted to Hannover lab. (see Hannover III): Hv-354, 5160 ± 110 B.P. Beam parts confirmed by E. Wall who collaborated with both excavations and also knows the older Reinerth excavations. Another sample dated at Hannover was Hv-353, 5130 ± 100 .

General comment: date is comparable to that of Ehrenstein (KN-2, 191, this date list); a palynological study of both sites will be published by R. Schütrumpf.

5210 \pm 120

3260 B.C.

KN-2. Ehrenstein, Sch-170

5290 \pm 120

3340 B.C.

KN-191. Ehrenstein, 41b

Two samples, charred cereal grains (Sch-170) and wood charcoal (41b), from Neolithic village Ehrenstein, Kreis Ulm, Baden-Württemberg ($48^{\circ} 25' N$ Lat, $9^{\circ} 55' E$ Long), Germany. Village excavated in 1952 by O. Paret (Paret, 1955) and in 1960 by H. Zürn, Staatliches Amt für Denkmalpflege, Abt. Bodendenkmalpflege, Stuttgart (Zürn, 1962). Site belongs to Schussenried culture, with influence of Michelsberg culture. Samples taken during excavation campaign of 1960 by H. Schwabedissen and R. Schütrumpf, from Area no. 8, lane between Houses 5 and 6, depth 1.52 m. *Comment:* material of same sample Sch-170 was also dated at Berlin and Heidelberg labs.: H-1749/1201, 5030 ± 80 B.P., and Bln-167, 5195 ± 100 B.P. (K. O. Münnich and H. Quitta, pers. commun.).

The following dates of comparable samples from same site were published (Berlin I): Bln-54, 5140 ± 80 B.P.; Bln-71, 5200 ± 100 B.P.; Bln-70, 5240 ± 100 B.P.; and also two samples from 1952 excavation (Heidelberg I; see also Groschopf, 1957): H-125/107, 5200 ± 200 B.P. and H-61/149, 5140 ± 130 B.P.

Special comment (H.S.): the exact location of the 1952 samples has been questioned.

KN-38. Baia-Hamangia**4060 ± 160****2110 B.C.**

Charcoal from Ochre Grave culture layer, Grave no. 1, in Burial Mound no. 1, at Baia-Hamangia, r. Istria, reg. Constanta (44° 47' N Lat, 28° 42' E Long), Romania. Excavated 1952 and subm. by D. Berciu, Romanian Acad. of Sci., Archaeol. Inst., Bucharest, Romania, on commission of H. Quitta, Deutsche Akademie der Wissenschaften zu Berlin, Institut für Vor- und Frühgeschichte, as cross-check sample. *Comment:* material of same sample dated at Berlin lab. (Berlin I, Kohl and Quitta, 1963): Bln-29, Baia-Hamangia, 4090 ± 160 B.P. Sample from same grave was dated at Groningen lab. to give 2331 ± 65 B.C. (Berciu, 1961, p. 124), corresponding to the value Gro-1995, 4280 ± 65 B.P., as quoted by Kohl and Quitta (1963). Proper correction for the Suess effect as given in Groningen IV results in date there given as GrN-1995, Hamangia-2, 4530 ± 65 B.P.

KN-8. Carmona**2470 ± 120****520 B.C.**

Wood charcoal from large charred area found during excavations of ancient town of Carmona, prov. Sevilla (37° 29' N Lat, 5° 37' W Long), Spain. This charred layer, no. 3, is attributed to a great fire, supposedly in third or fourth century B.C. (Raddatz and Carriazo, 1961, p. 104). Coll. and subm. 1959 by K. Raddatz, Institut für Ur- und Frühgeschichte der Universität Göttingen. *Comment:* material from same sample dated by Heidelberg lab.: H-1037/1550 (Sch-155), 2400 ± 50 B.P. (K. O. Münnich, pers. commun.).

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LOUVAIN NATURAL RADIOCARBON MEASUREMENTS IV

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The following list covers most of the samples measured at the Louvain C¹⁴ laboratory since the last list (Louvain III).

The method is essentially the same as the one used for the work described in the previous lists. A CH₄ proportional counter, 0.6 L volume, operating at 3 atm pressure, is used. Equipment and counting techniques have been described in Louvain I. Dates are computed on the basis of the Libby half-life, 5570 yr, and the zero of the age scale is A.D. 1950. Ages are quoted with 1 σ experimental error, which includes the counting variations of the sample as well as that of the background and the contemporary standard. As modern standard we now use NBS oxalic-acid standard or wood taken from A.D. 1870 to A.D. 1900 tree rings. No differences between the two standards have been observed.

We wish to acknowledge the help of F. Frix in routine operations and chemical preparations. We also thank G. Michotte and D. Rössler for maintenance of electronics. The description and comments are mainly those of persons submitting the samples. Financial support was provided by the "Institut Interuniversitaire des Sciences Nucléaires," Brussels.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Anlier series

Peat from Fange Pouilleuse (49° 43' 59" N Lat, 5° 29' 42" E Long) in forest of Neuchâteau at Villers sur Semois, Prov. of Luxemburg, Belgium, alt 390 m. Coll. 1962 and subm. by W. Mullenders, Univ. of Louvain, Lab. of Palynology.

1820 \pm 100**Lv-61. Anlier I/3****A.D. 130**

Peat from 50.0 to 55.0 cm below surface, Sub-Atlantic horizon. *Comment* (W.M.): pollen analysis indicates the 1st beech maximum (*Fagus silvatica*—FI). Agrees with date of this level at Baraque Michel (Dricot, 1960).

1930 \pm 130**Lv-62. Anlier I/4****A.D. 20**

Peat from 72.5 to 77.5 cm below surface. *Comment* (W.M.): according to pollen analysis, level is the Sub-Boreal—Sub-Atlantic transition with the end of the 5th hazel maximum (*Corylus avellana*—C IV). Date seems too young; contamination by roots is assumed.

5120 \pm 140
3170 B.C.

Lv-63. Anlier I/6

Peat from 95.0 to 112.5 cm below surface, Atlantic horizon. *Comment* (W.M.): pollen analysis shows the 3rd hazel maximum (*Corylus avellana*—C X) with the classical decrease of *Ulmus*. Date perfectly agrees with Lv-51 (Louvain III) and with the other datings of this level in the Netherlands, Germany and England (Van Zeist, 1959; Copenhagen IV; Cambridge I).

3850 \pm 140
1900 B.C.

Lv-64. Anlier I/7

Peat and gyttja with wood remains from 125.0 to 130.0 cm below surface, Atlantic horizon. *Comment*: sample is taken from below Lv-63; date is thus more than 1000 yr too young. Contamination by roots is assumed.

1620 \pm 100
A.D. 330

Lv-109. Fange aux Mochettes II

Peat from Fange aux Mochettes (50° 13' N Lat, 5° 39' E Long) at Samrée, Prov. of Luxemburg, Belgium, alt 600 m. Sample taken at depth of 90 to 100 cm below surface. Coll. 1962 and subm. by W. Mullenders. *Comment* (W.M.): Sub-Atlantic horizon. Sample from between the 1st and 2nd beech maximum (*Fagus silvatica*—F I and F II). Date agrees with expectations.

Rouge Ponceau series

Peat or gyttja from Rouge Ponceau (50° 04' N Lat, 5° 25' E Long) at Tenneville, Prov. of Luxemburg, Belgium, alt 545 m. Coll. 1961 and 1962 and subm. by W. Mullenders.

General Comment for the gyttjas: samples are very poor in organic matter and cannot be burned. They are not pretreated. Humic matter is dissolved in NaOH and precipitated from solution by HCl. After washing, the precipitate is used for age determination. Age is thus a minimum age, because possible recent humic contamination is not removed.

550 \pm 130
A.D. 1400

Lv-150. Rouge Ponceau III/1

Peat from 22.5 to 25.0 cm below surface, Sub-Atlantic horizon. *Comment* (W.M.): this level is the 3rd beech maximum (*Fagus silvatica*—F III). Date appears satisfactory.

1450 \pm 110
A.D. 500

Lv-151. Rouge Ponceau III/2

Peat from 42.5 to 50 cm, Sub-Atlantic horizon. *Comment* (W.M.): sample covers the 2nd beech maximum (*Fagus silvatica*—F II). Palynologically estimated age ca. 1400 yr ago.

Lv-152. Rouge Ponceau III/3**2260 ± 130****310 B.C.**

Peat from 52.5 to 60.0 cm, Sub-Atlantic horizon. *Comment* (W.M.): this level contains the 1st beech maximum (*Fagus silvatica*—F I). Date seems to be reasonable although too old in comparison with Lv-61 (this list).

Lv-153. Rouge Ponceau III/4**2980 ± 170****1030 B.C.**

Peat from 67.5 to 75.0 cm, Sub-Boreal horizon. *Comment* (W.M.): sample confirms age of 5th hazel maximum (*Corylus avellana*—C IV), and corresponds well with palynological results. The same level in the Netherlands was dated at 3090 yr ago (Van Zeist, 1955).

Lv-154. Rouge Ponceau III/5**3380 ± 180****1430 B.C.**

Peat from 90.0 to 100.0 cm below surface. *Comment* (W.M.): at this level is situated the Atlantic-Sub-Boreal transition. Pollen analysis shows hazel increase, probably the 4th maximum (*Corylus avellana*—C III). Date seems 500 yr too young in comparison with C III dates in Germany and the Netherlands. Further investigations are necessary.

Lv-144. Rouge Ponceau I/2**6160 ± 260****4210 B.C.**

Peat from 127.5 to 140.0 cm below surface. *Comment* (W.M.): at this level comes the Boreal-Atlantic transition, palynologically estimated age ca. 7500 yr ago. Date thus seems much too young. But the pollen diagram shows major variations, so that the presence of unconformities is not impossible.

Lv-145. Rouge Ponceau I/3**7140 ± 190****5190 B.C.**

Clayey peat from 165.0 to 187.5 cm below surface. *Comment* (W.M.): sample covers the Pre-Boreal-Boreal transition, palynologically estimated age ca. 8500 yr ago. Same level in the Netherlands is dated at 8625 ± 180 (Van Zeist, 1955).

Lv-146. Rouge Ponceau I/4**8130 ± 210****6180 B.C.**

Gyttja from 190 to 200 cm below surface, Pre-Boreal horizon. *Comment*: according to estimated age for Pre-Boreal-Boreal transition, date is a little too young. But as humic contamination was not removed, date is minimum.

Lv-147. Rouge Ponceau I/5**7550 ± 190****5600 B.C.**

Gyttja from 220 to 225 cm, Pre-Boreal horizon. *Comment*: sample is taken from below Lv-146; date is thus much too young. Humic contamination is assumed.

Lv-148. Rouge Ponceau I/6 **8880 ± 220**
6930 B.C.

Gyttja from 230 to 235 cm, Pre-Boreal horizon. *Comment* (W.M.): pollen analysis gives no precision. Date seems to be reasonable.

Lv-149. Rouge Ponceau I/7 **9090 ± 230**
7140 B.C.

Gyttja from 240 to 250 cm, Pre-Boreal horizon. *Comment* (W.M.): pollen diagram gives no precision. Date appears satisfactory.

Tourbière du Grand Passage series

Peat from Tourbière du Grand Passage (50° 17' 31" N Lat, 5° 45' 12" E Long), near Les Tailles, Prov. of Luxemburg, Belgium, alt 605 m. Coll. 1963 and subm. by W. Mullenders. First part of this series is published in Louvain II (Lv-57 to Lv-60).

Lv-155. Grand Passage V/1 **<250**

Peat from 40 to 50 cm below surface, Sub-Atlantic horizon. *Comment* (W.M.): pollen analysis indicates a level between the 3rd and 4th beech maximum (*Fagus silvatica*—F III and F IV). Date agrees with Lv-57 and with pollen chronology.

Lv-157. Grand Passage V/3 **1310 ± 100**
A.D. 640

Peat from 80 to 90 cm below surface, Sub-Atlantic horizon. *Comment*: according to pollen analysis, sample is taken from below the 3rd beech maximum (*Fagus silvatica*—F III). Date appears satisfactory, although a little too old in comparison with Lv-159. The difference is probably due to statistical errors.

Lv-159. Grand Passage V/6 **1200 ± 130**
A.D. 750

Peat from 120 to 135 cm, Sub-Atlantic horizon. *Comment*: sample from between the 2nd and 3rd beech maximum (*Fagus silvatica*—F II and F III). A similar horizon is dated at 1100 ± 90 (Lv-58).

Lv-161. Grand Passage V/8 **1740 ± 110**
A.D. 210

Peat from 145 to 155 cm, Sub-Atlantic horizon. *Comment* (W.M.): sample from between the 1st and 2nd beech maximum (*Fagus silvatica*—F I and FII). Date agrees with pollen analysis.

Terneuzen series

Wood from fossil pine stand at Terneuzen (51° 19' N Lat, 3° 48' E Long), Zealand Flanders, the Netherlands, at sealevel. The trunks were covered by Sub-Boreal peat, 150 cm thick, under Sub-Atlantic clay, 100 cm thick. Coll. 1962 and subm. by A. Munaut, Univ. of Louvain, Lab.

of Palynology and Dendrochronology. *Comment*: the following samples represent the last part of the program to test the dendrochronologic method in the Terneuzen site (see Louvain II and III). Results are analyzed in a thesis by A. Munaut.

4430 \pm 140
2480 B.C.

Lv-130. Terneuzen pine T 36

Wood from pine stub *in situ* (*Pinus silvestris*, id. by E. Frison) from peat 180 cm below ground surface. Sample taken from the last growth rings. The first growth rings of the same pine were dated at 2750 B.C. \pm 120 (Lv-129, Louvain III).

4510 \pm 150
2560 B.C.

Lv-131. Terneuzen pine T 7

Wood from pine stub *in situ* (*Pinus silvestris*, id. by E. Frison) from peat 180 cm below ground surface. Sample taken from the first growth rings. Last growth rings of same pine were dated at 2430 B.C. \pm 120 (Lv-115, Louvain II).

4430 \pm 130
2480 B.C.

Lv-133. Terneuzen pine T 637

Wood from pine stub *in situ* (*Pinus silvestris*, id. by E. Frison) from peat 180 cm below ground surface. Sample taken from the first growth rings. Last growth rings of same pine were dated at 2170 B.C. \pm 120 (Lv-127, Louvain III).

5010 \pm 130
3060 B.C.

Lv-134. Terneuzen pine T 246

Wood from pine stub *in situ* (*Pinus silvestris*, id. by E. Frison) from peat 180 cm below ground surface. Sample taken from the first growth rings. Last growth rings of same pine were dated at 2620 B.C. \pm 130 (Lv-114, Louvain II).

11,550 \pm 330
9600 B.C.

Lv-230. Burcht

Vegetable peat from Burcht (51° 12' N Lat, 4° 30' E Long), prov. of Eastern Flanders, Belgium, alt 6 m below sealevel. Sample is taken at 15 m depth from a peat layer carried in a Quaternary gravel underlying sand and clay layer 2 to 3 m thick. Above the clay level, a Holocene peat layer. In gravel and sand above the sampled peat layer was found a rich Würmian fauna, age of which is estimated ca. 60,000 yr. Coll. 1965 by R. Paepe; subm. by A. Delmer and R. Paepe, Service Geol. de Belgique. *Comment* (A.D.R.P.): age determination made to fix the shore line of old Scheldt estuary. Date shows that the site was altered. Sampled peat and bones were carried there during a period posterior to the age of this peat, but before the formation of the Holocene peat layer, thus probably during the Dryas period.

II. ARCHAEOLOGIC SAMPLES

Lv-216. Mesvin 2**5340 ± 150****3390 B.C.**

Charcoal from Sans Pareil mine (50° 24' 53" N Lat, 3° 57' 24" E Long) at Mesvin, Prov. of Hainaut, Belgium. Sample found under a big kidney-shaped silex still partly imbedded in chalk geologic stratum in North gallery of shaft I at 3.30 m depth. Gallery was not filled up, but closed by dirt in the shaft. Coll. 1957 by Joris and Lefrancq; subm. by P. H. Moisin, Société de Recherche Préhistorique en Hainaut. *Comment* (P.H.M.): sample corresponds to age of actual stone extraction. Date agrees perfectly with Lv-65 (Louvain II) dated 3270 B.C. ± 170, and corresponding to the mine filling-up.

3260 ± 160**Lv-208. Montbec****1310 B.C.**

Wood from hunting or fishing spear found at 1.50 m depth in the Neuchatel lake in prehistoric site of Montbec (46° 56' N Lat, 6° 58' E Long) near Chabrey, Canton of Vaud, Switzerland. Coll. 1941 and subm. by E. Borel, Prehist. Commission Neuchatel Canton. *Comment* (E.B.): weapon should be contemporary with the last occupation of the site.

Salies de Béarn series

Charcoal from Salies de Béarn (43° 28' N Lat, 0° 55' W Long) in Béarn, Dept. of the Lower Pyrenees, France. Charcoal together with potsherds was found at 60 cm depth in a muddy clay layer covered by broken stones and brown clay. Coll. 1965 by Arambourou and subm. by Thibault, Univ. of Bordeaux, Lab of Prehist. *Comment* (T.): potsherds correlated with a salt mine in the next Triassic level; estimated Iron age, perhaps Bronze age.

3210 ± 170**Lv-246. Salies de Béarn A****1260 B.C.****3070 ± 120****Lv-247. Salies de Béarn E****1120 B.C.**

Comment: because of experimental conditions of the measurements, difference is not significant.

Alba Fucens series

Charcoal from embankment behind the first enceinte at Alba Fucens (42° 05' N Lat, 13° 25' E Long), Prov. of Aquila, Italy. Samples from Excavation 121, Level 2. Coll. 1957 and subm. by J. Mertens, Univ. of Louvain, Archaeol. Inst.

2310 ± 90**Lv-28. Alba Fucens 121-2/a****360 B.C.****2360 ± 90****Lv-179. Alba Fucens 121-2/b****410 B.C.**

General Comment (J.M.): at a few meters from the samples was found a coin not older than the beginning of the 3rd century B.C., but it is pos-

sible that the dirt comes from an older burned horizon and was brought there for the embankment.

Hamont series

Charcoal from prehistoric burial mounds at Hamont (51° 16' N Lat, 5° 30' 30" E Long), Prov. of Limburg, Belgium. Coll. 1963 by W. Thyssen, Service des Fouilles, Brussels; subm. by J. Mertens.

Lv-191. Hamont T III AB **2520 ± 120**
570 B.C.

Sample from a Neolithic or Bronze age burial mound, at 95 cm below the top. *Comment* (J.M.): C¹⁴ date agrees with archaeological date.

Lv-192. Hamont T III AE **2880 ± 150**
930 B.C.

Sample from prehistoric burial mound, at 80 cm below the top. *Comment* (J.M.): C¹⁴ date agrees with archaeological date.

Lv-228. Vaux sous Chèvremont **540 ± 80**
A.D. 1410

Charcoal from burned horizon of feudal castle of Chèvremont (50° 36' N Lat, 5° 37' E Long) at Vaux sous Chèvremont, Prov. of Liège, Belgium. Sample is taken at 1.15 m depth. Coll. 1965 and subm. by J. Mertens. *Comment* (J.M.): castle was destroyed in the 10th century; C¹⁴ date is still unexplained.

Lv-40. Gistel III **4330 ± 120**
2380 B.C.

Charcoal from Gistel (51° 09' N Lat, 2° 57' E Long), Prov. of Western Flanders, Belgium. Sample taken at 1.50 m depth in the original sand layer below a Middle Age artificial eminence. Coll. 1958 and subm. by J. Mertens. *Comment*: pollen analysis, by W. Mullenders, shows at this level the Sub-Boreal-Sub-Atlantic transition, with perhaps the end of Atlantic horizon. Age of that transition is estimated ca. 4000 yr ago.

Zoutenaai series

Samples from Zoutenaai (51° 03' N Lat, 2° 45' E Long), Prov. of Western Flanders, Belgium, alt 4 m. Coll. 1960 and subm. by J. Mertens. Age determination in order to see the succession of the marine transgressions.

Lv-85. Zoutenaai 60.Zo.8 **2060 ± 130**
110 B.C.

Wood from Excavation I, Profile AB. *Comment* (J.M.): archaeological estimate 1st century B.C.

Lv-86. Zoutenaai 60.Zo.12 **2490 ± 130**
540 B.C.

Charcoal from Excavation II, Profile CD. *Comment* (J.M.): date agrees with archaeological estimation.

Lv-90. Zoutenaie 60.Zo.38**2330 ± 110****380 B.C.**

Peat from Excavation VII, Profile AB.

Lv-91. Zoutenaie 60.Zo.39**3000 ± 110****1050 B.C.**Pine stub *in situ* (*Pinus silvestris*, id. by J. Heim) at same level as Lv-90.**Lv-193. Male****600 ± 110****A.D. 1350**Wood from beam used in basement of feudal castle of Male (51° 11' 30" N Lat, 3° 16' E Long) at Sint-Kruis, Prov. of Western Flanders, Belgium. Sample taken at 2.20 m depth. Coll. 1962 by L. Devliegheer; subm. by Mertens. *Comment* (J.M.): C¹⁴ date agrees with archaeological date.

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UNIVERSITY OF MICHIGAN RADIOCARBON DATES XI

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The following is a list of dates obtained since the time of the compilation of List X in December 1964. The method is essentially the same as that used for the work described in the previous list. Two $\text{CO}_2\text{-CS}_2$ Geiger counter systems are used. The equipment and counting techniques have been described elsewhere (Crane, 1961). The dates and estimates of error in this list follow the practice recommended by the International Radiocarbon Dating Conferences of 1962 and 1965, in that (a) dates are computed on the basis of the Libby half-life, 5570 yr, (b) A.D. 1950 is used as the zero of the age scale, and (c) the errors quoted are the standard deviations obtained from the numbers of counts only. In previous Michigan date lists up to and including VII we have quoted errors at least twice as great as the statistical errors of counting, in order to take account of other errors in the over-all process. If the reader wishes to obtain a standard deviation figure which will allow ample room for the many sources of error in the dating process, we suggest he double the figures that are given in this list.

We wish to acknowledge the help of Patricia Dahlstrom in preparing chemical samples and David M. Griffin in preparing the descriptions.

GEOLOGIC SAMPLES

- M-1361. Genesee Co. mammoth, Michigan** **11,400 \pm 400**
9450 B.C.
- Tusk of mammoth (*Mammuthus jeffersoni*), from Clayton Twp. (42° 58' N Lat, 83° 58' W Long), Sec. 31, T7N, R5E, Genesee Co., Michigan. Found at 12 ft depth in calcareous clay, overlain by layer of sand, then layer of peat. Coll. 1962 by Biology Dept., Flint Community Junior College; subm. by G. A. Buck, Biology Dept., Flint Community Junior College, Flint, Michigan. *Comment* (G.A.B.): date established by pollen analysis agrees substantially with above date (Oltz and Kapp, 1963).
- M-1282. Pre-Lake Nipissing Shoreline, Michigan** **6270 \pm 210**
4320 B.C.

Wood chips and twigs of northern white cedar (*Thuja occidentalis*) id. by H. I. Mitchell, U. S. Forest Service, from Pre-Lake Michigan shoreline (45° 25' N Lat, 84° 35' W Long), Cheboygan Co., Michigan. Location is 800 ft S of N section line and 1700 ft E of W section line, Sec. 25, T35N, R3W. Site is located on N-sloping forest-covered sandy beach of Pre-Lake Nipissing shoreline bordering S end of Burt Lake. Nipissing shoreline is ca. 500 ft S of collection site. Material was coll. from depth of 23 to 25 ft below land surface, which is 610 to 615 ft above sealevel; i.e., wood chips were 585 to 590 ft. Coll. 1961 and subm. by J. R. Byer-

lay, Dept. of Conserv., Lansing, Michigan. Comment (J.R.B.): sample probably deposited during one of series of successively higher stages between Lake Chippewa and Lake Nipissing.

M-1375. Todd Harbor (docksite), Michigan **3360 ± 150**
1410 B.C.

Wood (*Larix laricina*), from Todd Harbor docksite (48° 00' 30" N Lat, 88° 45' 50" W Long), Isle Royale, Michigan. Overlain by "hardpan" several in. thick with 6 to 8 ft of silt over that, and 8 ft of water over silt. Date may assist in determining previous level of Lake Superior lower than present lake level. Coll. 1958 by R. M. Johnson; subm. by Robert Lind, Natl. Park Service, Houghton, Michigan. Comment (J.B.G.): date places sample between Nipissing and Algoma Lake stages.

Dunlavy Lake Bog series, Michigan

Wood and peat from S side of Dunlavy Lake Bog (42° 25' 30" N Lat, 83° 52' 00" W Long), located in Huron Valley, 6.5 mi N of Dexter, SW¼ NW¼ Sec. 33, T1N, R5E, Hamburg, Twp., Livingstone Co., Michigan. This middle reach of the Huron River Valley is dammed by glacial and peat deposits into series of small, bog-bordered lakes. Peat section contains no evidence of stream erosion or flooding, implying that peat deposit surface was always outside or above active river channels. From fossil pollen. to be descr. by Benninghoff, it is clear that base of this section was deposited early in post-ice spruce forest period, and that deposition continued until ca. 100 yr ago. Coll. 1962 by W. S. Benninghoff and D. F. Eschman; subm. by W. S. Benninghoff, Dept. of Botany, Univ. of Michigan.

M-1459. Dunlavy Lake Bog, 200 to 210 cm depth **8630 ± 300**
6680 B.C.

Log fragments from 200 to 210 cm depth in peat deposits 400 cm thick. Taken from cleaned wall of trench excavated by dragline for that purpose. Sample believed to be middle Hypsithermal in age.

M-1460. Dunlavy Lake Bog, 150 to 165 cm depth **7120 ± 220**
5170 B.C.

Block of peat from 150 to 165 cm depth from cleaned wall of trench. Comment (W.S.B.): pollen still under study. Dates seem reasonable.

Galien River Terrace series, Michigan

Hardwood and nut shells from Galien River Terrace (41° 51' N Lat, 86° 33' W Long), S of New Troy, SE¼ NW¼ Sec. 17, T7N, R19W, Weesaw Township, Berrien Co., Michigan. At sampling point, river near end of its N course. Immediately downstream it turns toward W for 2 mi, then SW for 8½ mi, until it cuts through shore dunes to empty in Lake Michigan. Nipissing rise of Lake Michigan may have caused dune field to impede river's drainage at same time base level was rising, and this may have been responsible for construction of 6 ft terrace S of

New Troy. Samples found in buried forest bed, probably representing major flood near close of Lake Michigan rise to Nipissing level. If so, samples should date 4500 B.P. Coll. 1962 by Paul Randall; subm. by W. S. Benninghoff, Univ. of Michigan.

3090 ± 160

M-1461. Galien River Terrace

1140 B.C.

Shells of *Juglans cinerea* and *Juglans nigra* from buried forest bed in low terrace, surface of which is 6 ft above mean level of Galien River. Forest bed is 1 ft above river level and 1 to 2 ft thick, resting on cobbly gravel and overlain by coarse sand with pebbles.

2370 ± 130

M-1462. Galien River Terrace

420 B.C.

Hardwood log fragments from buried forest bed in low terrace of Galien river. *Comment* (W.S.B.): it is likely that interpretation of forest bed as a relic of rise of Lake Michigan to Nipissing level is not correct.

11,800 ± 400

M-1603. Krutsch site, Michigan

9850 B.C.

Black spruce wood fragments from Krutsch site (43° 24' 25" N Lat, 84° 03' 45" W Long), SW¼ NW¼ Sec. 36, Saginaw Co., Michigan. Sample chopped from black spruce stump in buried forest bed at 605 ft alt, overlain by complex dune-soil sequence. Should be of Two Creeks age or ca. 10 to 11,500 B.C. Less probably, might be pre-Nipissing or ca. 2000 B.C. (Hough, 1963). Coll. 1964 and subm. by H. T. Wright, for Mus. of Anthropol., Univ. of Michigan. *Comment* (H.T.W.): date tends to confirm the Two Creeks age established by Broecker and Farrand (1963).

5300 ± 200

M-1604. Dodge Park Dump site, Michigan

3350 B.C.

Twigs and small branch fragments from Dodge Park Dump site (42° 35' 30" N Lat, 83° 00' 30" W Long), NE¼ SW¼ NW¼ Sec. 14, Stealing Township, MaComb Co., Michigan. Sample overlain by sand, near floor of peat-filled channel cut into estuarine terrace which tops at 605 ft alt (Hough, 1963; Dreimanis, 1964). Coll. 1964 and subm. by H. T. Wright, for Mus. of Anthropol., Univ. of Michigan. *Comment* (H.T.W.): compares favorably with date obtained on log from same site (M-1635, this list).

5800 ± 200

M-1635. Dodge Park Dump site, Michigan

3850 B.C.

Fragment of large log from the Dodge Park Dump site (42° 35' 30" N Lat, 83° 00' 30" W Long), NE¼ SW¼ NW¼ Sec. 14, Sterling Township, MaComb Co., Michigan. From lower peat level of a peat-filled river channel. Lower peat is separated from upper peat by cross-bedded sands. Entire channel is overlain by pond sediments (Hough, 1963; Dreimanis, 1964). Coll. 1964 by Jerry DeVisscher; subm. by J. E. Fitting, Mus. of

Anthropol., Univ. of Michigan. *Comment* (J.E.F.): this sample, along with M-1604, probably dates an interval of slight lake level drop during general rise of Nipissing stage in area.

11,800 \pm 350

M-1626. Meilock Road sandpit, Michigan

9850 B.C.

Unburned wood from Meilock Road sandpit (44° 02' N Lat, 83° 32' W Long), SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 15, T21N, R7E, Iosco Co., Michigan. From stump in buried forest fixed in peat layer under beach believed to be either Nipissing or Algonquin. Strong podzol development on beach favors interpretation as Algonquin, but precise alt is not known. Also dates large body of plant remains, identification of which will contribute to understanding of post-Pleistocene ecology of Upper Great Lakes. Coll. 1964 and subm. by H. T. Wright for Mus. of Anthropol., Univ., of Michigan. *Comment* (H.T.W.): date conforms to Two Creeks age of Broecker and Farrand (1963).

Skeldal series, NE Greenland

Shells, id. by H. G. Richards, Acad. Natl. Sci., Philadelphia, at various altitudes from emerged marine deposits and from fjord deposit (Yale VII; Washburn and Stuiver, 1962), and a peat deposit in Skeldal (72° 15' N Lat, 24° 15' W Long), Mesters Vig district, SW side of Kong Oscars Fjord, NE Greenland, ca. 70 km from entrance. Samples provide information for establishing glacial chronology, and for determining rate and amount of crustal uplift in district. **N.B.** For comparative purposes, shell dates have been corrected by subtracting 550 \pm 70 yr, age of modern shells (Y-606) from same locality (Yale VII). Coll. 1963 and subm. by N. P. Lasca, Dept. of Geology-Mineralogy, Univ. of Michigan.

7190 \pm 250

M-1611. Skeldal 31 m

5240 B.C.

Mya truncata Linné and *Macoma calcarea* (Gmelin) from Location 1 at alt of 31 \pm 2 m, E cut bank emerged delta in soliflucted fjord-bottom material, E side Skelelv, ca. 2.5 km down valley from waterfalls, and 4 km S of Skelhytte.

7940 \pm 300

M-1612. Skeldal 59 to 60 m

5990 B.C.

Hiatella arctica (Linné) and *Mya truncata* from Location 2, at alt of 59 to 60 \pm 2 m, ca. 0.4 km E of Location 1, NW bank emerged delta, E side Skelelv, *in situ*.

8290 \pm 300

M-1613. Skeldal 59 to 60 m

6340 B.C.

Macoma calcarea, *Hiatella arctica* and *Mya truncata* from Location 3, at alt of 59 to 60 \pm 2 m, SE cut bank emerged delta, 1 km W of Location 2, W side Skelelv, *in situ*.

- M-1614. Skeldal 14 m** **6460 ± 250**
4510 B.C.
Macoma sp., *Hiatella arctica*, and *Mya truncata* from Location 4 at alt of 14 ± 1 m, SE cut bank emerged delta W side Skelev at Kong Oscars Fjord, *in situ*.
- M-1615. Skeldal 59 m** **8590 ± 300**
6640 B.C.
Mya truncata and *Hiatella arctica* from Location 5 at alt of 59 ± 2 m, N face of bank cut by tributary, in soliflucted material of fjord-bottom and delta, W side Skelev, ca. 1.5 km up valley from Location 4.
- M-1616. Skeldal 36 m** **7220 ± 250**
5270 B.C.
Mya truncata from Location 6 at alt of 36 ± 2 m, N face of strandline, W side Skeldal, ca. 1.2 km up valley from Location 4, *in situ*.
- M-1617. Skeldal 21 m** **6410 ± 220**
4460 B.C.
Hiatella arctica, *Mya truncata*, *Macoma calcarea*, and *Mytilus edulis* Linné from Location 7, at alt of 21 ± 1 m, strandline W side Skelev, ca. 1 km up valley from Location 4, *in situ*.
- M-1618. Skeldal 20 to 21 m** **6720 ± 250**
4770 B.C.
Hiatella arctica, *Mya truncata*, and *Astarte* sp., from Location 8 at alt of 20 to 21 ± 1 m, NW cut bank emerged delta E side Skelev, ca. 1 km SW of Skelhytte, *in situ*.
- M-1619. Skeldal 4 m** **5430 ± 200**
3480 B.C.
Macoma calcarea, *Mya truncata*, *Mya arenaria*, and *Hiatella arctica* from Location 9 at alt of 4 ± 0.5 m, NW cut bank emerged delta, ca. 4.5 km SE of Skelhytte, SW side Kong Oscars Fjord, *in situ*.
- M-1620. Skeldal 17 m** **6280 ± 200**
4330 B.C.
Mya truncata and *Macoma calcarea* from Location 10 at alt of 17 ± 1 m, NW cut bank emerged delta ca. 1.5 km SE of Skelhytte on SW side Kong Oscars Fjord, *in situ*.
- M-1621. Skeldal 3 to 4 m** **5130 ± 200**
3180 B.C.
Astarte sp., *Macoma* sp., *Serripes grenlandicus* (Bruguère), *Mya truncata*, *M. arenaria*, and *Mytilus edulis* from Location 11 at alt of 3 to 4 ± 0.5 m, NW cut bank emerged delta SE side Skelev at entrance to Kong Oscars Fjord, *in situ*.
- M-1622. Skeldal 11 m** **6610 ± 250**
4660 B.C.
Hiatella arctica and *Mya truncata* from Location 12 at alt of 11 ± 1 m, NE cut bank emerged delta, ca. 0.7 km E of Skelev on SW side Kong Oscars Fjord, *in situ*.

M-1623. Skeldal 9 m **6240 ± 220**
4290 B.C.

Hiatella arctica and *Mya truncata* from Location 13 at alt of 9 ± 1 m, NW cut bank emerged delta SE side Skelelv at entrance to Kong Oscars Fjord, *in situ*.

M-1624. Skeldal 51 m **4930 ± 200**
3120 B.C.

Peat deposit from Location 14, 1.45 m below surface, overlain by interbedded sands, silts, and pebble gravel at alt of 51 ± 2 m, S exposure cut bank in lacustrine sediments, E side Skelelv, ca. 7 km S of Skelhytte. *Comment* (N.P.L.): dates satisfactory; to be discussed elsewhere.

ARCHAEOLOGICAL SAMPLES

Upper Mississippi, Great Lakes

Norton mound series, Michigan

Charcoal and ash from Norton mounds ($42^{\circ} 54' 42''$ N Lat, $85^{\circ} 43' 36''$ W Long), Kent Co., Michigan. Dates from Mound H should date construction of mound in which the burial included one extended female, one bundled adult male, three juveniles, and ceramics resembling those from Utica mounds. Date from Mound C should predate construction of mound. Coll. 1963 and subm. by R. E. Flanders for Mus. of Anthropol., Univ. of Michigan.

M-1488. Norton Mound H **1790 ± 120**
A.D. 160

Charcoal from Mound H, 90 E 190, in hearth at base of cap, in ash lens, and immediately above black dirt from burial pit, 5 ft S of pit.

M-1489. Norton Mound H **950 ± 100**
A.D. 1000

Ash and charcoal from Mound H, ash lens below cap, 3 ft E of pit.

M-1490. Norton Mound H **1850 ± 100**
A.D. 100

Ash from Mound H, at base of cap, 5 ft N of burial pit.

M-1493. Norton Mound C **1960 ± 120**
10 B.C.

Charcoal from Mound C in hearth area on original land surface W of burial. Hearth overlain by artificial layer of clay, then mound fill. Associated with charcoal was burned animal bone, pottery, and shell. *General Comment* (J.B.G.): three of four dates are acceptable but M-1489 is ca. 900 yr too late.

M-1519. Sissung Farm site (20 Mr-30), Michigan **1250 ± 120**
A.D. 700

Charcoal from Sissung Farm site (20 Mr-30) ($42^{\circ} 05' 30''$ N Lat, $83^{\circ} 30'$ W Long), Monroe Co., Michigan. From Feature 1, Test Pit B-2 contain-

ing ceramic material similar to earlier horizon at Riviere au Vase, a transitional stage in this area between Middle and Late Woodland. Coll. by G. R. Peske; subm. by J. E. Fitting. *Comment* (J.E.F.): previous estimates for duration of Riviere au Vase phase of Younger tradition (Fitting, 1965) were too conservative. Because this date and several others have consistently run about a century earlier than originally expected, entire dating for Younger tradition has been revised (Fitting, in press). It should be noted that corn was found in this feature.

630 ± 100

M-1520. Verchave I (20 Mb-178), Michigan A.D. 1320

Charcoal from Verchave I (20 Mb-178) (42° 34' N Lat, 82° 50' W Long), Harrison Twp., T2N, R14E, Macomb Co., Michigan. From Feature 2 in Unit 500 E 200, Late Woodland refuse pit containing plain, smoothed, fine-tempered sherds of type believed to be late in area. One Madison point also came from pit (Fitting, 1965). Coll. 1962 and subm. by J. E. Fitting. *Comment* (J.E.F.): since bulk of material from site can be attributed to Wolf phase of Younger tradition, including material in this feature, I believe this is an accurate date for Wolf Phase. It is earlier than A.D. 1400 which I had suggested (Fitting, 1965) for beginning of Wolf phase and, along with other consistently earlier than expected dates, has led to a chronological revision for Younger tradition (Fitting, in press).

Green Point (Schultz) site series, Michigan

Charcoal and hickory nuts from Green Point (Schultz) site (20 Sa-2), (42° 23' N Lat, 83° 59' W Long), S½ NE¼ Sec. 3, T11N R4E, Saginaw Co., Michigan. From lower dark silts, compare with M-1432 for similar Early Woodland cultural horizon and with M-1433 (Michigan XII) for overlying Middle Woodland occupation with a sterile medium brown silt separating the two. Coll. 1963 and subm. by D. W. Taggart, for Mus. of Anthropol., Univ. of Michigan.

2490 ± 130

M-1524. Green Point (Schultz) site, Feature 48 540 B.C.

Charcoal, predominantly *Carya* and some *Quercus*, *Salix*, *Prunus*, and *Ulmus*, and hickory nut shells from Feature 48 at depth of 1½ ft in top of lower dark silts. Associated with 10 sherds from vessel: thick, interior-exterior cordmarked, straight vertical rim and flattened base.

2480 ± 150

M-1525. Green Point (Schultz) site, Feature 62 530 B.C.

Charcoal, mostly *Quercus* and *Carya* and some *Salix*, *Prunus*, *Alnus*, and *Ulmus* from Feature 62, 2.2 ft below surface in lower dark silts. Associated with 2 thick, interior cordmarked potsherds and Early Woodland occupation floor.

General Comment (D.W.T.): dates appear entirely adequate. These, in combination with M-1432, all from sealed deposits, serve to date rather

definitely the Early Woodland Schultz component at ca. 530 B.C. Likewise, by associated chert and projectile point types, they inferentially date Late Pomranky burial complex as expressed at Pomranky, Hodges, and Stroebel burials (Binford, 1963a, 1963b). To my knowledge, these dates represent only C¹⁴ dates obtained in direct association with thick, interior cordmarked pottery in NE United States.

1340 ± 110

M-1625. Goodwin-Gresham site, Michigan A.D. 610

Wood charcoal and cooking debris from Goodwin-Gresham site (42° 16' N Lat, 83° 20' W Long), NE¼ SW¼ Sec. 34, T23N, R9E, Iosco Co., Michigan. Sample from Feature 12, a hearth 0.9 ft below present surface. Hearth at base of red-brown sandy occupation zone 0.6 ft thick. Associated material indicates Late Point Peninsula tradition. Coll. 1964 and subm. by H. T. Wright for Mus. of Anthropol., Univ. of Michigan. *Comment* (J.B.G.): date is acceptable and conforms with other reasonable Late Point Peninsula time estimates.

440 ± 100

M-1640. Lookout site, Isle Royale, Michigan A.D. 1510

Wood from Lookout site (48° 09' 43" N Lat, 88° 29' 06" W Long), Isle Royale, Michigan. Site 225 ft above Lake Superior on Greenstone Ridge near Monument Rock. Sample found 2.6 ft below surface of fill in Pit 4. A possible aid in determining length of time taken to fill pit with debris (Michigan X). Coll. 1960 by Tyler Bastian; subm. by J. B. Griffin, Univ. of Michigan. *Comment* (J.B.G.): apparently one of latest pits of Isle Royale Copper workings.

Steed-Kisker site series, Missouri

Charcoal from Steed-Kisker site (39° 17' 15" N Lat, 94° 49' 30" W Long), center of W edge Sec. 27, T52N, R35W, Platte Co., Missouri. This is type site of Steed-Kisker focus in W Missouri (Wedel, 1943). Coll. 1962 and subm. by J. M. Shippee, Univ. of Missouri.

840 ± 110

M-1395A. Steed-Kisker midden deposit A.D. 1110

950 ± 110

M-1395B. Steed-Kisker midden deposit A.D. 1000

Charcoal and charred corncob and kernels from 12 to 24 in. deep in midden deposit of general refuse from semi-subterranean lodges on slope midway between village site and cemetery described by Wedel.

50 ± 100

M-1396. Steed-Kisker post mold, House 3 A.D. 1900

Charcoal from large posthole near fireplace of House 3.

1090 ± 110

M-1397. Steed-Kisker fireplace, House 3 A.D. 860

Charcoal from saucer-shaped fireplace of House 3. Material recovered from house included polished stone pipe, clay pipe, 12 restorable

pottery vessels of typical Steed-Kisker shapes and decoration, projectile points, scrapers, and sandstone abraders.

740 ± 110

M-1398. Steed-Kisker roasting pit

A.D. 1210

Charcoal from pit 39 in. wide and 14 in. deep containing fired limestone and charcoal at depth of 10 in. Pit was outside and on uphill side of House 3.

General Comment (J.B.G.): except for M-1396, which was too small for a completely satisfactory run, dates seem reasonable for this Mississippian complex and may well bracket time of occupation.

1170 ± 120

M-1356. Klunk Mound 10, Illinois

A.D. 780

Charcoal, red cedar (*Juniperus virginiana*) and some black walnut, id. by R. Yarnell, from Klunk Mound 10 (39° 12' 35" N Lat, 90° 32' 48" W Long), Calhoun Co., Illinois. Sample from crematory A in small mound containing 2 crematories. Crematory A was 8½ ft in diam and 24 in. deep from mound surface to crematory floor. Charcoal was associated with 3 burials, a crude baked clay pipe, Canteen Cordmarked sherds, and portion of charred bone pendant. Should date construction of three Klunk Mounds with 7 crematories in and outside Mounds 8, 9 and 10, possibly preceding Mississippian-influenced Jersey Bluff culture. Coll. 1961 and subm. by Gregory Perino, Thm. Gilcrease Found., Tulsa, Oklahoma. *Comment* (G.P.): this mound and its two crematories should fit into same time period, ca. A.D. 600, as Klunk Mound 8, dated and described in Michigan IX (p. 6).

1300 ± 120

M-1357. Koster Mound 2, Illinois

A.D. 650

Charred human bone from Koster Mound 2 (39° 12' 35" N Lat, 90° 32' 48" W Long), Greene Co., Illinois. Sample from Burial 2, male skeleton lying on original ground surface under W edge of mound and 6 in. from surface. Should date construction of Koster mounds and occupation of village site within Late Woodland framework of area. Coll. 1961 and subm. by Gregory Perino. *Comment* (G.P.): only date available from seven Koster mounds and is from lone cremation found. Typologically, burials from this site should date after Klunk Mounds 8 and 10 dates as indicated by discovery of Late Woodland discoidal and semi-flexed burials. Earlier Klunk burials were flexed or cremated. Eleven Koster burials contained one or more corner-notched arrow points in vital areas, indicating considerable local conflict among tribes, perhaps at beginning of Mississippi infiltration.

Schild site series, Illinois

Charcoal from Schild site (39° 14' 15" N Lat, 90° 32' 57" W Long), Greene Co., Illinois. Site consists of cemetery on two knolls on bluff overlooking Illinois River Valley. Burials apparently were those of

acculturated Late Woodland (Jersey Bluff), Mississippian group on Old Village time level. Coll. 1962 and subm. by Gregory Perino.

1020 \pm 110

M-1393. Schild site, Knoll B, Burial 275 A.D. 930

Charred wood from Knoll B, Burial 275 consisting of bundle of charred human bone and various burned and charred artifacts. All were at depth of 14 to 16 in. on E end of Knoll B.

750 \pm 110

M-1394A. Schild site, Knoll A, Burial 122 A.D. 1200

Charred wood from Knoll A, Burial 122, consisting of partly charred remains of child, articulated remains of two adults, each burial having been placed on top of a lower one.

General Comment (G.P.): dates from Schild site seem to have bracketed age limits for Old Village including acculturation period. Average of these dates would produce reasonable figure for date of site.

Peisker site series, Illinois

Charcoal and antler from Peisker site (39° 5' 26" N Lat, 90° 35' 46" W Long), Calhoun Co., Illinois. Coll. 1962 by Gregory Perino; subm. by Stuart Struever, Dept. of Anthropol., Univ. of Chicago.

2180 \pm 130

M1403. Peisker site, Mound 1

230 B.C.

Charcoal from charcoal mass (Feature 20) situated in sand ridge beneath Peisker Mound 1. Occurring at surface of sand ridge. Feature is associated with latest premound occupation of sand ridge and this would give it an early to middle Havana affiliation.

2275 \pm 130

M-1404. Peisker site, Mound 2

325 B.C.

Charcoal occurring as mottling throughout fill of pit (Feature 4), located in sand ridge beneath Peisker Mound 2 in SE quarter. Sand ridge yielded homogenous Black Sands artifact complex. Should be Early Woodland and date 550 to 650 B.C.

1770 \pm 130

M-1405. Peisker site, Mound 2

A.D. 180

Carbonized wood and antler (*Odocoileus virginianus*) from shallow pit (Feature 7) located in sand ridge beneath Peisker Mound 2, SE quarter. Feature 7 occurred close to Burials 5, 6 and 7 and is regarded as probably associated with burial activity. Since sand ridge beneath Mound 2 yielded an homogenous Black Sands artifact complex, and burials clearly antedate mound itself, burials and Feature 7 have Early Woodland origin and should date 550 to 650 B.C.

General Comment (S.S.): date of 230 B.C. for early Havana occupation is reasonable but 325 B.C. for Early Woodland is later than expected. Date for M-1405 suggests that Feature 7 is associated with period of mound building instead of with Early Woodland.

Apple Creek site series, Illinois

Charcoal from Apple Creek site (39° 22' 15" N Lat, 90° 32' 22" W Long), Greene Co., Illinois. Coll. 1962 and subm. by Stuart Struever.

1310 ± 100**M-1406. Apple Creek site, pit (Feature 84c) A.D. 640**

Wood-charcoal from ash-charcoal-burnt soil lens within storage refuse pit (Feature 84c). Soil lens, with concentration of burnt limestone fragments, is interpreted as residue of hearth redeposited in empty storage pit. Associated cultural materials belong to White Hall phase, a Late Havana manifestation according to Streuver, and may date A.D. 400 to 500.

1160 ± 120**M-1407. Apple Creek site, pit (Feature 203c) A.D. 790**

Wood-charcoal from cylindrical storage refuse pit (Feature 203c), part of redeposited residue of hearth or roasting pit. Associated artifacts are affiliated with White Hall phase. Since it is Late Havana, it should date A.D. 400 to 550.

2660 ± 130**M-1408. Apple Creek site, pit (Unit 179d) 710 B.C.**

Wood-charcoal from charred mass at base of pit in provenience unit 179d, located in floor of house.

General Comment (S.S.): the early date for M-1408 is difficult to understand and does not apply to White Hall phase material with which charcoal was associated. Dates for White Hall phase of M-1406 and M-1407 are acceptable.

150 ± 100**M-1590. Vandruff's Island site, Illinois A.D. 1800**

Charred wood from Vandruff's Island site (IAS No. Ri-22), (41° 25' 30" N Lat, 90° 30' 45" W Long), SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 14, T17N, R2W, on island in Rock River near Rock Island, Rock Island Co., Illinois. From Feature 41, 555-30W, a large cylindrical pit, bottom 5.5 ft below surface, distance 3.6 ft. Charcoal found in section 3.1 to 4.3 ft below surface. Assemblage found at site is primarily Archaic although some Late Woodland sherds and some historic objects have been recovered. Oval houses occurred at site as did large storage (?) pits and concentrations of shell refuse. Coll. 1961 and 1962 and subm. by E. B. Herold, 2128 Frisco Dr., Davenport. Iowa. *Comment* (E.B.H.): date indicates association with historic Sauk occupation.

1650 ± 120**M-1591. Wolf site, Illinois A.D. 300**

Charred wood from Wolf site (41° 25' 20" N Lat, 90° 25' 45" W Long), SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 22, T17N, R1W, Rock Island Co., Illinois. Site on E side of Coal Creek at foot of bluff on S side of Rock River. Sample found in Feature 1, 95E-0, 0.8 to 2.0 ft below surface of complex

of several refuse pits. Associated pottery is similar to Weaver in decoration. Surface collections have also produced Middle Woodland material similar to Havana types. Oval houses found on site. Coll. 1963 by G. J. Fenner and E. B. Herold and subm. by E. B. Herold. *Comment* (E.B.H.): date is reasonable for this occupation.

Lawrence site series, Illinois

Charred wood from Lawrence site ($41^{\circ} 45' 45''$ N Lat, $89^{\circ} 45'$ W Long), NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 36, T20N, R6E, Whiteside Co., Illinois. Site above flood plain on W side of Rock River. Fisher trailed pottery and other Upper Mississippian artifacts occurred in assemblage. Coll. 1963 by C. J. Bareis and E. B. Herold; subm. by E. B. Herold.

780 \pm 110

M-1592. Lawrence site, Feature 27 A.D. 1170

Charred wood from Feature 27, 109-33 E, basin-shaped refuse and firepit, 2.5 ft in diam, 1.37 ft deep below grader level.

790 \pm 110

M-1593. Lawrence site, Feature 59 A.D. 1160

Charred wood from Feature 59, 235 N-7 W, bell-shaped refuse pit, 3.5 ft in diam, 0.9 ft deep below grader level.

690 \pm 110

M-1594. Lawrence site, Feature 16 A.D. 1260

Charred wood from Feature 16, 98 N-25 E, slightly bell-shaped pit, 3.1 ft in diam, 1.3 ft below grader level.

680 \pm 110

M-1595. Lawrence site, Feature 39 A.D. 1270

Charred wood from Feature 39, 175 N-26 E, slightly undercut refuse pit, 3.1 ft in diam, 1.5 ft deep below grader level.

General Comment (E.B.H.): dates are consistent and satisfactory for this Upper Mississippian assemblage.

430 \pm 100

M-1722. Loyd site, Illinois A.D. 1520

Charred corn kernels from Loyd site ($38^{\circ} 44' 35''$ N Lat, $90^{\circ} 00' 15''$ W Long), Madison Co., Illinois. Sample from multi-component occupational site, Late Woodland and Mississippian, and found in Feature 48, refuse pit cut by wall trenches of two Mississippian houses in house location occupied by sequence of four Mississippian houses. Pottery association of Feature 48 is Mississippian with slight mixing of small Woodland sherds; plain polished Tippetts Bean Pot sherds and polished handle are present but no Cahokia Cordmarked or Wells Incised: two plain, low-rimmed jar sections are present but no Ramsey Incised. One sherd of foreign paste is polished and engraved. Pottery types missing from feature are found elsewhere at site. Should date early phase of Mississippian occupation of site, perhaps just prior to introduction of

Cahokia Cordmarked pottery, and date of 700 to 800 B.P. is expected. Coll. 1963 by P. J. Munson; subm. by R. L. Hall, Illinois State Mus., Springfield, Illinois. *Comment* (R.L.H.): substantially later than expected.

Monks Mound series, Illinois

Charcoal from Monks Mound (38° 39' 36" N Lat, 90° 04' 27" W Long), SE $\frac{1}{4}$, SE $\frac{1}{4}$, SE $\frac{1}{4}$, Sec. 34, T3N, R9W, Madison Co., Illinois. Coll. 1964 and subm. by James Porter and C. J. Bareis, Univ. of Illinois.

840 ± 150

M-1636. Monks Mound, Feature 13 **A.D. 1110**

Charcoal from fourth terrace in middle of N end of Feature 13. From N225 profile at E188.2, 160 cm below surface or 230 to 235 cm below arbitrary datum for mound top. Associated with second to last occupation and distinct prehistoric occupation surface.

670 ± 100

M-1637. Monks Mound, Feature 4 **A.D. 1280**

Charcoal from Feature 4, burned floor of house, from N199,328 E44,895, 39 to 42.5 cm below surface, on slope bordering (S side) of major ravine on W side. Associated underneath charcoal were three vessels, an undecorated Wells plate, an effigy bowl without its head, and a plain shattered vessel.

General Comment (J.P.): M-1636 is indicative of period just prior to last building phase of fourth terrace of Monks Mound. Dates fit very nicely within range of dates previously run for the Mitchell site, and indicates this satellite center was occupied during terminal phases of the Monks Mound area. M-1637 falls very nicely within range of two dates previously run for the Collinsville Airport site. Feature 1 at that site dated A.D. 1135 to 1145 (M-1297) and also contained Cahokia Cordmarked sherds.

Rogers site series, Kentucky

Charcoal from Rogers site (BE 35-61), (39° 2' 9" N Lat, 84° 52' 25" W Long), Boone Co., Kentucky. Site is composed of two different village areas located on second terrace overlooking Ohio River. Perhaps a Hopewell site, first to be found S of Ohio River. Possibly contemporary with Late Adena, as traits of both cultures exist at site. Coll. 1961 and subm. by Ellis Crawford, Wm. Behringer Memorial Mus., Covington, Kentucky.

1440 ± 130

M-1351. Rogers site, Pit 4 **A.D. 510**

Charcoal, chiefly red oak group, id. by R. Yarnell, from Pit 4, Square H-6. Pit 4 was 5 ft in depth, 4 ft in diam. Bottom lined with

fired stones and hard black substance. Sample found at bottom of pit in direct association with thick and easily crumbled pottery.

M-1352. Rogers site, refuse pit **500 ± 100**
A.D. 1450

Charcoal, mostly ash, white oak and red oak groups, id. by R. Yarnell. Sample found 12 to 18 in. deep at base of refuse pit. Found in associated with thinner and better fired pottery than M-1351. Should date later.

M-1353. Rogers site, Pit 5 **2380 ± 130**
430 B.C.

Charcoal, some red oak, id. by R. Yarnell, from Pit 5 at depth of 6 ft. Pit was bell-shaped, 3 ft in diam and 6 ft deep. Sample was at base of pit in direct association with thick and easily crumbled pottery.

General Comment (E.C.): M-1351 and M-1353 are acceptable and suggest contemporaneity between Hopewell and Adena here in Ohio basin. M-1352 is somewhat recent for pottery in association with sample. Assuming pottery not intrusive due to shallow refuse pit (12 to 18 in.), we would have a cultural sequence that extended into Fort Ancient aspect.

Lower Mississippi, Southeast U. S.

M-1486. Cherry Valley mound group, Arkansas **850 ± 110**
A.D. 1110

Charred wood from Cherry Valley mound group (35° 26' N Lat, 90° 45' W Long), NE¼ Sec. 2, T9N, R3E, Mitchell Township, Cross Co., Arkansas. Sample from Mound Two, in entrance of burned house beneath mound. Site yielded new culture complex for NE Arkansas and is important because of remarkable resemblance of pottery vessels to bean-pot shape found at Cahokia in Illinois. Cherry Valley may represent splinter group created by population increase at Cahokia (Michigan V, p. 37). Coll. 1958 and subm. by Gregory Perino. *Comment* (J.B.G.): this date more in line with other Middle Mississippi assays than earlier run of A.D. 700.

M-1446. Mounds Plantation, Louisiana **900 ± 100**
A.D. 1050

Wood from Mounds Plantation (16 Cd-12), (38° 38' N Lat, 93° 45' 40" W Long), Louisiana, ca. 2 mi S of Dixie, Louisiana and 10 to 12 mi N of Shreveport, 1 mi W of Red River on W bank old Red River channel. Log No. 1 from Mound B, Burial 5, 20 in. above pit floor in fill forming frame above part of burial pit. Sherds in mound and site: Coles Creek, Alto, and Haley. Occupation late, with intrusive Belcher burial in mound top. Association in pit exclusively Alto-Gahagan. Gibson Aspect Caddoan, should date unassigned focus much like Alto and Gahagan. Same log sample dated by Univ. of Texas, sample Tx-55 at 860 ± 120 (Texas II, p. 155). Coll. 1960 by R. McKinney; subm. by C. H.

Webb, Shreveport, Louisiana. *Comment* (J.B.G.): agreement of Michigan and Texas dates would help place some part of Gibson aspect well within developed Middle Mississippi to north.

Pinson site series, Tennessee

Charred logs, white oak, id. by R. Yarnell, from Pinson site (Md 1), (35° 29' 40" N Lat, 88° 40' 55" W Long), Madison Co., Tennessee. Samples from post molds from floor of House 1, Area 2, located 1500 ft SW of Great Saul's mound. Should date house and associated sand and/or clay tempered pottery, the predominant ceramic assemblage at site (Fischer and McNutt, 1962). Coll. 1960 by F. W. Fischer and C. H. McNutt; subm. by F. W. Fischer for the McClung Mus., Knoxville, Tennessee.

820 ± 110

M-1362A. Pinson site, House 1, Area 2 A.D. 1130

Charred wood from fill of post molds of House 1, Area 2.

1100 ± 120

M-1362B. Pinson site, House 1, Area 2 A.D. 850

Charred wood, a second sample, from collapsed wall or roof beams, of House 1, Area 2.

General Comment (F.W.F.): M-1362B coincides with recent extreme of our original estimate based upon apparently associated Miller II ceramics (Fischer and McNutt, 1961). Discrepancy between two dates may be explained in three ways. Samples may actually represent two non-contemporaneous structures. One or both samples may have been contaminated. Third explanation offered by G. H. McNutt: only one structure is represented and computation of the standard error of difference between these two assays (Spaulding, 1958) provides value of $t = 1.72$. This indicates that difference in two dates is not significant at $p = .05$ level, and suggests that two dates might be combined, giving average of A.D. 990 ± 115.

Fatherland site series, Mississippi

Charcoal, corncobs and cane from Fatherland site, Grand Village of the Natchez (31° 32' 45" N Lat, 91° 22' 45" W Long), Adams Co., Mississippi. Mound B is historically referable Great Sun's House of the Natchez Indians and was built in four stages. Stage IV falls within the French Colonial time period, 1682 to 1729. M-1379 and M-1380 should reflect approximate beginning of the Natchez mound building occupation at site. Mound C is historic temple mound and is contemporaneous with Mound B, at least in its later phases. Also built in four stages, the last two supported temple structures (Albrecht, 1964; Neitzel, 1965). Coll. 1962 and subm. by R. S. Neitzel, Dept. of Archives and Hist., Jackson, Mississippi.

380 ± 100**M-1376. Mound A, Feature 101****A.D. 1570**

Charcoal from Mound A, Feature 101, 8 ft below surface. Grid location: N20-30, E80-90.

140 ± 100**M-1377. Mound B, Feature 30****A.D. 1810**

Burned clay and charcoal from Mound B, Feature 30 in Stage IV, 4.0 ft depth. From bed of charcoal and fired plaster, 20 in. S of S40-W55, just under humus.

425 ± 100**M-1378. Mound B, Feature 7****A.D. 1525**

Burned cane and thatch from Mound B, Feature 7, at 2.6 ft depth in S33.5-W40.6.

700 ± 110**M-1379. Mound B, Feature 7****A.D. 1250**

Charcoal from Mound B, Feature 7, an ash bed in S30-35, W50-55, floor of house structure 7.5 ft below surface of mound on pre-French Stage II surface.

770 ± 110**M-1380. Mound B, Feature 1****A.D. 1180**

Charcoal from Mound B, Feature 1 in upper loading of Stage I, 9.0 ft below surface, S40-W90.

725 ± 110**M-1381. Mound C, Feature 33****A.D. 1225**

Charred corncobs from Mound C, Feature 33 from pit in house floor of Stage III, 3.8 ft below surface, S630-640, W290-300.

680 ± 110**M-1382. Mound C, Feature 30****A.D. 1270**

Charcoal from Mound C, Feature 30, 2.0 ft depth, S650-660, W270-280.

520 ± 100**M-1383. Mound C, Feature 44****A.D. 1430**

Corncoobs and charcoal from Mound C, Feature 44, 9.0 ft depth, S630-640, W280-290, old humus layer beneath mound.

General Comment (R.S.N.): sample M-1383 from oldest surface beneath Mound C should be oldest sample in series, so something is obviously wrong. Otherwise series seems to be in order.

980 ± 110**M-1354. McLean mound, North Carolina****A.D. 970**

Charcoal, pine, id. by R. Yarnell, from McLean mound (35° 05' 10" N Lat, 78° 51' 12" W Long), Cumberland Co., North Carolina. Sample, not burned in place, was located immediately over and touching unburned bones of bundle burial 78, at depth of 14 in. from top of mound and 16 in. from mound base in Square 21, Sec. 2. Should date

near end of mound's use since sample occurs high in low circular sand mound, containing over 300 burials. McLean mound is first of class of mounds, found rather widely over coastal North and South Carolina, to yield charcoal for dating. Date should provide starting point for future work on a Late Woodland culture (plain and fabric impressed pottery, small triangular projectile points, stone pipes, and stone celts). Coll. 1961 and subm. by Lt. Col. H. A. MacCord, Richmond, Virginia. *Comment* (J.B.G.): this date appears satisfactory.

1890 \pm 130

M-1373. Holley Creek site, South Carolina

A.D. 60

Charred wood and nut shells from Holley Creek site ($33^{\circ} 19' 10''$ N Lat, $81^{\circ} 51' 50''$ W Long), Aiken Co., South Carolina. Sample found in base of fire pit ca. 26 in. from ground surface. Will date Deptford culture. Coll. 1961 and subm. by W. F. Stiles, Mus. of the American Indian, New York City. *Comment* (W.F.S.): date is satisfactory for this Deptford complex.

8380 \pm 130

M-1557. Carters Dam site, Georgia

6430 B.C.

Charcoal from Carters Dam site (9 Mu 100) ($34^{\circ} 36' 44''$ N Lat, $84^{\circ} 41' 22''$ W Long), Murray Co., Georgia. Sample found in Square A, at 66 to 72 in. depth, which was 1 ft or more beneath 48 to 60 in. zone of occupation representing Old Quartz layer defined by quartz ovate projectiles. Top 18 in. in profile represents Early Woodland including fiber-tempered and late Archaic defined by irregularly stemmed flint or chert projectiles. Late Archaic and Old Quartz levels are separated by sterile layer of homogeneous fluvial sand. Coll. 1964 by John Wear; subm. by A. R. Kelly, Univ. of Georgia. *Comment* (J.B.G.): should indicate Old Quartz culture cannot be earlier than 6430 B.C., and thus does not intervene between the Pablo-Indian and Archaic occupation in the Southeast.

Fort Center site series, Florida

Wood and charcoal from the Fort Center site ($26^{\circ} 58'$ N Lat, $81^{\circ} 26'$ W Long), $2\frac{1}{2}$ Sec. 29, R31E, T40S, W bank Fisheating Creek, Glades Co., Florida. Samples from collapsed and submerged charnel house. Wood carvings structure found at same level. Lack of ceramic change and trade sherds makes age estimate difficult. Platform pipes from deposit and earthworks suggest Hopewell. Charnel house apparently built in basin to facilitate flooding. Platform in building held burials and artifacts above high water. Coll. 1963 and subm. by W. H. Sears, Florida State Mus., Gainesville.

1340 \pm 125

M-1599. Fort Center site

A.D. 610

Wood fragments associated with burials in charnel house.

770 ± 100**M-1600. Fort Center site****A.D. 1180**

Wood fragments from deposit on floor of basin built to hold house. Sample in place when structure collapsed. Clay monitor pipes present.

1920 ± 100**M-1601. Fort Center site****A.D. 30**

Wood and charcoal fragments from basin floor deposit and from certain burials, selected for improbability of intrusion.

General Comment (W.H.S.): dates satisfactory for this complicated site. Extensive excavations are planned for the immediate future.

1550 ± 130**M-1598. Weeden Island site, Florida****A.D. 400**

Charcoal from Weeden Island site (Pi-1) (27° 45' N Lat, 81° 30' W Long), T30S, R17E, Weeden Island on W shore of Tampa Bay, Florida. From wall of midden in lowest 1 ft of 6 ft thick shell midden. Level yielding sample is early occupation of site, possibly contemporaneous with burial mound excavated by Fewkes (1924). Coll. 1962 and subm. by W. H. Sears. *Comment* (W.H.S.): date is satisfactory.

*Northeast U. S., Canada***Martins Pond site series, Maryland**

Charred hickory nuts and charcoal from Martins Pond site (39° 00' 45" N Lat, 76° 31' 30" W Long), Anne Arundel Co., Maryland. Site on W end of Martins Pond. Coll. 1964 and subm. by H. T. Wright for Mus. of Anthropol., Univ. of Michigan.

1870 ± 125**M-1605. Martins Pond site, Zone 2****A.D. 80**

Charred hickory shells from Zone 2, S3E2-3, S/MP/Z, dark humic soil 6 ft above sealevel covered by complex soil-colluvial series. Only material associated with Accokeek Cordmarked (Stephenson, Ferguson and Ferguson, 1963, p. 186-188) and Martins Pond complex. Should date 500 to 100 B.C.

50 ± 100**M-1606. Martins Pond site, Zone 4****A.D. 1900**

Charcoal from Zone 4, S/MP/Z, in dark humic soil near top of complex soil-colluvial sequence 2 ft below surface and 10 ft above sealevel. Only available sample from Sullivan Cove phase and should date A.D. 500 to 1000.

General Comment (H.T.W.): M-1605 is somewhat later than expected but is acceptable. M-1606 is substantially later than expected and has nothing to do with aboriginal occupants.

- 1370 \pm 120**
- M-1608. Luce Creek site, Maryland** **A.D. 580**
- Charcoal from Luce Creek site (39° 00' 15" N Lat, 75° 31' 00" W Long), Anne Arundel Co., Maryland. Site on SE side of Luce Creek on Henry Mann estate. Sample found in shallow oyster midden, 80 ft above sealevel. Will date Selby Bay phase and Mockley ware. Should be 200 B.C. to A.D. 300 (Stephenson, 1963, p. 189-190). Coll. 1958 and subm. by H. T. Wright for Mus. of Anthropol., Univ. of Michigan. *Comment* (H.T.W.): while somewhat later than expected, lateness seems to be true of most dates from group of samples in this area.
- 2400 \pm 150**
- M-1607. Ruf site, Maryland** **450 B.C.**
- Charcoal from Ruf site (38° 56' 50" N Lat, 76° 40' 50" W Long), Anne Arundel Co., Maryland. Site 4.0 mi WNW of Davidsonville on Abends Bros. estate. Sample found in dark humic midden overlying reddish sand B' zone and overlain by plowed soil. From type site of Selby Bay phase (Mayr, 1958). Coll. 1941 by Thomas Mayr; subm. by H. T. Wright for Mus. of Anthropol., Univ. of Michigan. *Comment* (H.T.W.): date seems too early for this complex.
- 1930 \pm 130**
- M-1482. Killarney Bay I, Canada** **A.D. 20**
- Charcoal (cat. no. 39676) from Killarney Bay I (46° N Lat, 81° 30' W Long), Ontario, Canada. Found in Trench 3 in apparent steam bath, 24 to 25 ft above Lake Huron's former 579.3 ft level. Coll. 1953 and subm. by E. F. Greenman, Mus. of Anthropol., Univ. of Michigan. *Comment* (J.B.G.): date is satisfactory for this multi-component site.
- 2390 \pm 150**
- 2250 \pm 130**
- M-1528. Tanfield site (KdDq-7), Canada** **370 B.C.**
- Charred animal fat, presumably seal blubber (Sample 3) from Tanfield site (KdDq-7) (62° 39' N Lat, 69° 37' W Long), Northwest Territories, at Cape Tanfield, Baffin Island. Mass of charred material flaked from heavily encrusted "cooking rock" at 8 in. depth below sod (total surface depth 14 in.). Site in "Tanfield Valley" 18 ft above present highest tide, which, in this specific location, puts its chronological position early in Dorset sequence; typology agrees. Midden 18 to 22 in. deep, all except top 4 in. below sod permanently frozen. Covers est. 1100 sq ft of which 80 sq ft excavated. No stratigraphic layers, apparently short occupation. Sample should provide important key to series of "Tanfield Valley" sites, of which 12 have been located from 11 to 50 ft above sealevel. Seriated typologically in single continuum from what has been called pre-Dorset through Dorset period. Will cross-check part of sample sent to Univ. of Pennsylvania C¹⁴ lab. Est. age 600 to 300 B.C. (should be slightly more recent than T1 Site, Southampton Is.). Coll. 1962 by M. S. Maxwell; subm. for Maxwell by J. V. Wright, Natl. Mus. of Canada.

Comment (M.S.M.): since this is a fragment of same sample sent for C¹⁴ analysis to Applied Sci. Center for Archaeol., age determination should ideally be same from Michigan and Pennsylvania labs. Ages arrived at by Univ. of Pennsylvania Lab. (P-698 and P-698A) are: 2594, 2618, 2628, and 2645, all ± 74 . Average age of these runs, based on half-life of 5568 and terminal date of A.D. 1950 would be 671 B.C. This date would be nearly identical with dates for similar assemblages at T-1 site. Southampton Island, and Alarnerk site, Igloodik. On basis of typological comparison, and other carbon dates, M-1528 and M-1528A seem 200 to 350 yr too recent. Discrepancy can be resolved if Pennsylvania s.d. of 74 is subtracted from their most recent age determination, and Michigan s.d. of 130 is added to their oldest determination (M-1528); thus we arrive at same figure of 2520 B.P. Furthermore, if all assessments are averaged, we arrive at 2521 B.P., or 571 B.C. Dates from 500 to 700 B.C. would be most satisfactory from current archaeological interpretation. It should be kept in mind in age determinations in this series, that there are relatively few comparative assessments based on charred fat and that some of these have produced peculiar interpretive problems.

1470 \pm 110

M-1529. Sandy site (KdDq-2), Canada

A.D. 480

Charcoal, predominantly driftwood, but with some indigenous *Salix* (Sample 9), from the Sandy site (KdDq-2) (62° 37' N Lat, 69° 32' W Long), Northwest Territories, at Juet Is. on S shore of Baffin Is. From 3rd or bottom layer of site, combined from 3 different squares. Each layer ca. 2.5 in. thick, separated by thin zones of sterile sand. Small habitation site 13.5 ft above high tide (based on lowest point of growth of salt-intolerant lichen). Late in local Dorset sequence on basis of elevation and typology. Approx. 200 sq ft completely excavated 1960 to 1963. Should provide key point at most recent end of seriation of sites, and of typologies, which includes 38 sites on S coast Baffin Is. (lag between death of tree and drift to area should be taken into account). Est. age A.D. 200 to 400. Coll. 1960 by M. S. Maxwell; subm. for Maxwell by J. V. Wright. *Comment* (M.S.M.): on basis of our current archaeological interpretation of seriation of site and assemblages on SE coast of Baffin Island, this is satisfactory date. Since age determination was based on charcoal, some of which may have come from old driftwood, cultural assemblage may be as much as 100 yr more recent, an age which would also be satisfactory. Significantly, date confirms our interpretation that in this specific region use of true stone burins (constituting 6% of total stone tool inventory of site) persists well into first millenium A.D.

2180 \pm 120

M-1530a. Avinga site (KdDq-8), Canada

230 B.C.

1790 \pm 120

M-1530b. Avinga site (rerun)

A.D. 160

Charred animal fat (Sample 27) from Avinga site (KdDq-8) (62° 39' N Lat, 69° 37' W Long), Northwest Territories, at Cape Tanfield,

Baffin Is. Scraped from 6 small cooking rocks and 1 vessel fragment from various parts of site, all locations 8 or more in. beneath sod base, well into permafrost. Site in "Tanfield Valley," 33 ft above highest tide. Lowest cultural material, at 16 in. below sod base, rests directly on water-washed beach sand. Limited testing indicates site covers at least 400 sq ft of which 200 sq ft excavated in 1963. Sample should provide important key to series of "Tanfield Valley" sites (12), and typological seriation of samples from 38 sites in general vicinity. Preliminary analysis of artifacts indicates intermediate period between what has formerly been considered pre-Dorset and Dorset. On basis of "Tanfield Valley" evidence, dividing point between the two appears to be presence of significant percentages of burins, burin-like tools, burin spalls and ground and polished slate knives, which at this site are respectively 8.11, 3.15, 9.46, and 9.01. Est. age 800 to 700 B.C. Coll. 1963 by M. S. Maxwell; subm. for Maxwell by J. V. Wright. *Comment* (M.S.M.): it seems virtually impossible that either age determination could date major assemblage of site. Subsequent analysis suggests that this is due to a number of factors, not least of which is sampling error. Since site contained no pieces of organic residue, and an age determination of assemblage was so critical in our seriation analysis, we scraped what carbon powder we could from a very few cooking rocks and one large lamp sherd. Scraping was done in open air, and we have now learned that concentrations of mold spores and pollen in air at that time of summer is very high. Conceivably this could be a source of contamination. Furthermore, analysis of field and laboratory data has virtually proved that lamp sherd, which contributed at least 75% of carbon, came from small pocket of late artifacts lying just beneath sod, and was separated from major component of site by 6 in. of sterile humus. Age differential between carbon taken from lamp sherd and that from cooking rocks is probably as much as 1000 yr.

3480 \pm 200

M-1531. Site KdDq-13, Canada

1530 B.C.

Charred animal fat dripped on sand (Sample 28) from Site KdDq-13 (62° 39' N Lat, 69° 37' W Long), Northwest Territories, at Cape Tanfield, Baffin Is. From 4 in. below surface, above permafrost. Site at 38 ft elev on N-facing slope of "Tanfield Valley." Thinly occupied. Satisfactory camping location only if sealevel 35 ft above present high tide. Site est. 1600 sq ft and 80 sq ft excavated. Assemblage appears intermediate between pre-Dorset and Dorset assemblages. Est. age 1000 B.C. (but based on inadequate amount of assemblage). Coll. 1963 by M. S. Maxwell; subm. for Maxwell by J. V. Wright. *Comment* (M.S.M.): very satisfactory date for camp site. Although cultural inventory recovered to date is small, elements of it demonstrate development of traits which become common in later Dorset sites. Typologically this agrees well with slightly later assemblage of Killilugak site dated 1093 \pm 63 by Univ. of Pennsylvania (P-699).

M-1532a. Site KdDq-8-3, Canada**3880 ± 150****1930 B.C.****M-1532b. (rerun)****3850 ± 150****1900 B.C.**

Charred animal fat cementing sand grains (Sample 29) from Site KdDq-8-3 (62° 39' N Lat, 69° 37' W Long). Northwest Territories, at Cape Tanfield, Baffin Is. From 10 in. below sod base, below permafrost line. Site intensively occupied, small pocket in rocks at "Tanfield Valley," 27 ft above sealevel. Cultural midden extending to 16 in. depth below sod base. Bottom of lowest cultural level rested on old sod surface. Site apparently first occupied some time after retreat of sea water from this level. Site not particularly valuable habitation location any time after retreat of sea water to 25 ft level. Site est. to be 400 sq ft, and 225 sq ft excavated. Sample should provide important key to what appears to be seriation of 12 sites in "Tanfield Valley." Assemblage should be early in Dorset continuum. Est. age 700 to 600 B.C. Should be slightly younger than T1 site, Southampton Is. Coll. 1963 by M. S. Maxwell; subm. for Maxwell by J. V. Wright. *Comment* (M.S.M.): major and probably only component of this small site falls within period of developed Dorset culture, and date for assemblage any earlier than 700 B.C. would do violence to interpretations of all archaeological investigators in E Arctic. Initial age determination of 1930 B.C. was so impossible that re-run was requested, which confirmed first determination. After analysis, I have resolved problem to my satisfaction. Field data indicates that charred animal fat sample came from same locally restricted zone (not more than two sq ft) as small sample of what appear to be very early stone tools. These artifacts were originally interpreted as persistent forms, but more detailed lab. analysis indicates that they are older than major part of assemblage. Since this is not enough to predicate an early component on, remaining assumptions are that sod shelters were used on site, as we use them today, that sod was cut from very early site and incorporated some artifacts and a lump of charred seal fat, which we were unlucky enough to select for dating site. Correlative information is: 1) sod is thicker on habitation sites due to increased nutrients in humus, and 2) there is pre-Dorset site (Loon site dated by Univ. of Pennsylvania, P-170—3590 ± 63 B.P) 50 yd from where charred fat was recovered. Unfortunately this situation raises some doubts about other sites in immediate vicinity and will be closely investigated.

M-1533. Kiliktee site (KdDq-19), Canada**1670 ± 150****A.D. 280**

Charred animal fat dripped on sand, cementing sand grains (Sample 30), from Kiliktee site (KdDq-19) (62° 58' N Lat, 69° 40' W Long), Itivirk Bay, Baffin Is., Northwest Territories. Depth 4 in. beneath sod base, well above permafrost line. Small site, possibly no more than two tent rings. Elevation est. at 14 ft above present high tide. Located within boundaries of Kiliktee's winter camp, and 80% of artifacts coll. by

members of Kiliktee's family. Area 15 ft by 35 ft excavated, cultural layer only 4 to 6 in. thick. Sample should provide important terminal date for Dorset culture of 38 site pre-Dorset-Dorset continuum in the Lake Harbor region. Part of continuum recognized in "Tanfield Valley" although 5 mi N of that location. Est. age A.D. 300 to 400. Typology and elevation suggest contemporaneity with Aberjar site, Igloolik, Northwest Territories. Coll. 1963 by M. S. Maxwell; subm. for Maxwell by J. V. Wright. *Comment* (M.S.M.): this age determination fits in very well with our typology seriation from vicinity of Lake Harbour, Baffin Island.

2200 ± 120

M-1534. Site KdDq-8-2, Canada

250 B.C.

Charred fat dripped on sand grains, cementing them together (Sample 32) from Site KdDq-8-2 (62° 39' N Lat, 69° 37' W Long), Northwest Territories, at Cape Tanfield, Baffin Is. From 8 in. beneath sod base, 2 in. below permafrost line. Very rich midden, 14 to 16 in. deep in "Tanfield Valley," 31 ft above present high tide. Site covers est. 400 sq ft and 150 sq ft excavated. Artifacts intermediate between pre-Dorset and Dorset. Sample should provide key to interpreting 12-site pre-Dorset-Dorset continuum in "Tanfield Valley," and 38-site Dorset continuum in region of S Baffin Is. Est. age 800 to 700 B.C. In terms of typology, elevation, and sod cover above base sand, should be 50 to 100 yr more recent than Site KdDq-8. Coll. 1963 by M. S. Maxwell; subm. for Maxwell by J. V. Wright. *Comment* (M.S.M.): despite wide discrepancy between est. age of sample and age determination, est. age was based on preliminary analysis of data, and age determination of 250 B.C. is satisfactory for part of site. There is no discernible sterile zone between two components; however, they were laid down under markedly different climatic conditions. M-1534 provides satisfactory date for more recent component and habitation of site in warmer times. Older component, culturally richer and therefore giving impression of greater age to total site, is still thought to date between 800 B.C. and 600 B.C.

2410 ± 120

M-1535. Nanook site (KdDq-9-1), Canada

460 B.C.

Charred animal fat cementing sand grains and pieces of seal skin (Sample 33) from Nanook site (KdDq-9-1) (62° 39' N Lat, 69° 37' W Long), Northwest Territories, at Cape Tanfield, Baffin Is. From 12 in. beneath sod base. Area of site est. at 3600 sq ft and 325 sq ft excavated. Midden 20 to 24 in. deep, all except top 6 in. in permafrost. Lack of drainage makes possible contamination by modern microorganisms. Should be slightly more recent than sample from Site KdDq-9, Component 2 (under analysis by Univ. of Pennsylvania lab.). Not beach site. Probably occupied in winter at time when sealevel almost 25 ft higher than present. Typology fits into 12-site continuum for "Tanfield Valley." Est. date 700 to 600 B.C. Typology suggests coeval with Site KdDq-8-3. Actual elevation of site 40 ft. Coll. 1963 by M. S. Maxwell; subm. for

Maxwell by J. V. Wright. *Comment* (M.S.M.): date of 460 B.C. seems 400 yr too early, not on basis of est. age, but on basis of Univ. of Pennsylvania dates for what has been thought to be simply another part of same site 20 ft to SW. From this latter location, identified as KdDq-9-2, willow twigs in permafrost at a depth of 6 to 8 in. were 1840 ± 53 B.P., and sod buried in permafrost between two cultural layers was 1929 ± 53 B.P. (P-706 and P-704). In field these two excavation units were treated separately, but analysis of field and lab. data has indicated their virtual identity, both qualitatively and quantitatively. Furthermore, KdDq-9-2 are equally unique in having so few soapstone lamp sherds that they constitute less than 1% of artifact inventory—suggesting occupation either in warm seasons and/or warm yr. Admittedly, sample M-1535 comes from deeper in midden. One solution to problem is that sufficient cultural conservatism on this site, occupied only in summer months over 500 yr span, would not display marked stylistic differences in kind or relative frequency of tools (this is not at variance with my basic contention that in this series of 38 sites spanning 3000 yr, process of cultural change as reflected by artifacts is remarkably slow). Another possible solution is more critical because it throws doubts on majority of dates from Lake Harbour vicinity. It should be noted that more recent dates (P-704 and P-706) are based on samples of sod and willow twigs, whereas older date is based on charred fat (presumably seal blubber) and seal skin (M-1535). At Port aux Choix site Elmer Harp (pers. commun.) has found that with regularity charred seal fat dates and charcoal dates from same houses vary by nearly same order of magnitude, with seal fat always older than charcoal dates.

U. S. Great Plains

320 \pm 100

M-1368. Burkett site, Nebraska

A.D. 1630

Charcoal (No. 590) from Burkett site (25NC1) ($41^{\circ} 25' 16''$ N Lat, $97^{\circ} 47' 35''$ W Long), Nance Co., Nebraska. NE $\frac{1}{4}$ Sec. 29, T17N, R4W. Sample found in storage pit intrusive in refuse deposit. Site is of Lower Loup focus, and specimen should date middle occupation of site. Should be ca. A.D. 1500 to 1650: Protohistoric Pawnee (Dunlevy, 1936; Grange, 1962). Coll. 1940 by A. T. Hill; subm. by M. F. Kivett, Nebraska Hist. Soc., Lincoln, Nebraska. *Comment* (M.F.K.): date is acceptable but somewhat late in terms of previous estimates and relative amounts of contact materials. Date of 1530 would be more satisfactory in my opinion.

270 \pm 100

M-1369. Wright site, Nebraska

A.D. 1680

Charcoal (No. 161) from Wright site (25 Nc3) ($41^{\circ} 26' 21''$ N Lat, $97^{\circ} 45' 25''$ W Long), Nance Co., Nebraska. NW $\frac{1}{4}$ Sec. 23, SE $\frac{1}{4}$ Sec. 15, NE $\frac{1}{4}$ Sec. 22, T17N, R4W. Sample found in House 5 on floor with 50 scattered human skeletons, interpreted as evidence of attack on village.

Wright site is of Lower Loup focus. Should date middle occupation of site. Should be ca. A.D. 1650 to 1750: Protohistoric Pawnee (Grange, 1962; Kivett, 1958). Coll. 1936 by A. T. Hill and George Lamb; subm. by M. F. Kivett. *Comment* (M.F.K.): date is in agreement with previous estimates based on artifact inventory. Trade goods are relatively common in comparison to Burkett site.

Western U. S.

Wilson Butte cave series, Idaho

Bone from Wilson Butte cave ($42^{\circ} 45' N$ Lat, $114^{\circ} 15' W$ Long), Jerome Co., Idaho. Coll. 1959 and 1960 by Ruth Gruhn; subm. by E. H. Swanson, Idaho State Univ. Mus., Pocatello, Idaho.

M-1409. Wilson Butte cave, Stratum C **14,500 \pm 500**
12,550 B.C.

Bone from Wilson Butte cave, Stratum C, lower zone of grey/brown sand. A pooled sample, from Square T_8S_5 (depth 160 to 200 cm below T_8S_6), Square $T_{11}S_2$ (depth 210 to 280 cm below St. $T_{11}S_2$), and Square $T_{11}S_4$ (depth 220 to 320 cm below St. $T_{11}S_4$). Sample should date early period of deposition of grey/brown sand. Character of sediment and microfaunal remains indicates cool moist climate. Should date ca. 8000 to 9000 B.C. Extinct fauna: horse, camel, sloth. Associated artifacts: Assemblage I (Gruhn, 1961).

M-1410. Wilson Butte cave, Stratum E **15,000 \pm 800**
13,050 B.C.

Bone from Wilson cave, Stratum E, yellow/brown clay. Square T_9S_1 , depth 200 to 300 cm below St. T_8S_1 . Earliest deposit in cave and expected to antedate 10,000 B.C. Microfaunal remains indicate cool moist climate. Extinct fauna; horse, camel, and possibly bird. Associated artifacts: two fragments of bone with cuts marks.

General Comment (R.G.): since artifacts are associated, these dates place Wilson Butte cave among earliest dated archaeological sites in North America (Gruhn, 1961).

M-1466. 18 Mile Bend Site, New Mexico **820 \pm 110**
A.D. 1130

Bison bone from P4B (Mesita Negra phase) component of L8 Mile Bend site ($34^{\circ} 14' N$ Lat, $104^{\circ} 13' W$ Long), De Baca Co., New Mexico. From Trench 2 at 8 to 10 in. level (Jelinek, 1960). Coll. 1960 and subm. by A. J. Jelinek, Mus. of Anthrop., Univ. of Michigan. *Comment* (A.J.J.): date as expected on basis of intrusive Anasazi ceramics.

Mexican, Central South America

La Quemada series, Mexico

Charcoal and wood from La Quemada ($22^{\circ} 27' N$ Lat, $102^{\circ} 49' W$ Long), State of Zacatecas, Mexico. Should date building and destruction

of a number of conjoined rooms on SE side of acropolis. Samples from same room as M-430 and M-331 (Michigan II). Coll. 1964 by Ignacio Armillas and Peter Taylor; subm. by Pedro Armillas, Southern Illinois Univ.

M-1651. La Quemada, Room 3 **1230 ± 120**
A.D. 720

Charcoal (LQW1) found in rubble filling Room 3, above adobe floor and 1.56 in. below datum. Probably fragment of charred beam. Should date construction of roof.

M-1652. La Quemada, Room 4 **1540 ± 120**
A.D. 410

Wood (LQW22) from beam above floor of Room 4, one of several partially turned parallel beams that had supported adobe roof.

M-1653. La Quemada, Room 4 **1230 ± 120**
A.D. 720

Charcoal (LQW35) from N post, one of two posts that supported roof of room. Stumps were found under debris of roof. Should date construction of room and be roughly contemporary with M-1652 and M-1654.

M-1654. La Quemada, Room 4 **1080 ± 120**
A.D. 870

Wood (LQW38) from S post, Room 4.

M-1655. La Quemada, Room 4 **1180 ± 120**
A.D. 770

Charcoal (LQW13 and LQW28) lying in rubble on hard adobe assumed to be upper surface of roof in Room 4, from Excavation Blocks 1 to 5.

M-1656. La Quemada, Room 4 **770 ± 110**
A.D. 1180

Small charcoal sample (LQW25) lying in rubble of Room 4 from Excavation Blocks 3, 4, and 5.

M-1658. La Quemada, Room 4 **1020 ± 120**
A.D. 930

Charcoal from hearth in rubble of Room 4, 50 cm above upper surface of fallen roof and 50 cm below present ground. Several stones placed in circle (diam 1½ m) around fire. Animal bones and broken pot in same general area. Definitely post-dates destruction of house, but does not necessarily date event. Fire may have been lit long after building was ruined.

General Comment (J.B.G.): dates conform with archaeological interpretations.

La Presa de Ambosco series, Mexico

Charred beans and corn from La Presa de Ambosco (22° 27' N Lat, 102° 49' W Long), State of Zacatecas, Mexico. A village site located on

plain of Malpaso River Valley, 6 km from La Quemada to SW. Coll 1964 and subm. by Pedro Armillas.

1100 \pm 120

M-1659. La Presa de Ambrosco, House 2 A.D. 950

Charred beans from House 2, Bin 2, one of twin sunken bins adjacent to house; bottoms and walls of these pits were plastered with hard adobe.

960 \pm 110

M-1660. La Presa de Ambrosco, House 2 A.D. 990

Charred corn seeds from House 2, Bin 1.

General Comment (J.B.G.): dates conform with archaeological interpretations.

1300 \pm 130

M-1580. Mejicanos site (Site C), Guatemala A.D. 650

Shell, *Spondylus princeps* Broderip, from Mejicanos site (14° 25' N Lat, 90° 34' W Long), on S shore of Lake Amatitlán, Guatemala, adjacent to Lavadores underwater site 1A and 1B. Sample found in cache in mound inside Esperanza fleshware cylindrical tripod vessel, with jadeite bead. Traditional date for ware is A.D. 300 to 600. Underwater archaeological specimens from Lavadores appear to be mostly Esperanza types (Middle Classic). Date from Mejicanos will therefore help date Lavadores underwater archaeological complex (Borhegyi, 1960). Coll. 1963 and subm. by S. F. Borhegyi, Milwaukee Public Mus., Milwaukee, Wisconsin. *Comment* (S.F.B.): date is satisfactory.

Africa, Europe, Siberia

Gebel Silsileh series, Egypt

Charcoal from Locality III at Gebel Silsileh (24° 28' N Lat, 32° 57' E Long), near Kom Ombo, Upper Egypt. Charcoal was collected from uppermost of two archaeological levels in stratified site ca. 4 km from present Nile. Site has been buried in late Pleistocene Nile silts. Charcoal was associated with Late Pleistocene industry, the *Sebekian*, in occupation level rich in faunal materials and artifacts. Present dates were run to assist in checking discrepancies in dates from Michigan and Isotopes Inc. labs. (Smith, 1964; Crane and Griffin, 1965). Site was investigated by Canadian Prehistoric Expedition to Nubia for Natl. Mus. of Canada. Coll. 1963 and subm. by P. E. L. Smith, Univ. of Toronto.

M-1641. Gebel Silsileh, Locality III, 13,611 \pm 600
Square 14-J, Level 1 11,661 B.C.

Charcoal from Square 14-J, Level 1, upper part, associated with flint tools of Sebekian culture and animal bones.

M-1642. Gebel Silsileh, Locality III, 15,200 \pm 700
Squares 17-O and 18-O 13,250 B.C.

Charcoal from Squares 17-0 and 18-0, a hearth area, and associated with Sebekian flints and animal bones.

General Comment (P.E.L.S.): reasons for the discrepancies are not clear.

Monastery of St. Catherine series, Egypt

Wood from Church of the Transfiguration in Monastery of St. Catherine (28° 44' S Lat, 34° 00' E Long), Sinai Peninsula, Egypt. Coll. 1960 and 1963 and subm. by G. H. Forsythe, Kelsey Mus., Univ. of Michigan.

1435 \pm 120

M-1673. Church of the Transfiguration nave A.D. 515

Wood from truss of roof over nave of church. From diagonal strut against king post. Roof of central nave is unique example of Byzantine carpentry. Once sheathed with lead plates, its stout struss construction is still in perfect condition. One of lower chords bears inscription of Emperor Justinian which appears to date chord between A.D. 548 and 565.

1215 \pm 120

M-1674. Church of the Transfiguration nave A.D. 735

Wood from truss of roof over nave of church. Sample is from side board against lower chord of truss.

1315 \pm 120

M-1675. Church of the Transfiguration nave A.D. 635

Wood from truss of roof over nave of church. Sample is from decorative molding applied to lower chord of truss.

1700 \pm 120

M-1676. Church of the Transfiguration gable A.D. 250

re-run 1500 \pm 120

A.D. 450

Wood from part of chassis used to hold in position circular window (oculus), composed of glass panes set in plaster at E end of church in a gable. On basis of other structural and archaeological evidence, this appears to be Byzantine window of sixth century A.D. still *in situ*, and therefore earlier by 500 yr than other comparable windows now in place.

150 \pm 100

M-1677. Church of the Transfiguration nave A.D. 1800

re-run 0 \pm 100

Wood from truss of roof over nave of church. Sample is from N end of lower chord.

General Comment (G.H.F.): dates seem to be reasonable except for M-1677 which should not be modern. Additional comparable specimens will be run in the future.

Date lists:

Michigan V	Crane and Griffin, 1960
Michigan IX	Crane and Griffin, 1964
Texas II	Tamers, Pearson and Davis, 1964
Yale VII	Stuiver and Deevey, 1962
Yale VIII	Stuiver, Deevey and Rouse, 1963

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MONACO RADIOCARBON MEASUREMENTS II

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This series reports some of the measurements made since publication of the previous list. Chemical preparation of samples is basically the same as described in Monaco I.

The counting electronics of the proportional counter has been entirely rebuilt by J. Galliot and P. Albertinoli of C.S.M. The new device is transistorized and battery-operated. At regular intervals of time, usually 10 min, the count (anti-coincidence channel) is printed in tape. Large deviations from the mean are easily visible and can lead to rejection of the measurement if the distribution is not normal, i.e. does not fit a straight line on Gaussian paper.

No δC^{13} measurements have been made, and carbonate substances are dated by reference to the standard without correction. All the ages have been calculated using the formula

$$T = - \frac{t_{1/2}}{\ln 2} \ln (1 + 10^{-3} \times \delta C^{14})$$

$$\text{where } \delta C^{14} = \frac{\text{Sample Activity} - 0.95 \text{ NBS Activity}}{0.95 \text{ NBS Activity}} \times 1000$$

C^{14} half life value $t_{1/2} = 5568 \pm 30$ yr. The reference year is 1950.

Precision measurements are given with one standard deviation, calculated by combining deviations of the unknown sample, the background and the modern sample, these last two taken over a period of several weeks with at least three independent fillings. When the net sample activity, with a standard deviation σ , is less than 2σ above the background, an infinite age is reported, and when the activity is greater than 0.95 NBS minus 2σ , a modern date is given.

Besides the dates reported here, a series of ten measurements has been made of C^{14} content of surface and deep sea-water of the north Indian Ocean, collected in 1963 (Thommeret and others, 1965).

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

*A. France***Beaulieu Canyon series, Alpes Maritimes**

Three samples taken in May 1961 in Beaulieu submarine canyon, from R/V Winnaretta Singer. Coll. and subm. by M. Gennesseaux, Lab. de Géog. Physique et Géol. Dynamique, Faculté des Sci. Paris.

MC-22. Beaulieu Canyon 1**18,200 \pm 1000****16,250 B.C.**

Piece of bryozoan, 12 mm diam, taken in core no. 123 ($43^{\circ} 34' N$ Lat, $7^{\circ} 26' E$ Long), 1080 m depth in axis of canyon.

MC-24. Beaulieu Canyon 2 **22,800 ± 1000**
20,850 B.C.

Compact ooze from canyon wall taken at 1950 m depth, dredging no. 677 (43° 38' N Lat, 7° 27' E Long). Grain-size fractions are 0.25 to 0.08 mm.

MC-25. Beaulieu Canyon 3 **20,300 ± 1000**
18,350 B.C.

White, very compact bottom ooze, dredging no. 677. Grain-size fractions are 0.25 to 0.08 mm.

General Comment (M.G.): measurements show a type of sedimentation essentially pelagic on the continental slope during Würmian period and prove recent submarine erosion involving formation of some canyons; MC-22 suggests outcrop of old compact deposits in head of canyon and their erosion by slumping.

Monaco series

MC-52. Monaco 1 **21,000 ± 1000**
19,050 B.C.

Shells of *Pteridochiton* L. from sea-deposit at +2.5 m above present sealevel, found near S entrance of road tunnel under Rock of Monaco (43° 43' 50" N Lat, 7° 25' 3" E Long). Coll. 1957 by members of Assoc. de Préhistoire et de Spéléologie; subm. by L. Barral, Conservator of Musée d'Anthropol. Préhistorique de Monaco.

MC-53. Monaco 2 **16,600 ± 700**
14,650 B.C.

Organic matter from sandy tubes ("Hermelles") of the polychaetous worm *Sabellaria alveolata* (L.). Coll. as MC-52. *Comment* (L.B.): MC-52 and MC-53 may date a sealevel of last interstadial Würmian period ($W_{III} - W_{IV}$).

MC-54. Monaco 3 **>30,000**

Big shell of *Spondylus gaederopus* L. from colony found in small rocky cavity at +16 m level, in the course of grading works, Boulevard Charles III (43° 43' 52" N Lat, 7° 24' 52" E Long). Coll. by Travaux Publics de Monaco; subm. by L. Barral. *Comment*: date given is that of carbonate fraction, but no deduction can be drawn, as there is a large difference of age (more than 15,000 yr) between internal and external parts of the shell.

MEDITERRANEAN OPEN-SEA CORES

Samples from two piston-cores, taken at area distant from coast in western basin of Mediterranean Sea. Coll. summer 1962 from R/V Calypso; subm. by J. Ros, Centre des Faibles Radioactivités, C.N.R.S., Gif sur Yvette, (S. & O.), France.

Core no. 16 series

Taken at depth 2460 m (41° 22' N Lat, 05° 53.5' E Long), sedimentary column is 170 cm long and shows two layers: an upper yellow mud (0 to 117 cm), overlying sand (117 to 170 cm). Two foraminiferan layers are found in mud portion at 14 and 60 cm. Ca. 42% CaCO₃. The coarse fraction (>40 μ) is below 10% and composed of shells of foraminifera. Deeper sand appears homogeneous in grain size and the coarse fraction is almost constant. All samples analyzed are bulk CaCO₃ from mud section.

MC-27. C 16, 0-10 cm	3400 \pm 200
	1450 B.C.
MC-28. C 16, 17-25 cm	6350 \pm 300
	4400 B.C.
MC-29. C 16, 47-56 cm	13,200 \pm 470
	11,250 B.C.
MC-30. C 16, 100-108 cm	25,700 \pm 1400
	23,750 B.C.

Comment (J.R.): MC-27 value agrees with results obtained at C.F.R. (Saclay I). As reworked carbonate may have been present, age should be considered maximum. Sedimentation rate is markedly constant: 5 to 21 cm, 5.3 cm/1000 yr; 21 to 51 cm, 4.3 cm/1000 yr; 51 to 104 cm, 4.2 cm/1000 yr.

Core no. 18 series

Taken at depth 2525 m (41° 02.5' N Lat, 05° 35.5' E Long). Sedimentary column of 88 cm long is composed of yellow mud, containing foraminiferan and pteropod layers. Average content of CaCO₃ is 53%. Coarse fraction averages 14% and is composed of shells of foraminifera and pteropods. All C¹⁴ analysis made on the bulk CaCO₃.

MC-31. C 18, 0-4 cm	3050 \pm 220
	1100 B.C.
MC-32. C 18, 21-27 cm	6250 \pm 200
	4300 B.C.
MC-33. C 18, 42-50 cm	6960 \pm 200
	5010 B.C.
MC-34. C 18, 60-66 cm	9840 \pm 400
	7890 B.C.

General Comment (J.R.): MC-31 value of surface layer 0 to 4 cm similar to MC-27. Sedimentation rate is very irregular as in most other Mediterranean cores but unlike core no. 16: 2 to 24 cm, 6.8 cm/1000 yr; 24 to 46 cm, 31.0 cm/1000 yr; 46 to 63 cm, 5.8 cm/1000 yr.

*B. Lebanon***Lebanon littoral series, Tabarja**

The Lebanon shore shows, all along its rocky limestone coast, a peculiar facies called "le trottoir" (the bench), constituted by tabular agglomerates of sessile gastropod mollusks, *Vermetus* sp. At coast NE of Beirut, between Nahr Ibrahim River and Bay of Jounieh, a raised blackish bench lies behind infra-littoral bench, at ca. 1 m above present sea-level. Upheaval of higher bench seems to result from a recent tectonic movement, as suggested by remains of pottery and tiles found in the dead bioherm. Samples coll. Oct. 1964 and subm. by M. Fevret, Lab. de Géog. d'Aix, France, and P. Sanlaville, Inst. de Géog. de Beyrouth, Lebanon.

MC-63. Tabarja 1 **1635 ± 130**
A.D. 315

MC-64. Tabarja 2 **1560 ± 140**
A.D. 390

MC-63 and MC-64: fossil shells of *Dendropoma petraeum* (Monterosato) from upper bench of Tabarja (34° 02' N Lat, 35° 37' E Long).

MC-65. Tabarja 3 $\delta C^{14} = +19 \pm 13\%$

Shells of living *Dendropoma* taken at Bouar Tabarja (34° 03' N Lat, 35° 37' E Long) on present mediolittoral bench.

General Comment (M.F. and P.S.): age found for MC-63 and MC-64 confirms that upheaval of higher bench is related to one of the seisms which affected Lebanon shore in late Roman Empire or early medieval time and may correspond to earthquake that destroyed Beirut in A.D. 551. MC-65 shows enrichment of the biocenosis by recent C^{14} bomb effects. Thus no correction needed for MC-63 and MC-64.

C. Viet Nam

MC-60. Glacière de Cholon **12,230 ± 270**
10,280 B.C.

Wood from 68.6 m depth below surface in boring in "Glacière de Cholon" (Quaternary alluvium of Donnaï delta), Saïgon, South Viet Nam (10° 45' N Lat, 106° 39' E Long). Coll. 1962 and subm. by E. Saurin, Univ. of Saïgon, Viet Nam. *Comment* (E.S.): age shows rapid filling in area, considered to be part of Mekong-Donnaï delta since the end of Würm.

II. ARCHAEOLOGIC SAMPLES

A. France

MC-55. Beaulieu sur Mer, Alpes Maritimes **27,500 ± 1400**
25,550 B.C.

Carbonaceous earth from a well-characterized fireplace (2 m long, 30 cm thick) found at 4 m below present ground level, on a paleosol from an interstadial Würmian loess deposit (probably $W_{II} - W_{III}$). This paleosol, included in a defined stratigraphy, is overlain by strongly red-

dened clay layer, another paleosol spotted with pseudo-mycelium (2 m thick), and present ground, Beaulieu sur Mer ($43^{\circ} 42' 9''$ N Lat, $7^{\circ} 11' 40''$ E Long). Coll. 1961 and subm. by G. Jaworsky, Musée d'Anthropol. Préhistorique de Monaco. *Comment* (G.I.): date confirms human occupation in area at very early epoch.

2500 ± 100

MC-81. Annecy lacustrine city, Haute Savoie

550 B.C.

Section of hard Quercus wood, diam 2 in., found in Lake of Annecy; from "Palafitte" ("Lake Dwellers'") city of Roselet, near Duingt ($45^{\circ} 50'$ N Lat, $6^{\circ} 10'$ E Long). Coll. June 1963 and subm. by Dr. P. Servettaz. *Comment*: date, though very young, could correspond to late Alpine Bronze Age and thus agree with expectation (Blanchard, 1958, p. 31-33).

B. Viet Nam

Hang Gon series

Two samples of charcoal found in field of burial urns (used for cremation burials) on archaeological site of Hang Gon, near Xuan Loc, South Viet Nam ($10^{\circ} 48'$ N Lat, $107^{\circ} 15'$ E Long). Coll. Jan. 1963 and subm. by E. Saurin.

2190 ± 150

MC-61. Hang Gon 1

240 B.C.

Charcoal found in Jar no. 1.

2300 ± 150

MC-62. Hang Gon 2

350 B.C.

Charcoal found around jars.

General Comment (E.S.): it is reasonable to suppose that these samples of charcoal were contemporaneous with the jars, in or around which they were found. Their age supplies date for "Sa Yuinh" culture which developed on S coast of Viet Nam and influenced neighbouring regions of Philippines and Malaya. Archaeological estimates indicated date near the beginning of the Christian era, and are confirmed.

III. ATMOSPHERIC RADIOCARBON

Atmospheric radiocarbon series, Monaco

The following list covers samples of atmospheric CO_2 measured since 1962 to determine increase of C^{14} in air. For each measurement 2 L 0.5N carbonate-free NaOH are exposed to atmospheric CO_2 for 5 days, in a plastic tray on terrace of Musée Océanographique de Monaco ($43^{\circ} 43'$ N Lat, $7^{\circ} 25'$ E Long, alt 80 m). Site is believed to be far enough from domestic and industrial fuel sources.

		$\delta\text{C}^{14}\text{‰}$
MC-66.	Aug. 1962	349 ± 10
MC-67.	Dec. 1962	353 ± 10
MC-69.	Aug. 1963	754 ± 15

MC-70.	May	1964	957 ± 15
MC-71.	Aug.	1964	850 ± 15
MC-72.	Nov.	1964	828 ± 15
MC-73.	Nov.	1964	740 ± 15
MC-74.	Feb.	1965	751 ± 15
MC-75.	May	1965	809 ± 15
MC-76.	Aug.	1965	814 ± 15

MC-72 was coll. on top of Mont Agel (43° 46' N Lat, 7° 25' E Long, alt 1095 m), far from houses, roads and factory smoke, to compare with MC-73, coll. near sealevel. *Comment:* results are in close agreement with those published by other labs. (Uppsala VI, UCLA IV).

Modern organisms series

MC-77. Modern organisms 1 $\delta C^{14} = +751 \pm 15\%$

Buds of sea-pines grown near sealevel in Monaco. Coll. June 1965.

MC-58. Modern organisms 2 $\delta C^{14} = +93 \pm 10\%$

Shells of *Mytilus galloprovincialis*. Coll. alive March 1964 on rocks of Cape Martin at sealevel (43° 45' N Lat, 7° 29' E Long).

MC-80. Modern organisms 3 $\delta C^{14} = +113 \pm 10\%$

Bryozoan: *Retepora cellulosa*. Coll. July 1965 by diving near Musée de Monaco at 35 m depth.

General Comment: measurements are part of a work intended to determine relative rapidity of C^{14} transfer from air into terrestrial plants and shallow-water marine organisms.

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RADIOCARBON DATING IN THE VERNADSKY INSTITUTE I-IV

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Results of absolute age determination by the radiocarbon method, obtained in the Radiocarbon Laboratory of the Vernadsky Institute are given in this article. The counting of natural C^{14} activity was realized by measuring the gaseous carbon compounds— CO_2 and C_2H_6 —with the aid of a proportional counter. Investigation objects were wood, peat, coal, plant and animal remains and other organic material. All samples were preliminarily treated with hot 2% NaOH and 5% HCl to remove foreign humic acid and carbonate. Carbon dioxide, which was obtained after burning, was freed of electronegative admixtures by purification with the aid of CaO. Ethane was synthesized from the sample carbon through the following stages: natural sample $\rightarrow CO_2 \rightarrow CaCO_3 \rightarrow CaC_2 \rightarrow C_2H_2 \rightarrow C_2H_6$. The counting gas was let into the counter up to a pressure of 2 atm. Counters of stainless steel or copper of different volumes from 0.5 to 2 litres were used. The screening of the counters was effected by steel (24 cm thick) and mercury (2.5 cm thick) shields; the counter together with the mercury shield was enclosed in a circle of Geiger counters of the GS-60 type arranged in anti-coincidence. A detailed description of the methods, the constructions and the apparatus has been published (Vinogradov, Devirts, Dobkina, Markova, Martishchenko, 1961).

At the present time the background of a copper counter with a working volume of 1.5 L, at a pressure of 2 atm for CO_2 , is 6.3 counts/min, the standard counting 16.0 counts/min. The ethane measurement in a similar counter is carried out in a steel chamber, where besides the mentioned shielding an additional screen of a paraffin and boric acid mixture is established, the background in this case being 8.7 counts/min, the standard counting 36.5 counts/min. Each sample was measured twice, the measurement duration was ca. 24 hr, or 48 hr if necessary.

Wood from a thirty-year-old birch which had been felled in 1908 in Kamtchatka was used as a recent standard. For the verification of the recent standard it was compared with oxalic acid from the U.S. Natl. Bureau of Standards, which we had at our disposal. The oxalic acid activity, multiplied by a coefficient 0.95, coincided with the activity of our recent standard. All datings, given in this article, are calculated on the basis of the value of C^{14} half-life, which is 5568 ± 30 yr. As all ages in the present collection of papers were calculated as years before A.D. 1950, we have where necessary counted anew the previously published data, chiefly for archaeological and some geological samples of young age. For the elucidation of possible C^{14} variations in the past we carried out a mass-spectrometric analysis of the C^{13}/C^{12} value in CO_2 from fossil

samples of various ages, up to 35,000 B.P. The isotopic ratio values were compared with the C^{13}/C^{12} values in the contemporary standard. No considerable deviations were noted; therefore for the samples below a correction for $\Delta C^{14} = 28 C^{13}$ was not introduced. Absence of isotopic fractionation in the synthesis of ethane has also been established with the aid of mass-spectrometric determinations.

The chief line of investigations was connected with the subject "Paleogeography and chronology of the Upper Pleistocene and Holocene in the north-western European part of the USSR". The work was carried out together with the Geographical Institute of the Academy of Sciences, the scientific workers of which collected the material. A detailed consideration and interpretation of the results obtained was published in the Collected Papers to the VIIth Congress of INQUA which took place in August 1965, in USA (Paleogeography and Chronology of the Upper Pleistocene and Holocene According to Data of the Radiocarbon Method, 1965).

Most of the datings below were published by the authors in 4 communications (Vinogradov, Devirts, Dobkina, Markova, Martishchenko, 1956; the same authors, 1959; Vinogradov, Devirts, Dobkina, Markova, 1962; the same authors, 1963); some datings are published for the first time.

The sample descriptions were kindly given by specialists who collected the samples; the authors express their thanks to them.

SAMPLE DESCRIPTIONS

I. GEOLOGICAL SAMPLES

A. Peat and lake deposits of the Holocene

The material was selected from a series of key sections of peat bogs from the territory of the central and NW regions of the Russian plain.

The formation of these peat deposits dates from the disappearance of the last (Valdai) glaciation from the mentioned territory. The data obtained must characterize the time of retreat of the ice sheet and the evolutionary history of peat deposits in the Holocene—establishment of the chief stages of the vegetative cover and the climatic conditions. In addition, one other peat deposit from territories near the Black Sea was investigated, the well-known Imnat bog. The great thickness of its peat layers spans the history of Holocene events in the Caucasus. The sampling in each section was carried out layer by layer, taking into account the stratigraphy of the whole thickness of the peat deposit. Usually 5-10 samples were selected, as far as possible on the boundaries of vegetative zones, in order to establish the duration of each climatic phase.

Preliminary age estimations (before C^{14} dating) are given on the basis of the pollen-and-spore analysis.

Shuvalovo Peat Bog series

The Shuvalovo peat bog is located on the northern outskirts of the city of Leningrad (60° 00' N Lat, 30° 20' E Long). The choice of the Shuvalovo deposit as well as of the following—the Osechenski mokh—was determined by the fact that these peats were widely known and may be considered as classical examples of high peat bog types, such as are characteristic of the central and NW regions of the European part of USSR. Sampling of the Shuvalovo peat bog was carried out from an open exposure in the N part of the peat bog, where the deposit is exposed down to the mineral substratum. The general thickness of the peat deposits was 3.18 m; they are underlain by sands with clay intercalations. Samples were coll. 1962 and subm. by M. I. Neistadt (Geog. Inst. of the Acad. Sci., USSR).

Mo-319. Shuvalovo

3200 ± 190
1250 B.C.

Sphagnum peat, decomposition degree 5-10%, taken from a depth of 1.30 to 1.35 m. The supposed age is 2500 to 3000 yr.

Mo-320. Shuvalovo

4820 ± 260
2870 B.C.

Woody cotton-grass peat, border horizon, decomposition degree 50-60%, sampling depth 1.70 to 1.75 m. The supposed age is 5000 to 5500 yr. In this horizon a great amount of root, stump, stem remains are met. The age of pine wood from this horizon (Mo-325) was also determined.

Mo-321. Shuvalovo

7790 ± 265
5840 B.C.

Woody cotton-grass peat, decomposition degree 55-60%, sampling depth 2.10 to 2.15 m. The supposed age is 7500 to 8000 yr.

Mo-322. Shuvalovo

8600 ± 310
6650 B.C.

Sphagnum (with Hypnum) peat, decomposition degree 10-15%, sampling depth 2.40 to 2.45 m. The supposed age is 8500 yr.

Mo-323. Shuvalovo

8770 ± 295
6820 B.C.

Reed peat, decomposition degree 10-15%, sampling depth 2.82 to 2.87 m. The supposed age is 8500 to 9000 yr.

Mo-324. Shuvalovo

8720 ± 275
6770 B.C.

Woody peat, well decomposed (to 50%); sampling depth 3.13 to 3.18 m. The supposed age is more than 9000 yr.

Mo-325. Shuvalovo

4125 ± 195
2175 B.C.

A sawn piece of root from a border horizon (see Mo-320). Taken from a depth of 1.35 to 1.85 m. The supposed age is 4000 to 5000 yr.

Osechenski Mokh Peat Bog series

The Osechenski mokh deposit is situated in the Kalinin province near the town Vyshni Volochok (57° 30' N Lat, 34° 50' E Long). The sampling was carried out from a slope, previously prepared by stripping back 1.25 m from the ditch border, to exclude the possibility of contamination. The general thickness of the peat deposit is 2.58 m. Selections were carried out by M. I. Neistadt in 1962.

1605 ± 170
A.D. 345

Mo-326. Osechenski mokh
Sphagnum—cotton-grass peat, decomposition degree 10-15%, sampling depth 0.75 to 0.80 m. The supposed age is not over 2500 yr.

2885 ± 185
935 B.C.

Mo-327. Osechenski mokh
Cotton-grass—Sphagnum peat, decomposition degree 35%, sampling depth 1.02 to 1.07 m. The supposed age is not over 4500 yr.

3820 ± 195
1870 B.C.

Mo-328. Osechenski mokh
Woody (pine) peat, decomposition degree 50-60%. Sampling depth 1.20 to 1.27 m, border horizon. The supposed age is not over 4500 yr.

6945 ± 250
4995 B.C.

Mo-329. Osechenski mokh
Sphagnum—Carex peat with cotton grass, sampling depth 1.70 to 1.75 m. The supposed age is not over 7700 yr.

9300 ± 215
7350 B.C.

Mo-330. Osechenski mokh
Peat (*ryzhak*, of Carex and reeds with wood remains), depth 2.25 to 2.30 m. The supposed age is over 9800 yr.

9575 ± 305
7625 B.C.

Mo-331. Osechenski mokh
Woody peat, decomposition degree 50-60%, depth 2.50 to 2.58 m. The supposed age is about 9800 yr.

Tiosovo-Netylskoye Peat Bog series

The peat bog is located in the Novgorod province NW of Novgorod (58° 45' N Lat, 31° 00' E Long). The samples were taken from the ditch; the face of the ditch was cut back by 1.25 m. The total section depth is 4.25 m. Basal layer, 3.4 m to 4.25 m, is light-olive-colored sapropel, becoming sandy downward. The samples were selected in 1962 by M. I. Neistadt and N. A. Khotinsky (Geog. Inst.).

490 ± 140
A.D. 1460

Mo-347. Tiosovo-Netylskoye
Sphagnum fuscum peat; decomposition degree 5%, sampling depth 0.25 to 0.30 m. The supposed age is 300 to 500 yr.

1575 ± 165
A.D. 375

Mo-348. Tiosovo-Netylskoye
 Sphagnum—cotton-grass peat, sampling depth 0.65 to 0.73 m. The supposed age is 1000 to 1400 yr.

2875 ± 120
925 B.C.

Mo-349. Tiosovo-Netylskoye
 Woody *Carex* peat, greatly decomposed, bedding depth 1.05 to 1.10 m. The supposed age is 3000 yr.

3730 ± 200
1780 B.C.

Mo-350. Tiosovo-Netylskoye
 Sphagnum—cotton-grass peat, of a lighter color, greatly decomposed, bedding depth 1.45 to 1.50 m. The supposed age is 4000 to 4500 yr.

6275 ± 230
4325 B.C.

Mo-351. Tiosovo-Netylskoye
 Peat (*ryzhak*), rapidly darkening on exposure, with admixture of wood remains. Depth is 3.2 to 3.4 m. The supposed age is about 7000 yr.

5860 ± 210
3910 B.C.

Mo-346. Tiosovo-Netylskoye
 Birch wood with bark remains, depth 2.33 m. The supposed age is 5000 to 6000 yr.

Berendeevo Peat Bog series

The Berendeevo peat deposit is located near the railway station of the same name in the Yaroslav province, 100 km NE of Moscow (56° 35' N Lat, 39° 00' E Long). Its choice is explained by the fact that it is well known, having been exploited from 1906. A bore-hole was sunk in the NW part of the bog, in high moor peat, near the second pit. Total thickness of peat at boring site is 365 cm; below is sapropel, 55 cm thick, overlying blue clay (Neistadt, Devirts, Markova, Dobkina, Khotinsky, 1962). The samples were selected by M. I. Neistadt in 1960.

1020 ± 150
A.D. 930

Mo-206. Berendeevo
 Sphagnum peat from a depth of 0.75 m. Supposed age is upper part of Late Holocene (Sub-Atlantic period) ca. 1000 yr.

3360 ± 150
1410 B.C.

Mo-207. Berendeevo
 Sphagnum peat from a depth of 1.5 m. Relative age is lower part of Late Holocene (Sub-Atlantic period). The approximate absolute age is ca. 2500 yr.

4730 ± 190
2780 B.C.

Mo-208. Berendeevo
 Sphagnum—cotton-grass peat from a depth of 2.25 m. Relative age is middle of Middle Holocene (Atlantic period). The approximate absolute age is ca. 5000 yr.

Mo-209. Berendeevo**5415 ± 195****3465 B.C.**

Sphagnum—cotton-grass peat from a depth of 2.75 m. Relative age is first half of Middle Holocene (Atlantic period), absolute age is ca. 6000 yr.

Mo-210. Berendeevo**4220 ± 180****2270 B.C.**

Carex (*ryzhak*) peat, sampling depth 3.25 m. Relative age is beginning of Middle Holocene (Atlantic period). The supposed absolute age is ca. 7000 yr.

Mo-211. Berendeevo**6090 ± 210****4140 B.C.**

Sapropel, sampling depth 4.0 m. Relative age is upper part of Early Holocene (Boreal period). The supposed absolute age is ca. 7500 yr.

Mo-212. Berendeevo**4720 ± 190****2770 B.C.**

Wood from the border horizon, depth of sampled layer 2.25 to 2.50 m. The supposed age is ca. 5000 yr.

Mo-213. Berendeevo**3630 ± 165****1680 B.C.**

Root, cut from the border horizon at 2.25 to 2.50 m depth, at some distance from the chief section. The supposed age is ca. 5000 yr.

Mo-214. Berendeevo**9160 ± 280****7210 B.C.**

Wood from the same bog, but from another section, where the upper part of the deposit is already worked out. Sample was taken close to bottom of peat deposit. The supposed age is 9000 yr. *Comment:* the C¹⁴ determinations of peat from the main Berendeevo bog series (Mo-206-211) give somewhat younger ages than were expected on the basis of the pollen analysis, though they are in stratigraphic order. An exception is Mo-210, the younger age of which is perhaps connected with contamination during drilling. The age of the wood Mo-212 closely approaches the age of peat at the same depth, 2.25 m (Mo-208). The woody layer sampled as Mo-213, which was found at the same depth, but at some distance, in a destroyed peatworks, gave a significantly younger age; perhaps it was the result of unequal settling, as bog had been drained.

Lake Somino series

The lake Somino is situated near the left bank of the Upper Volga, in the valley of its tributary, the river Nezl Volzhskaya (Pereslavl'ski district, Yaroslavl province). It is surrounded by a whole group of bogs forming the Pereslavl'-Usolsk peat massif (56° 50' N Lat, 38° 30' E Long). The total thickness of the deposit is 40.0 m. Samples from two holes

(No. 10 and No. 86), located in the SE part of the lake at a distance of 0.5 km from one another, were investigated to establish the absolute chronology of the oldest Holocene sections (Vinogradov, Devirts, Markova, Khotinsky, 1963). The samples were selected by N. A. Khotinsky (Geog. Inst., Acad. of Sci., USSR).

9560 ± 345
7610 B.C.

Mo-259. Somino

Black fine-detritus gyttja from lower part of lacustrine strata, 40 m thick, of lake Somino. Sample from hole No. 10 at a depth of 36.2 to 37.0 m. The supposed age is 9000 to 10,000 yr.

9780 ± 315
7830 B.C.

Mo-262. Somino

Fine-detritus gyttja from same hole as Mo-259, but from depth of 38.0 to 38.5 m. The supposed age is 9000 to 10,000 yr.

9890 ± 300
7940 B.C.

Mo-264. Somino

Fine-detritus gyttja from same hole as Mo-259, but from depth of 39.0 to 39.5 m. The supposed age is 9000 to 10,000 yr.

9430 ± 300
7480 B.C.

Mo-266. Somino

Buried sapropel from layer laid bare by hole No. 86. Here, under sands, at 17 to 22 m depth, sapropel is 5 m thick. Sampling depth is 17.05 to 17.45 m. Spores and pollen, isolated from the lake sediments, show that the vegetative cover developed under rigorous climatic conditions. Before dating, it was supposed that the sapropel accumulation occurred at the end of the Valdai glaciation.

10,260 ± 330
8310 B.C.

Mo-268. Somino

Gray mineralized sapropel from same hole as Mo-266, sampling depth 18.5 to 19.5 m. The supposed age is the boundary between late-glacial and postglacial time.

10,535 ± 330
8585 B.C.

Mo-271. Somino

Gray mineralized sapropel from same hole as Mo-266, sampling depth 21.0 to 22.0 m. Pollen analysis shows predominance of grass and shrub formations, which agrees with the ideas about the forestless landscapes of the Upper Dryas.

Melekhovo Peat Bog series

The bog is located in the Pereslavl district of the Yaroslav province, at S border of the Polovets-Kupansk peat deposit, 15 km N of lake Somino (56° 55' N Lat, 38° 35' E Long). Samples for pollen and spore analysis were selected from this bog in 1961. Having at his disposal a detailed diagram, N. A. Khotinsky selected in 1963 at the same point

samples for radiocarbon analysis, taking into account the most important stratigraphical levels of the Holocene deposits. The two sapropel samples dated here are intended to give a more precise notion of age of the boundary between the late-glacial and postglacial time. The total thickness of the deposit is 12 m (Khotinsky, 1964 a,b).

Mo-361. Melekhovo

**11,370 \pm 370
9420 B.C.**

Light-grey sapropel; contact with underlying black gyttja is very distinct. Sampling depth 10.25 to 10.40 m. The supposed age corresponds to the Upper Dryas, 10,300 to 10,900 B.P.

Mo-360. Melekhovo

**11,975 \pm 300
10,025 B.C.**

Sapropel of a dark-grey, almost black color, sampling depth 10.6 to 10.75 m. The supposed age corresponds to the Alleröd and is estimated as 11,000 to 12,000 yr.

General Comment: study of C¹⁴ results on peat deposits, together with stratigraphic data, provides details in the Holocene subdivision which existed before on the basis of paleobotanic data (Neistadt, 1957); it gives dates of biostratigraphic levels or boundaries that correspond to considerable changes of the vegetative cover over enormous territories, and traces the duration of some Holocene periods.

The dated levels facilitate synchronization of Holocene events on the territory of the Russian plain with those of Western Europe. Thus, according to the peats of the lake Somino (Mo-268), the transition from the late-glacial to the postglacial period took place on the Russian plain 10,260 yr ago. This event is synchronous with that in Western Europe, where deposits in Denmark, England and Sweden showed the absolute figure of 10,300 yr (Iversen, 1953; Godwin, Walker, Willis, 1957; Nilsson, 1964). Older peat deposits, dating from the late-glacial period, had not been found before on the territory of the Russian plain. Now, according to samples from the Melekhovo peat deposit (Mo-360, Mo-361) we have layers corresponding to the Alleröd and the Upper Dryas, and these important stratigraphic boundaries are also correlated with Western Europe.

The establishment of a border (recurrence) horizon in the peats under investigation, marked by buried wood and stumps, is dated in the range from 7000 or 6000 to 3000 B.P. (Mo-321, Mo-319, Mo-328, Mo-207). The border horizon was apparently produced by a drier and warmer climate, when a forest vegetation began to grow on the bogs.

Imnatskoye Peat Bog series

The Imnatskoye peat deposit is a part of the vast Potian bog, located 8-9 km SW of Poti in the Georgian Soviet Socialist Republic (42° 00' N Lat, 41° 45' E Long.). It was chosen by reason of the considerable thickness of the peat bed, ca. 11.3 m, known from preliminary

data to have begun deposition 9000 to 10,000 yr ago. A confirmation of these data would provide an absolute chronological scale for the whole Holocene. The peat samples were coll. by N. A. Khotinsky in 1961 by Hiller auger in a central area of high moor type.

Mo-249. Imnatskoye **<100**

Peat, sampling depth 1.75 to 2.00 m. Supposed age is 1000 to 1500 yr.

2100 ± 150

Mo-251. Imnatskoye

150 B.C.

Peat, sampling depth 5.75 to 6.0 m. Supposed age is 4000 to 5000 yr.

4130 ± 195

Mo-253. Imnatskoye

2180 B.C.

Peat, sampling depth 8.25 to 8.50 m. Supposed age is 8500 to 9000 yr.

5825 ± 215

Mo-254. Imnatskoye

3875 B.C.

Peat, sampling depth 11.0 to 11.3 m. Supposed age is 9500 to 10,000 yr. *Comment:* the dating has shown that the 11-m-thick peat bed began to form ca. 6000 years ago, i.e., that it is considerably younger than was assumed. In this connection it is of interest to make use of data obtained in investigating bottom sediments of the Black Sea. Thus, marine sediments taken off nearby Batumi (see below, Mo-283, 344) belong to older phases of the Holocene and even to the Upper Pleistocene and may be considered as a continuation of the Imnatskoye section.

B. Samples connected with the glaciation and formation of post-glacial landscapes

In the first part of this section are collected samples connected with the study of events during and after the last glacial age in the NW European part of the USSR: time fixation of the end of the last Valdai glaciation on the Russian plain, definition of the number and duration of glacial stages and interstadials, elucidation of the rate of glacier retreat, the time of low river-terrace formation, and other problems. Although the Valdai glaciation (correlative with the Würm glaciation in Western Europe) is the nearest to our time, its stratigraphy is the most intricate. Until now a number of scientists (A. I. Moskvitin, V. P. Grichuk) have divided the time after the Mikulinski interglacial age into 2 independent glaciations, between which was the Mologo-Sheksninskoye interglacial age. This problem has been considered in examining a number of samples from lake and bog deposits, both within the glaciated territory and beyond its borders.

1. Baltic Regions

Mo-296. River Rauna, Ratseni (Latvia)

13,390 ± 500

11,440 B.C.

Plant remains contained in aleurite with sand, coll. from a section at the r. Rauna close to the farm Ratseni, Latvian SSR (57° 10' N Lat,

24° 50' E Long). In this section a thick moraine layer crops out, on which are superposed lacustrine deposits overlapped by a thin bed of red-brown loam and aleurites. The lacustrine deposits contain remains of a polar vegetation (polar birch, willow, *Dryas octopetala*, etc.). Sample was taken from this layer at a depth of ca. 3 m from the surface. To judge by the vegetation character, the accumulation of lacustrine deposits occurred under conditions of a cold climate—in the Late-glacial period. Coll. 1962 by I. Ya. Danilans (Acad. of Sci. of the Latvian SSR) and N. S. Chebotareva (Geog. Inst., Acad. of Sci., USSR).

Mo-317. River Letizhe, Desele (Latvia) >34,000

Peat between tills from a river-bank section (Danilans, 1962) in the lower reaches of the river Letizhe (tributary of the r. Venta) near the settlement Desele in the Latvian SSR (56° 20' N Lat, 22° 00' E Long). Between two moraine layers there is a lacustrine-to-boggy deposit represented in the lower part by sandy bluish clay overlying red till. Over the clay is organic mud containing well-preserved, strongly mineralized plant remains, overlain by dark-brown compact peat, 0.1 to 0.33 m thick; sample was taken from this peat layer. A gray clay, 0.2 m thick, overlies the peat and is overlain by alternating sand and brown clay, then by light-yellow laminated sand, 0.8 m thick, and finally, with gradational contact, by red till, the thickness of which in the section is ca. 3 m. The data of pollen analysis are vague and show only that the accumulation of lacustrine-to-boggy sediments occurred during some interstadial. Coll. 1962 by I. Ya. Danilans and N. S. Chebotareva.

Mo-318. River Gauya, Leyastiemis (Latvia) >34,000

Peaty gyttja from a section on the left bank of the r. Gauya near the settlement Leyastiemis in the Latvian SSR (57° 30' N Lat, 26° 40' E Long). The lacustrine deposits are sands and gray aleurites, saturated with organic remains (pieces of moss, grass), and are crumpled and partly included in the red-brown moraine 6 m thick that overlies them (Danilans, 1962). According to pollen analysis climatic conditions during the accumulation of lacustrine sediments were rather temperate; apparently they belong to an interstadial of the Valdai glaciation. Coll. 1962 by I. Ya. Danilans and N. S. Chebotareva.

Mo-35. River Neman, Lipliunai (Lithuania) 950 ± 100 A.D. 1000

Wood from hanging peat bog exposed in terrace, 12 to 13 m high, on left bank of r. Neman, near the village Lipliunai, 5 km above the town Druskininkai in the Lithuanian SSR (54° 00' N Lat, 24° 00' E Long). Bog deposit is exposed in section between 7.0 m and 2.5 to 3.0 m above river level. It was formed during a period of a higher level of ground water, marked also by formation of a flood plain ca. 3 m high, in late Sub-Boreal or Sub-Atlantic time; it is not older than 3000 to 2000 yr and perhaps still younger. Sample was coll. 1956 from the middle

of the peat layer by L. N. Voznyachuk (Geol. Inst. of the Acad. of Sci. of the Belorussian Soviet Socialist Republic).

Mo-36. R. Neman, Lipliunai (Lithuania) Recent

Wood from the same outcrop as Mo-35. The sample was taken from the outer side of the peat bog. It is not clear whether the wood is of the same age as the peat bog.

6100 ± 230

6000 ± 240

4100 B.C.

Mo-46. Purmaliai (Lithuania)

Peat with wood from an outcrop near the settlement Purmaliai, Klaipeda district, Lithuanian SSR (55° 45' N Lat, 21° 20' E Long). The sample was taken from a bed, 0.4 to 0.6 m thick, at a depth of 15 cm. Subm. by V. K. Gudelis (Geol. and Geog. Inst. of the Acad. of Sci., Lithuanian SSR). *Comment:* the first figure is obtained by measuring ethane, the second by measuring CO₂.

Mo-202. Purmaliai (Lithuania) >29,000

Peat, settlement Purmaliai, Klaipeda district, Lithuanian SSR (55° 45' N Lat, 21° 20' E Long). Stratigraphy: peat is located at a depth of ca. 20 m overlain by sand, ca. 4 m thick, with an admixture of organic matter, then by till, 6 m thick. Peat is also underlain by sand with an admixture of organic matter. The supposed age is the interstadial of the last glaciation. Coll. 1960 and subm. by V. K. Gudelis (Gudelis, 1961).

8580 ± 270

Mo-203. Lake Berzuolaitis (Lithuania)

6630 B.C.

Peat from a bog of the lake Berzuolaitis, 15 km SW of Vievis, Lithuanian SSR (54° 40' N Lat, 24° 40' E Long). The bog is located in a glacial rill on the tract of the terminal moraines. Peat, sapropelized, occurs at a depth of 8 to 9 m, overlain by a lime-rich sapropel. The supposed age is Alleröd or Late Dryas or even the beginning of the Early Holocene. Coll. 1960 by A. A. Seibutis (Geol. and Geog. Inst. of the Acad. of Sci., Lithuanian SSR).

9860 ± 300

Mo-204. Vievis (Lithuania)

7910 B.C.

Peat from a bog within the city limits of Vievis, Lithuanian SSR (54° 50' N Lat, 24° 50' E Long). Sapropelized peat, the upper layer of which underlies sapropel, occurred at 6.55 m depth, in a district of monticulate (morainic) relief. The supposed age is the end of Late Dryas, beginning of the Early Holocene. Coll. 1960 by A. A. Seibutis (Seibutis, 1962).

11,200 ± 340

Mo-205. Vievis (Lithuania)

9250 B.C.

Peat from the same bog as Mo-204. Lower sapropelized peat layer at a depth of 7.0 m. The supposed age is the second half of the Alleröd period. Coll. 1960 by A. A. Seibutis.

Mo-302. River Ula, Zervynos (Lithuania) **16,260 ± 640**
14,310 B.C.

Moss from a section, laid bare by the r. Ula (tributary of the r. Merkys) near the village Zervynos, district of the town Varena, Lithuanian SSR (54° 05' N Lat, 24° 30' E Long). The r. Ula cuts the frontal apron, located along the outer margin of the Baltic ridge, that formed during the Pomeranian stage of the Valdai glaciation; below occur interstadial lacustrine-bog deposits, as well as sands of the Brandenburg stage. The lacustrine-bog deposits, consisting of clays and aleurites, form a lens interbedded between the sands. At their base at a depth of over 2 m from the surface occurs a well-preserved layer of green moss, 0.05 m thick, from which the material for analysis was taken by stripping to a depth of 0.75 m. On basis of pollen analysis Lithuanian scientists assign the lacustrine-bog stratum to an interstadial between the Pomeranian and the Brandenburg stages (Kondratiene, 1950; Basalikas, 1957). Coll. 1962 by N. S. Chebotareva and O. P. Kondratiene (Acad. of Sci. of the Lithuanian SSR).

Mo-339. River Ula, Rudnia (Lithuania) **12,715 ± 315**
10,765 B.C.

Peat from a section, laid bare by the r. Ula (tributary of the r. Merkys) near the village Rudnia, up-river from the village Zervynos (see Mo-302), Lithuanian SSR (54° 05' N Lat, 24° 40' E Long). Section exposes structure of an outwash plain striking SE from the Baltic ridge. Peat lens occurs under sand layer, 7 to 8 m thick. Paleobotanic investigations have shown that during the peat accumulation the climate was very temperate; plant cover was chiefly pine and birch. It is supposed that this episode corresponds to the interstadial preceding the Pomeranian stage of the Valdai glaciation. Sample coll. 1962 by O. P. Kondratiene.

Mo-341. River Merkys, Pamerkes (Lithuania) **11,500 ± 400**
9550 B.C.

Peat from a section, laid bare by the r. Merkys near the village Pamerkes in the district of the town Varena, Lithuanian SSR (54° 20' N Lat, 24° 45' E Long). Section exposes structure of an outwash plain striking SE from the Baltic ridge. A lacustrine-boggy lens with two peat horizons is included in a stratum of sand. Sample was taken from the upper horizon at a depth of 4.5 m from the surface. According to pollen analysis the accumulation of the whole lacustrine-boggy stratum occurred during the interstadial preceding the Pomeranian stage of the last glaciation. Sample coll. 1962 by O. P. Kondratiene.

Mo-340. River Merkys, Pamerkes (Lithuania) **12,260 ± 160**
10,310 B.C.

Wood and peat from the lower horizon of the same lacustrine-boggy stratum as Mo-341. The sampling depth is 6.5 m from the surface.

2. *Byelorussia***Mo-34. River Neman, Gozha****8500 ± 300****6550 B.C.**

Wood, right side of the r. Neman, village Gozha, below the town Grodno (53° 50' N Lat, 23° 50' E Long). Sample was selected from a lenticular mort-lake formation, lying in a deep cut in the base of alluvium underlying the second, 10 to 15 m terrace. According pollen geomorphic observations the alluvium of the second terrace of the Neman dates from the end of the Pre-Boreal and the first half of the Boreal periods, 9500 to 8500 yr ago. Coll. 1956 by L. N. Voznyachuk (Geol. Inst. of the Acad. of Sci. of the Byelorussian SSR) (Voznyachuk, 1959).

Mo-299. Zaberдово**>28,000**

Wood from a brickworks pit near the village Zaberдово, Korelich district, Grodno province (53° 30' N Lat, 25° 55' E Long). Zaberдово is located on a hill (Novogrudskaya) beyond the boundaries of the Valdai glaciation. Lacustrine-boggy deposits occur here in a depression in the surface of the older (Moscow glaciation) moraine and of the glacio-lacustrine clays that lie on it. They consist of peat, clays, and aleurite. A great amount of wood is included in the peat. A sample was taken at a depth of ca. 1 m from the surface. Over the peat only aleurites are lying; there are no glacial deposits. To judge by the stratigraphic conditions, the peat could have accumulated either during the Mikulinsk interglacial period or during an interstadial of the last glaciation, or even in the Holocene. Spores and pollen suggest that the peat was deposited under a rather cold climate, but such a climate is known from various periods of the Pleistocene and Holocene. Sample coll. 1962 by N. S. Chebotareva.

3. *Center of the European Part of USSR***Mo-201. Gorelovo****12,150 ± 390****10,200 B.C.**

Pine wood from a peat-bog near the r. Dudergovka, near the station Gorelovo, 15 km SW of Leningrad (59° 50' N Lat, 30° 10' E Long). The sample was taken at a depth of 1.2 m from the surface. The peat bog is overlapped by transgressive deposits of a young stage of the Baltic glacial lake. Here and there the peat passes into fossil gley soil. The peat flora is non-arctic, with much birch bark and pine wood. The sands overlapping the peat were formed as an offshore bar at ca. 30 m alt above present sealevel, an altitude that reaches the isobase drawn on the surface of the last stage of the Baltic glacial lake which is synchronous with the Salpausselkä moraines. From this it follows that the relative age of the peat bog is Late Glacial (Older Holocene). As far back as 1931 K. K. Markov, according to varved clays and data of pollen analysis, has estimated the age of this peat as Alleröd. The sample was coll. 1960 by O. M. Znamenskaya (Leningrad State Univ.) and subm. by K. K. Markov

(Moscow State Univ.). The sample has been described (Serebryanny, Devirts, Markova, 1962).

Mo-257. River Kynya, Spas-Priluki **>29,000**

Peat, river bank of the r. Kynya near the village Spas-Priluki of the Ploskosh district in the Pskov province ($56^{\circ} 50' \text{ N Lat}$, $31^{\circ} 00' \text{ E Long}$). The sampling depth is 9.9 to 10.0 m from the top of stripping, 10 cm above the water line of the r. Kynya. The stripping has laid bare (from the top downwards): moraine; sandy loam with gravel and pebbles; glaciolacustrine clays; horizontally stratified lacustrine sands with plant remains; foliated peat; coarse sand. The supposed age is the interstadial preceding the Krestetsk stage or older, i.e., from 55 to 30 or 25 thousand years. There are data of spore and pollen analysis which establish the interstadial character of the deposits. The sample was selected in 1960 by N. A. Korina (Geog. Inst. Acad. Sci., USSR).

Mo-242. River Balazna, Boyarshchina **5120 ± 200**
3170 B.C.

Plant remains from clays of the 5-to-6-meter terrace of the r. Balazna where it discharges into the r. Kaspilyu (basin of the Western Dvina) near the village Boyarshchina, Smolensk province ($55^{\circ} 15' \text{ N Lat}$, $31^{\circ} 20' \text{ E Long}$). Sample was taken at a depth of 2 m below top of terrace. The outcrop is 150 m above the mouth of the r. Balazna on its left side, where the terrace is not as high above the river as elsewhere; this is the location of a mort-lake depression that is well marked in the local relief. The section exposes a mort-lake lens built of clays which alternate with sands in the lower part. The clays contain a great amount of plant remains. The pollen analysis did not give a distinct picture, therefore the supposed age could be Holocene or 25 to 30 thousand yr. Coll. 1961 by N. S. Chebotareva (Gerasimov, Serebryanny, Chebotareva, 1963; Serebryanny, Chebotareva, 1963).

Mo-243. River Kunya, Sukhaya Gorka **6675 ± 235**
4725 B.C.

Wood from alluvial deposits of the first terrace of the r. Kunya near the village Sukhaya Gorka, Toropetsk district, Kalinin province ($56^{\circ} 40' \text{ N Lat}$, $31^{\circ} 00' \text{ E Long}$). The sample was taken by stripping, at a depth of 2.15 to 2.20 m. The stripping lays bare the structure of the terrace: sandy deposits of a mort-lake lens containing plant remains, overlain by floodplain sandy loam, overlying coarse sand of the river-bed facies. The supposed age is either 25 to 35 thousand yr or Holocene. Coll. 1900 by N. A. Korina and M. A. Faustova (Geog. Inst. Acad. of Sci., USSR).

Mo-244. R. Kunya, Sukhaya Gorka **7120 ± 245**
5170 B.C.

Wood from the same section as Mo-243, but from a depth of 2.75 to 2.80 m.

7835 ± 255**Mo-293. River Shcheberikha, Rvenitsy****5885 B.C.**

Wood from section of terrace of the r. Shcheberikha, 7 m high, near the village Rvenitsky, Kalinin province (57° 30' N Lat, 32° 40' E Long). Section is located within the limits of the Valdai glaciation. In the studied section of the terrace mort-lake deposits are found to contain plant remains and wood. The mort-lake deposits overlie a moraine which is the latest for this terrace—the highest in the valley of the r. Shcheberikha. The moraine is covered by alluvium. The sample was taken from a depth over 3.5 m. The supposed age of the deposits is Holocene. According to pollen analysis the accumulation of mort-lake sediments must have taken place in a relatively warm period, obviously warmer than the recent one. Coll. 1962 by N. S. Chebotareva.

8580 ± 150**Mo-237. River Melecha, Borok****6630 B.C.**

Peat from alluvial deposits of a high flood plain of the r. Melecha near the village Borok, N of the town Bezhetsk, Kalinin province (58° 10' N Lat, 36° 40' E Long). The sampling depth is 2.2 to 2.4 m. Besides the high flood plain there are no indications of alluviation at higher levels—neither higher terraces nor sloping benches. The river banks, veneered at the surface by light-brown aleurites (overlying moraine), typically have very gentle slopes. The flood plain lies 3.65 to 4.0 m above the river level, and is known to be overflowable. In some places near Borok are outcrops which expose this terrace structure. From the surface are aleurites which gradually pass into fine gray clay with a great amount of plant remains in the lower part; below is peat (0.1 to 0.3 m thick), overlying gray clay. The section near Borok has long been known in the literature (from 1909): it was thought that these deposits are overlapped by a moraine and had accumulated in the Mikulinsk interglacial period, i.e., that the peat age would be >60,000 B.P. In the opinion of N. S. Chebotareva, who coll. this sample in 1960, considering the fact that deposits belong to the flood plain, the age is Holocene. According to palynologic data the layers enclosing the sample accumulated in the beginning of the climatic optimum of the Holocene.

Mo-238. Toporikha**>33,000**

Wood, taken on the watershed near the E border of the village Toporikha in a trench, made during excavation of a pond, Kalinin province (57° 25' N Lat, 36° 30' E Long). Here (from top to bottom) were exposed fine sand, aleurites, gray clay with plant remains, peat with much wood; under the peat aleurites again occur, passing below into sand. Layers below the peat were explored by boring. The general thickness of the stripped deposits is 4.1 m; the sample was taken from a depth of 2 to 2.5 m. Pollen analysis did not give a distinct picture. The supposed age is 10,000 to 65,000 yr. Coll. 1960 by N. S. Chebotareva.

Mo-198. River Bolshaya Lipnya, Barmino **2400 ± 100**
450 B.C.

Wood imbedded in the first terrace of the r. B. Lipnya near the village Barmino (60 km W of the town Vladimir), Vladimir province (56° 00' N Lat, 39° 40' E Long). Character of the deposit: an accumulation of tree trunks, plant remains, cones, etc., occur in the form of a lens in the strata of the first terrace. Sample was coll. during stripping of the river cliff at a depth of 2.3 m below the surface of terrace, which is 4 m high. Sample is somewhat younger than Mo-199. According to micropaleobotanic investigations of the section, there are reasons to consider the deposits as belonging to an interglacial period younger than the Riss-Würm (the Mikulinsk). Coll. 1960 by V. P. Grichuk and L. R. Serebryanny (Geog. Inst. Acad. Sci., USSR).

Mo-199. River B. Lipnya, Barmino **2760 ± 100**
810 B.C.

Wood from the same terrace as Mo-198, but taken at a depth of 3.4 m below surface.

Mo-200. River Klyasma, Voinova Gora **945 ± 95**
A.D. 1005

Wood from deposits of the first terrace of the r. Klyasma, near the village Voinova Gora in the vicinity of the Orekhovo Zuyevo, Vladimir province (55° 50' N Lat, 39° 10' E Long). An accumulation of tree trunks, plant remains, etc., is imbedded in this terrace in the form of a lens. Sample was taken in stripping a river cliff at ca. 3 m depth. On paleobotanic evidence from the section, the deposits may date from an interglacial age, younger than the Mikulinsk interglacial (Riss-Würm). Coll. 1960 by V. P. Grichuk and L. R. Serebryanny (Gerasimov, Serebryanny, Chebotareva, 1963).

General Comment: in considering the sample ages of this group and comparing them with the characteristics of the sampling places some general conclusions are outlined. Until now no samples of organic origin have been found in the range of 17,000 to 34,000 B.P. (in these investigations 34,000 yr was the age limit). Lacking such samples, there is as yet no warrant for recognizing the younger (Mologo-Shekninsk) interglacial age. All samples selected with the aim of demonstrating this debatable interval, of a supposed age of 25,000 to 30,000 yr, proved to belong to the Holocene (Mo-198, Mo-199, Mo-200, Mo-237, etc.). Other dates show that the glaciers retreated from the south of Lithuania as far north as Leningrad in the time interval from 16,000 to 12,000 B.P.; consequently the process of ice wastage on this territory lasted ca. 4000 yr (Mo-201, Mo-296, Mo-302; Gerasimov and Chebotareva, 1963). The duration of the Alleröd interstadial is approx. 1000 yr and embraces the time from 12,000 to 11,000 yr ago (Mo-201 and Mo-205). The formation of low river terraces in the center of the Russian plain, both in the glaciated territory and beyond its borders, occurred in the Holocene (Mo-

237, Mo-242, etc.; Chebotareva, Serebryanny, Devirts, and Dobkina, 1962; Chebotareva and Serebryanny, 1963).

River Desna Fossil Soils series

Fossil soils from the periglacial zone of the Valdai glaciation are special indicators of paleoclimates and may serve for glacial-stratigraphic control as they show the influence of glaciation in their formation. In the present work samples of buried soils were taken from two sections, 250 km distant from one another. In these sections are 2 or 3 buried soils, of which the lower belong to the Mikulinsk interglacial period. We have analyzed the middle horizons in both sections. The carbon content in such samples is very low (a few percent) and therefore large amounts of soil (5 to 10 kg) had to be processed for dating. Samples were coll. 1962 by T. D. Morozova and A. A. Velichko (Georg. Inst. Acad. Sci., USSR).

Mo-337. River Desna, Bryansk

24,920 ± 1800

22,970 B.C.

Fossil soil from the plateau on the right side of the r. Desna near the southern vicinity of the town Bryansk, Bryansk province (53° 15' N Lat, 34° 30' E Long). The sample was taken from the ravine wall at a depth of 4.25 m from the surface; it is a humic horizon of a soil formed in loesses of the Valdai sequence. All humic substances were completely isolated from the soil to analyze them for C¹⁴. According to geological data the supposed age is the interstadial of the Valdai glacial stage.

Mo-342. River Desna, Mezin

24,200 ± 1680

22,250 B.C.

Fossil soil from the right side of the r. Desna near the village Mezin, Chernigov province (51° 30' N Lat, 33° 00' E Long). The sample was taken from the ravine wall at depth of 8.7 m from the surface. Sample was the humic horizon of a soil formed in loesses of the Valdai sequence. The sample preparation for C¹⁴ analysis was the same as for Mo-337. The supposed age is the interstadial of the Valdai glacial stage.

Comment: fossil soils from the middle horizons in both sections proved to be of the same age, ca. 25,000 B.P. The dates provide means of correlating the last (Valdai) glaciation on the Russian plain with the Paudorf interstadial of the West-European glaciation (Velichko, Devirts, Dobkina, Morozova, Chichogova, 1964).

4. Eastern Siberia

Beyond the Russian plain the problems connected with glacial and postglacial deposits were studied on the territory of Eastern Siberia. In the present paper samples from two regions of Eastern Siberia (Yakutia) are cited: from the basins of the rivers Vilyui (tributary of the r. Lena) and Indigirka.

Vilyui River Basin series (Yakutia)

Samples from the outcrops of the r. Vilyui were coll. by M. N. Alekseev in 1953 (Geol. Inst. of the Acad. of Sci., USSR) and A. V. Trofimov (V. I. Vernadsky Inst. of Geochemistry) and by M. N. Alekseev in 1955 (Alekseev, 1957).

Mo-136. River Vilyui**Recent**

Wood, left side of the r. Vilyui, 1 km below the river Byrykan mouth ($63^{\circ} 50'$ N Lat, $122^{\circ} 40'$ E Long). The sample was taken at a depth of 1 m from the surface from deposits of a high flood-plain, formed in part during the thermal optimum in the Holocene. The supposed age is 2000 to 10,000 yr.

Mo-137. River Vilyui **1910 ± 120
A.D. 40**

Wood from the same outcrop as Mo-136, but from a depth of 25 m. The supposed age is 2000 to 10,000 yr.

Mo-138. River Vilyui **$>30,000$**

Wood, left side of the r. Vilyui, 5 km above the landing Lankholokh. The supposed age is 12 to 30 thousand yr.

Mo-139. River Vilyui **$>30,000$**

Wood from a humified horizon, left side of the r. Vilyui, 4 km NW of mouth of the r. Tangnary ($64^{\circ} 05'$ N Lat, $124^{\circ} 00'$ E Long). The supposed age is 12 to 30 thousand yr.

Mo-140. River Vilyui **$>30,000$**

Wood and peat from sandy loams, left side of the r. Vilyui, 5 km N of mouth of the r. Tangnary ($64^{\circ} 05'$ N Lat, $124^{\circ} 00'$ E Long). Sampling depth is ca. 10 m. The supposed age is approx. the end of Q_3 . The nature of the sediment indicates an intensification of the continental character of the climate.

Mo-141. River Vilyui **$>30,000$**

Peat from lacustrine sand-loams, crumpled by cryoturbation, left side of the r. Vilyui, 13 km below the mouth of the r. Chebydy ($63^{\circ} 50'$ N Lat, $120^{\circ} 50'$ E Long). Sample was taken from a depth of ca. 10 m. The supposed age is the end of the Upper Pleistocene, approx. corresponding to the Sartansk (last) stage of the Zyryansk glaciation of Siberia. *Comment:* datings of the samples from the basin of the r. Vilyui (Yakutia) were obtained during the first working stage of the laboratory, when there was no experience in sampling for radiocarbon analysis. Though most of the datings proved older than expected, nevertheless they are of certain interest, as there are very few data on absolute geological ages for Siberia.

Indigirka River Basin series (Yakutia)

An investigation of Quaternary deposits of the lower course of the river Indigirka and its tributaries has been carried out on material coll. 1960 by Yu. A. Lavrushin (Geol. Inst. Acad. Sci., USSR).

360 ± 145

Mo-226. River Indigirka **A.D. 1590**

Wood, right side of the r. Indigirka, 80 km above the settlement Ozhogino (69° 50' N Lat, 147° 30' E Long). In a floodplain, terrace height ca. 2 m, aleurites, apparently 1 m thick, were overlain by fine sand, 1.1 m thick. Sample was taken from a depth of 1.2 m in the upper part of mort-lake alluvium sediments. The spore-and-pollen spectra of deposits from this section are similar to the spectrum of the recent vegetation of this region. The supposed age of the r. Indigirka low floodplain is the end of the Holocene (Sub-Atlantic period), continuing to the present time.

4125 ± 180

Mo-227. River Indigirka **2175 B.C.**

Wood, left side of the r. Indigirka, 0.8 km below the beginning of the branch Poloustnaya (69° 20' N Lat, 147° 20' E Long), in the 4.5-m-high floodplain section of the r. Indigirka. The terrace section is composed of dirty-brown fine sands. The sample, a piece of driftwood, was found in the lower quarter of the stratum, 0.5 m above water line. The supposed age is Sub-Boreal.

2100 ± 160

Mo-228. River Indigirka **150 B.C.**

Peat, left side of the r. Indigirka, 0.85 km below the beginning of the Poloustnaya branch (69° 20' N Lat, 147° 20' E Long), the same section of the r. Indigirka high floodplain as Mo-227. Downstream the terrace surface declines toward a river laida filled up with sediments, the section of which from bottom to top is the following: 1.5 m aleurites, 1.0 m peat. The sample was taken from the middle part of the peat and dates the end phases of the laida formation as well as the r. Indigirka high floodplain. The supposed age is the end of the Sub-Boreal time.

4770 ± 280

Mo-229. River Bolshaya Ercha **2820 B.C.**

Birch wood, from section of a high floodplain of the river B. Ercha (tributary of Indigirka), left side, ca. 50 km from the mouth (69° 45' N Lat, 148° 45' E Long). The terrace height is 4.0 m. The formation of this terrace is of the same age as the formation of the lower part of the r. Indigirka high floodplain. From bottom to top were exposed: sands with a maximum thickness 1.5 m, then alternating thin beds of dark-brown peat and dark-grey aleurites, 1.3 m thick. Sample was taken in the lower part of the stratum (1 m above water-line) where bark and small trunks of tree birches were found. Under this stratum occurs a layer of aleurites 0.4 to 0.5 m thick, and a peat layer, 0.4 to 0.5 m thick. The

sample characterizes the time of a climatic optimum in the Holocene. The supposed age is the Atlantic time.

Mo-230. River B. Ercha

**3470 ± 170
1520 B.C.**

Alder wood from the same section as Mo-229, from the upper part of the same stratum, where vertically standing alder trunks were met. The sample characterizes the end of the formation of the r. Bolshaya Ercha high floodplain. The supposed age is the Atlantic time.

Mo-231. River Indigirka

**2285 ± 160
335 B.C.**

Larch wood, from section of the first terrace on the right side of the r. Indigirka, 14 km above the settlement Khaiagystakh (69° 50' N Lat, 147° 30' E Long). Terrace height is 15 m. The sample was taken at a depth of 12 m where remains of an arborescent vegetation were met. The supposed age of the deposits is the time of the last (Zyryansk) glaciation—the end of the Upper Pleistocene. *Comment:* the discrepancy between the obtained and expected age may be accounted for by the fact that the sampling place is exposed to the action of flood water, which can emplace younger driftwood into terrace deposits.

Mo-232. River Indigirka

**8670 ± 270
6720 B.C.**

Birch wood, right side of the r. Indigirka, 6 km below the sovkhos Shamanovo (69° 55' N Lat, 147° 30' E Long). At this locality, on the surface of the first terrace there is a sunken lake basin which is partly filled with lacustrine sediments. At the base of these deposits, at ca. 4 m depth, remains of a tree birch were found. The sample characterizes the beginning of the climatic optimum of the Holocene. The supposed age is the Atlantic time.

Mo-245. River Indigirka

**6850 ± 225
4900 B.C.**

Larch wood taken from the middle part of the same lacustrine deposit as Mo-232, at ca. 2.3 m depth.

Mo-233. River Berelikh

**7820 ± 210
5870 B.C.**

Alder wood from the basal layer of lacustrine (alassy) deposits which partly fill the thermokarst sink on the surface of the alluvial lacustrine plain of the Primorye lowland, right side of the r. Berelikh (tributary of the r. Indigirka), 4 km below the channel Omuk-Saene (70° 30' N Lat, 147° 00' E Long). Sampling depth is 5.9 m. The supposed age is the climatic optimum of the Holocene.

Mo-234. River Berelikh

**7850 ± 250
5900 B.C.**

Birch wood, at the same place as Mo-233 from a depth of ca. 6.0 m. The supposed age is the climatic optimum of the Holocene. *Comment:*

according to the present sample series the climatic optimum of the Holocene on the territory of the NE of the USSR took place approx. 9000 to 4500 yr ago (Mo-232, Mo-229). This may be compared with analogous events in Western Europe and Alaska and permits one to synchronize the chief stages of the Holocene almost over the whole northern hemisphere (Lavrushin, Devirts, Gitterman and Markova, 1963).

C. Other Geological Samples

1. Marine sediments of the Black Sea

During the 32nd cruise of the ship *Vityaz* in 1960 V. A. Grinenko (V. I. Vernadsky Inst. of Geochemistry) coll. sea oozes from the Black Sea bottom in order to study the isotopic sulphur composition. Ooze cores from bottom deposits were selected along the vertical section on the ship moorings. In some cores the ooze samples contained an amount of organic matter sufficient for age determination by C^{14} . The ooze samples were as far as possible selected on the boundary of neoeuxinic and old Black sea sediments.

Mo-283. Black sea

**8000 \pm 260
6050 B.C.**

Ooze from the Black sea bottom, station 4745-2, slope near Batumi ($41^{\circ} 40' N$ Lat, $40^{\circ} 32' E$ Long). The sea depth in the sampling place is 1704 m, the sampling depth below bottom is 160 to 180 cm. The sample material consists of an interstratification of homogenous clayey ooze with microlaminated clayey sapropel-like ooze. Below 190 cm begin sediments of the neoeuxinic time.

Mo-344. Black sea

**23,000 \pm 1320
21,050 B.C.**

Sapropelic, brown, microlaminated ooze with a H_2S smell from the same station as Mo-283. The sample was taken from 680 to 710 cm depth below bottom.

Mo-284-A. Black sea

**7225 \pm 250
5275 B.C.**

Sapropelic, brown, microlaminated ooze with a H_2S smell. Station 4740, near the Crimean shore ($43^{\circ} 51' N$ Lat, $33^{\circ} 38' E$ Long). The sea depth is 2044 m, the sampling depth below bottom is 339 to 352 cm.

Mo-284. Black sea

**7510 \pm 240
5560 B.C.**

The same core as Mo-284-A, but the sampling depth is 352 to 365 cm. The sample lies on a clay of neoeuxinic age.

Mo-286. Black sea

**5040 \pm 195
3090 B.C.**

Microlaminated, greenish-gray, soft clay. Station 4754-5. Slope of the Bosphorus coast ($43^{\circ} 34' N$ Lat, $29^{\circ} 22' E$ Long). The sea depth at the sampling place is 1193 m, the sampling depth in core 115 to 140 cm.

Sample dates the end of the old Black-sea period. The supposed age is ca. 3000 yr.

Mo-287. Black sea

**9350 \pm 220
7400 B.C.**

The same as Mo-286. The depth in core is 435 to 458 cm. At date of this sample the Old Black-sea period began. Stratigraphically, sample is connected with samples Mo-283 and Mo-284. The end of the neoeuxinic stage and the beginning of the Old Black-sea time is dated by different investigators as belonging to the time-interval from 12,000 to 5000 yr ago. *Comment:* from the data on the sulphur isotope study and the C^{14} determination in organic matter (Mo-283, Mo-284, Mo-287) it was possible to establish that ca. 8000 yr ago the fresh-water basin of the Black sea began to fill up with sea water from the Sea of Marmora by way of the Bosphorus strait. Thus the time of the beginning of the recent hydrogen sulfide contamination of the Black sea was outlined (Vinogradov, Grinenko and Ustinov, 1962).

2. *The Arctic*

Sample finds of organic origin beyond the polar circle are rather rarely met. Datings of such finds by C^{14} are of exceptional value for the study of the history of the Soviet Arctic islands, especially, taking into account that usual paleobotanic methods are of no use in the present case. All samples (except one) are driftwood, cast ashore by the sea and buried by later deposits. Only in one case was autochthonous material found, i.e., peat which had not been subjected to transport and redeposition (Mo-355). All samples were subm. by M. G. Grosswald (Geog. Inst. of the Acad. of Sci., USSR).

Mo-195. Island Hooker

**7450 \pm 135
5500 B.C.**

Marine driftwood, Franz Josef Land, Isl. Hooker, Cape Dandy (80° 20' N Lat, 52° 40' E Long). The sample was broken off from the end of a tree trunk buried by rubbly-pebbly deposits exposed in sea cliff, 26 m high. The pebble beds have an undisturbed marine lamination. The sample was taken at a depth of 10 to 30 cm from the diurnal surface level. According to the terrace height above sealevel and the average rate of isostatic uplift (0.5 to 1.0 m/100 yr) in the region of former glaciation the supposed age is 5000 to 10,000 yr. The sample was taken by M. G. Grosswald in 1959.

Mo-239. Island Hayes

**4775 \pm 115
2825 B.C.**

Marine driftwood, Franz Josef Land, Isl. Hayes (80° 30' N Lat, 57° 00' E Long). Surface of a sea terrace, 10 m high above the sealevel. The sample, imbedded in the terrace surface, has partly been carried in by marine sands. The supposed age is 4000 to 5000 yr. The sample was coll. 1960 by L. S. Govorukha (Arctic and Antarctic Sci. Research. Inst.).

1020 ± 120**Mo-258. Island Victoria****A.D. 930**

Marine driftwood, Island Victoria (western sector of the Soviet Arctic) (80° 10' N Lat, 37° 00' E Long). The sample was taken from the surface of a marine terrace near the Cape of Knipovich at a height of 5.5 m. The driftwood had melted out from under the ice cap in summer 1961 and was coll. by L. S. Govorukha. The supposed age is the boundary between the Later and the Middle Holocene.

5500 ± 235**Mo-355. Island Alexandra Land****3550 B.C.**

Peat from sea weeds, Franz Josef Land, Island Alexandra Land, Cape Nagurski (80° 50' N Lat, 48° 00' E Long). The sample was taken at a depth of 20 to 30 cm from the surface of the sea terrace in a depression between low beach barriers. The absolute height of the sampling place is 17.5 m. The peat is in primary position, the possibility of its redeposition being excluded. During a long time the peat was submitted to the influence of permafrost. There is no recent vegetation on the peat surface. The supposed age is ca. 6000 yr. The sample was coll. 1961 by V. L. Sukhodrovski.

General Comment: all dates, excluding Mo-258, apply to the islands of the Franz Josef Land archipelago. In spite of the different character of the material it is possible to draw a general conclusion of a very rapid glacioisostatic uplift of the crust of the earth in this region during the late-glacial and postglacial time. This sample ages permit one to conclude that all terraces known on the islands of the archipelago have formed in the Holocene, while earlier the highest terraces were thought to date from the time of the Pre-Zyryansk interglacial period (Grosswald, Devirts, and Dobkina, 1961, 1963, 1964). The obtained datings are correlated with datings previously obtained in the laboratory of the Uppsala Univ. (Sweden) (Olsson, 1960) for islands of the adjacent Spitsbergen archipelago and show the synchronous and common character of the climatic changes in postglacial time in this part of the Arctic region.

3. Kamchatka

The territory of Kamchatka is characterized by the presence of a great number of active and extinct volcanoes. The present samples are related to the activity of two volcanoes: Khangar and Shiveluch.

6460 ± 135**Mo-169. Volcano Khangar****4510 B.C.**

Wood, a birch trunk fragment taken in a pumice terrace of the middle course of the r. Kheivan in the region of the Middle Mountain Range of Kamchatka (54° 45' N Lat, 157° 30' E Long). Fragments of charred wood are found among loose pumice deposits ejected by the volcano Khangar. On the basis of an assumption concerning the dacite cone formation of the Khangar in the postglacial period, the supposed

sample age is also postglacial (Marenina, 1959). The sample was coll. 1948 by A. E. Svyatlovski (Lab. of Volcanology, Acad. Sci., USSR).

1500 \pm 170

Mo-129. Volcano Shiveluch

A.D. 450

Part of a burnt log of wood from a pumice layer of an ancient ejection of the volcano Shiveluch below a moraine of the last glaciation; it was found near the volcano itself (56° 45' N Lat, 161° 30' E Long). Coll. 1955 and subm. by G. S. Gorshkov (Lab. of Volcanology, Acad. Sci., USSR). The supposed age is 10,000 to 12,000 yr.

3100 \pm 200

Mo-130. Klyuchi

1150 B.C.

Charcoal from the hearth of an ancient Kamchadal site in the region of the settlement Klyuchi (56° 20' N Lat, 161° 00' E Long). The sample was taken at a depth of 2.7 m from the surface. The deposits are covered by some layers of ash and sand from the gigantic ejections of the volcano Shiveluch. Coll. 1955 and subm. by G. S. Gorshkov. The supposed age is ca. 1000 yr.

Lake Ushkovskoye series

Samples of burnt wood from the coast of the lake Ushkovskoye located on the right side of the r. Kamchatka, 25 to 30 km below Kozyrevsk (56° 15' N Lat, 160° 10' E Long). The samples were coll. 1962 by N. N. Dikov (Siberian branch of the Acad. of Sci., USSR).

220 \pm 145

Mo-353. Lake Ushkovskoye

A.D. 1730

Charcoal from cultural deposits of a fisher site. The coal was coll. from subterranean humified loam containing remains of a material culture (stone and bone artifacts, house-hold pits and hearths). The coal bedding depth is 25 cm from the surface, over the ashes of the volcano Shiveluch, the height of the first terrace is 4 m. By a comparative-typological method this cultural layer (of the Later Neolithic stage) is only approx. estimated to date in the range from the first millennium B.C. to the beginning of the first millennium A.D.

2070 \pm 190

Mo-354. Lake Ushkovskoye

120 B.C.

Charcoal from a cultural layer of a Neolithic site at the same place as Mo-353, but at a depth of 1 m from the surface, among the ashes of the volcano Shiveluch. The sample was coll. from a loam layer containing remains of a burnt wooden ceiling of an ancient pithouse. By a comparative-typological method it is approx. established that the given cultural layer (of the Middle Neolithic stage) dates from the 2nd millennium B.C.

10,365 \pm 350**8415 B.C.****Mo-345. Lake Ushkovskoye**

Charcoal from a hearth pit. The sample was taken from the same place as Mo-353 and 354, but at a depth of 1.7 m. It was taken in a cultural layer containing stone artifacts of Mesolithic aspect, in yellow laminated loam under ash deposits of the volcano Shiveluch. The general thickness of the loose deposits is about 2 m. The supposed age is ca. 10,000 yr. *Comment:* the sample was suspected to be of Mesolithic age, as it is; it is the most ancient proof of the peopling of Kamchatka.

General Comment: B. I. Piip dates the whole series of Shiveluch ashes from the 2nd millennium A.D. However, samples Mo-354 and Mo-345, found below the chief ash layers of the Shiveluch, force us to deny such an estimation, which was based on the thickness of loose deposits enclosing the ashes (Piip, 1948).

II. ARCHAEOLOGIC SAMPLES

Khorezm Expedition series

The material of the finds was collected during the excavations of the Khorezm cooperative archaeological-ethnographical expedition of the Acad. of Sci., USSR in Middle Asia in 1953-59. All samples were studied by archaeologists and estimated on the basis of archaeological complexes including well datable objects: arrow-heads, ceramic artifacts, working tools, etc. The samples were subm. by the head of the expedition, correspond. memb. Acad. of Sci., USSR, S. P. Tolstov (Miklukho-Maklai Inst. of Ethnography, Acad. of Sci., USSR). All material presented here was obtained from sites located by the Khorezm expedition in the lower part of the r. Amu-Darya basin and in the zone of dry branches of the r. Syr-Darya ancient delta (Tolstov, 1961).

1855 \pm 130**Mo-91. Khorezm****A.D. 95**

Charcoal, Kanga-kala (Karakalpakian Auton. Sov. Soc. Republ.). Central building, No. 1. Taken in 1955. The supposed age is the 4th century A.D. *Comment:* the cited figure is the average of two determinations made in different counters.

2090 \pm 180**Mo-96. Khorezm****140 B.C.**

Charcoal, Koi-Krylgan-kala, eastern sector, room 13-B, pit No. 7. Taken in 1955. The supposed age is 4th to 2nd centuries B.C.

2325 \pm 100**Mo-99. Khorezm****375 B.C.**

Charcoal from a burnt layer, left bank of Khorezm, NE Kara-Kumy, Turkmenian SSR. Site of the ancient town Kalaly-gyr I, palace building, room No. 1. The sample was taken in 1953. The supposed age is the 4th to 3rd centuries B.C.

Mo-100. Khorezm**1840 ± 130
A.D. 110**

Charcoal, Kalaly-gyr, Tower 15 at the entrance into the furnace of the large (lower) kiln. Taken in 1953. The supposed age is the 2nd to 3rd centuries A.D. *Comment:* the cited age is an average of two determinations made at different times.

Mo-104. Khorezm**2145 ± 100
195 B.C.**

Charcoal, right bank of Khorezm, Karakalpakian Auton. Sov. Soc. Republ., environs of Adamli-kala, point 13/70. The sample was taken in 1953. The supposed age is 4th to 3rd centuries B.C.

Mo-172. Khorezm**2965 ± 100
1015 B.C.**

Fragments of a wooden beam, North Kzyl-Kumy, Kazakh SSR, Kzyl-Ordinsk region, site of the ancient town Babish-mulla I, big house, room No. 5 between floor 2 and 3. Stratigraphic conditions: in loose ground, not more than 30 cm from the surface. The samples were taken in 1959. The supposed age is 4th to 3rd centuries B.C.

Mo-174. Khorezm**2505 ± 100
555 B.C.**

Charcoal, right bank of Khorezm, Karakalpakian Auton. Sov. Soc. Republ., site Yakke-persan 2, house No. 8 (half-dug-out). Found on an earth floor, in cultural layer mixed with sandy-loam, 0.8 m from the recent surface. The sample was taken in 1959. The supposed age is the 9th to 8th centuries B.C.

Mo-175. Khorezm**3075 ± 100
1125 B.C.**

Charcoal, northern Kzyl-Kumy, Kazakh SSR, Kzyl-Ordinsk province, Tagisken, burial ground, sepulchral erection No. 7. Found in the central part of the burial, along the wall, 15 to 20 cm from the recent surface. The sample was taken in 1959. The supposed age is 9th to 8th centuries B.C.

Mo-193. Khorezm**3075 ± 100
1125 B.C.**

Charcoal, left bank of Khorezm, northern Kara-Kumy, Turkmenian SSR. Site of the ancient town Kyuseli-gyr, digging VI, room No. 1. From a hearth under a clay layer, 0.3 to 0.5 m thick. The sample was taken in 1954. The supposed age is the 6th to 5th centuries B.C.

Mo-194. Khorezm**2565 ± 100
615 B.C.**

Charcoal, northern Kzyl-Kumy, Kazakh SSR, Kzyl-Ordinsk province. Site of the ancient town Chirik-rabat, digging III, round sepulchral erection, passage from room No. 1 into room No. 4. Found in sockets of the

framework of the clay wall-coating. The sample was taken in 1958. The supposed age is the 4th century B.C.

Comment: in the investigated series of 10 samples most (8) of the datings approx. agree with the estimations of archaeologists (within limits of error of the method, including that from synthesis of counting gases and from measurement of C^{14} -activity). Two samples, Mo-172 and Mo-193, give a great discrepancy (600 to 700 yr too old) between archaeological estimations and dates according to C^{14} . The reason for such discrepancies may be that trees which had perished long before use could be employed as building material and fuel.

4360 \pm 200

Mo-1. Peat-bog Gorbunovsky, section 6

2410 B.C.

Wood of a fossil tree from a site on the 6th section of the Gorbunovsky peat-bog near the town Nizhni Tagil in the Sverdlovsk province ($57^{\circ} 55' N$ Lat, $60^{\circ} 00' E$ Long). On this site 2 cultural layers are well traceable and a 3rd cultural layer in the upper horizons is outlined. The sample was selected from the lower layer at a depth of 2.0 to 2.5 m during excavations carried out in 1949 by A. Ya. Bryusov and V. M. Rauschenbach (Hist. State Mus.) and subm. by the correspond. memb. Acad. Sci., USSR, B. A. Rybakov. On the basis of an analysis of the archaeological material the lower (dated) layer dates from the end of the 3rd to the beginning of the 2nd millennium B.C. (Rauschenbach, 1956).

4800 \pm 200

Mo-2. Peat-bog Gorbunovsky, Strelka

2850 B.C.

Wood of a fossil tree from the site Strelka in the N part of the peat-bog Gorbunovsky near the town Nizhni Tagil in the Sverdlovsk province. The site is single-layered. The sample was taken from the cultural layer which can be traced in the peat from a depth of 63 cm in the main peat body downward until sapropel is encountered at a depth of 95 cm. The sample was selected by A. Ya. Bryusov and V. M. Rauschenbach and subm. by the corresp. memb. B. R. Rybakov. The cultural layer of the site Strelka is stratigraphically somewhat older than the lower layer of the 6th section (Mo-1, above), and from analysis of archaeological complexes was estimated as belonging to the middle of the 3rd millennium B.C. (Rauschenbach, 1956).

23,000 \pm 800

Mo-11. Molodova, Ukraine

21,050 B.C.

Charcoal from remains of camp-fires of Upper Paleolithic man. The sample was taken from the 7th cultural horizon on a multi-layer Paleolithic site of Molodova V in the middle Dnestr foreland near the village Molodova of the Kelmenetsk district in the Chernovitsy province, Ukraine ($48^{\circ} 30' N$ Lat, $26^{\circ} 00' E$ Long). The Paleolithic layer from which the sample was taken is located in loess-like loams with feeble traces of soil formation at a depth of ca. 3.5 m from the surface. Accord-

ing to geological data the sampled deposit belongs to the Upper Pleistocene, the middle Würm (Q_3). Archaeologically similar cultural layers were dated in Western Europe (in Czechoslovakia and France) by the radiocarbon method; results obtained were in the range of 25,000 to 26,000 yr. The sample was coll. 1956 from a type stratigraphic section and subm. by I. K. Ivanova (Comm. for the Inv. of the Quaternary Period, Acad. of Sci., USSR) (Ivanova, 1959; Ivanova and Chernysh, 1963). *Comment:* the age of a charcoal sample from the same (7th) cultural horizon of the same site was determined by the scintillation method in the Lab. of absolute age, Geol. Inst. Acad. Sci., USSR. Datings of $23,950 \pm 980$ and $23,680 \pm 400$ yr have been obtained (Alekseev, Ivanova, Kind, and Chernysh, 1964).

Mo-176. Armenia

1700 ± 100

A.D. 250

Wood, part of an ancient mine timbering, Armenian SSR. The sample was found in 1959 during new prospecting borings at a depth of 100 m from the surface. Subm. by Sh. O. Amiryan (Geol. Inst. Acad. Sci., Armen. SSR). The supposed age is the 11th to 9th centuries B.C. or 7th to 8th centuries A.D. *Comment:* the obtained age characterizes the period of the first gold deposit exploitation on the territory of Armenia.

Mo-334. River Naryn, Kirgizia

1680 ± 170

A.D. 270

Coal from the cultural layer on the left side of the r. Naryn (Kirgizian SSR), 3 km E of the mouth of the r. Alabuga ($41^\circ 25' N$ Lat, $74^\circ 40' E$ Long). The sample was found at a depth of 7.6 m in the form of scattered coals in a loamy rock in deposits of a 26-m terrace. According to archaeological estimations the sample dates from the 5th to 7th centuries A.D. The sample was found by K. V. Kurdyumov (Moscow State Univ.) in 1962. *Comment:* the find serves as a verification of archaeological data on the peopling of the Tien-Shan.

Mo-343. River Yenisei, Krasnoyarsk

$11,335 \pm 270$

9385 B.C.

Charcoal from the site Afontova Gora II, left side of the r. Yenisei near the town Krasnoyarsk ($56^\circ 00' N$ Lat, $92^\circ 50' E$ Long). The sample was taken in an outcrop between the lower and middle layers of a Paleolithic site at a depth of 6 to 8 m from the surface. According to archaeological estimations the supposed age is the middle of the second half of the Later Paleolithic, i.e., 15,000 to 25,000 B.P. The sample was coll. 1961 and subm. by S. I. Rudenko and S. N. Astakhov (Archaeol. Inst. of the Acad. of Sci., USSR). *Comment:* by reason of the small number of samples no preliminary chemical treatment was carried out.

III. FOSSIL ANIMALS

We know finds of buried carcasses of animals—mammoths not existing today, but well-preserved until now. By dating such finds the prob-

lem of the extinction time of these animals may be solved. We have analyzed the remains of Taimyr and Chekurov mammoths (Siberia). The age of the Taimyr mammoth was determined in our laboratory just at the beginning of its work by the method of counting solid carbon. A figure of the order of 12 thousand yr was obtained (Vinogradov, 1954). Later the age of fossil wood, found in the mammoth horizon of Taimyr, was determined by the gas method. For the Chekurov mammoth, along with the determination of the age of the hair of the mammoth, an investigation of the peat located 0.5 m above the mammoth carcass was carried out.

11,700 \pm 300

Mo-3. Taimyr

9750 B.C.

Wood of a fossil tree (*Salix*) from the mammoth horizon, N shore of the Taimyr lake, excavations of 1949. Subm. by B. A. Tikhomirov (Komarov Bot. Inst., Acad. of Sci., USSR).

26,000 \pm 1600

Mo-215. River Lena, Chekurovka

24,050 B.C.

Mammoth hair, from carcass found 1.5 km below the settlement Chekurovka of the Bulunsk region, territory of the river Lena delta (71° 00' N Lat, 127° 40' E Long). The sample was found in the first terrace at a depth not exceeding 1.5 m from the surface in the permafrost zone. The specimen is a young female of ca. 2/3 of full-grown mammoth size and has very small tusks. Most of the bones lay in the illuvial-diluvial sandy-argillaceous layer containing rock debris of basal Cambrian limestone. The sample was found in 1960 and subm. independently by V. N. Yakovlev (Univ. of Yakutsk) and S. S. Korzhuev (Geog. Inst. Acad. Sci., USSR). According to the spore-and-pollen diagram of terrace deposits from the mammoth burial site the supposed age of the find is the xerothermic maximum of postglacial time (Korzhuev and Fedorova, 1962).

5610 \pm 200

Mo-215-A. River Lena, Chekurovka

3660 B.C.

Peat from the same section as the mammoth carcass Mo-215, but from a depth of ca. 1 m (i.e., 0.5 m above the mammoth carcass). Peat layer, 15 cm thick, is overlain by loam, 45 cm thick, with intercalations of decomposed matter; a thin loam 30 cm thick, underlies the peat. The sample was subm. by S. S. Korzhuev.

Comment: the provisional absolute age of the Taimyr mammoth remains (the tendons were investigated) coincided well with the age of wood from the mammoth horizon. In the case of the mammoth from Chekurovka the mammoth hair and the overlying peat proved to be of different age. The absolute peat age actually falls in the xerothermic period. This allows us to assume that the authors of the mentioned article (Korzhuev and Fedorova, 1962), having correctly estimated the age of the peat deposits, attributed this figure

also to the mammoth. The obtained datings of the death time of both mammoths agree with the known (C^{14}) time range of these animals, which was 47,000 to 11,000 B.P. for six finds of Siberian mammoths dated by R. Nydal in the Lab. of Radioactive Dating of the Phys. Inst. in Trondheim, Norway. The age of the Taimyr mammoth which was obtained in our laboratory coincided particularly closely with Nydal's results for the Taimyr mammoth, $11,450 \pm 250$ (T-297) and dates from the end of the Sartansk glaciation in Siberia (Heintz and Garutt, 1964).

2225 ± 130

Mo-255. Antarctic

275 B.C.

Shin of a seal mummy, Antarctic, oasis Shirmakhera, 8 km to the W-NW from the station Novo-Lazarevskaya ($70^{\circ} 45' S$ Lat, $11^{\circ} 35' E$ Long). The seal mummy was found on the surface, its lower part buried in sand; the upper part was slightly powdered with small pebbles. The upper part of the carcass was half decayed and the bones were jutting out. On the lower part which was lying in the sand, the pelt was well preserved. The mummy had a slightly curved form and was ca. 1 m long. The seal mummy was lying on large fragments of moraine on a hilly slope, 200 m from the N border of the oasis, at a height of 10 to 15 m above the surface of the ice adjacent to the oasis. (The oasis Shirmakhera is located at a distance of 80 km from the recent seacoast and is separated from it by shelf ice.) The slope gently dipped to the oasis border forming an inclined platform ca. 100 by 200 m which did not hinder the movement of seals. Found in 1961 and subm. by V. I. Bardin (Moscow State Univ.) (Bardin, 1963). *Comment:* the age obtained for the seal mummy agrees well with the age of analogous finds from other places of the Antarctic (Péwé, Rivard, and Llano, 1959).

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RIKEN NATURAL RADIOCARBON MEASUREMENTS II

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The C^{14} dates given below are a continuation of the work presented in our first list (RIKEN I), and have been obtained by counting CO_2 at about 2 atm pressure in a 2.7-L stainless steel counter. In this article, results obtained during 1964-65 are described.

Shell samples were treated with 1% HCl to remove the outer 10%. Calcareous deposits on the surface, when observed, were removed by mechanical means.

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. No correction was applied even for fresh water shell samples.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Iwo-dake series

N-148. Ashiaraidani 1

2060 \pm 120
110 B.C.

Trunk of wood (*Juniperus rigida*) washed out of the face of an eroded bank of Ashiaraidani valley, Nakao, Kamitakara-mura, Yoshiki-gun, Gifu pref. (36° 15' N Lat, 137° 14' E Long), 3 m above present river bed, between two layers of mud flow from volcano Iwo-dake. Coll. and subm. 1964 by M. Oishi, Natl. Research Center for Disaster Protection.

N-149. Ashiaraidani 2

2460 \pm 120
510 B.C.

Root of wood (*Pinus pentaphylla*) exposed on same site as above, 6 m above present river bed.

Comment: dates roughly determine rate of alluviation of valley and are useful in planning sand-control work. They are also consistent with belief (Kato, 1911) that the upper mud flow (60 to 70 m thick on the Nakao plateau above) occurred about 400 yr ago.

N-150. Sodegatani

modern

Wood (*Juniperus rigida*) exposed in debris of landslide at bank of Sodegatani valley, Nakao, Kamitakara-mura, Yoshiki-gun, Gifu pref. (36° 16' N Lat, 137° 35' E Long). Coll. and subm. 1964 by M. Oishi. *Comment:* dates the landslide which was reported to occur in 1889 (Kato, 1911).

Echuca series

Charcoal fragments from Echuca area, Victoria, Australia, where a relatively complete geomorphic and stratigraphic sequence has been established (Bowler and Harford, 1963). Coll. and subm. 1965 by J. M. Bowler, Univ. of Melbourne.

N-152. Echuca 1-B **6800 ± 150**
4850 B.C.

From a horizon, rich in organic remains, 7 ft below flood plain forming top of stratigraphic section in laminated lacustrine silts overlying a fossil soil, at S bank of Murray River, 11 mi ENE from Echuca (36° 5' S Lat, 144° 56' E Long).

N-153. Echuca 2 **4200 ± 130**
2250 B.C.

From exposure on S bank of Goulburn River 5½ mi E of Echuca (36° 6' S Lat, 144° 51' E Long). Material found in a single layer, 3 ft deep, in channel deposits of Kanyapella prior stream, which are set into older lake sediments represented by sample 1-B.

N-155. Port Phillip Bay 1 **5990 ± 160**
4040 B.C.

Marine pelecypod shell (*Anadara trapezia*) from core in water 47 ft deep through Recent sediments of Port Philip Bay, 2 mi SW of Sandringham Harbour, Australia (37° 58' S Lat, 144° 58' E Long). Sediments overlie a fossil soil and are believed to be considerably younger than first postglacial transgression. Sample from 74 cm below top of core, and 3 cm above fossil soil. Coll. and subm. 1965 by J. M. Bowler.

Akashi Channel series

Material from boring at Akashi channel. Coll. by T. Yoshinaka; subm. 1965 by K. Kojima, Public Work Research Inst., Ministry of Construction.

N-162. Akashi Boring No. 8 **10,800 ± 230**
8850 B.C.

Charcoal fragments in dark-brown clay from 14 m below top of core, Boring No. 8, depth in sea 30 m, off Iwaya, Awaji-cho, Tsunagun, Hyogo pref. (34° 36' N Lat, 135° 1' E Long).

N-163. Akashi Boring No. 11 **>36,800**

Shell fragments in coarse bluish gray sand from 10 m below top of core, Boring No. 11, depth in sea 30 m, off Tarumi, Kobe City, Hyogo pref. (34° 37' N Lat, 135° 3' E Long).

Comment (K.K.): dates serve to distinguish between Pleistocene Akashi formation and alluvial sediments filling up a submarine valley. Akashi bed is thought to be suitable to support a bridge across Akashi channel.

Daisen series

Wood and charcoal found at various sites around volcano Mt. Daisen. Coll. and subm. 1963-64 by T. Kimachi, Yonago Kita High School.

N-107. Sukezawa **>36,800**

Charcoal from Sukezawa, Kobu-cho, Hino-gun, Tottori pref., S side of Mt. Daisen (35° 17' N Lat, 133° 33' E Long), coll. from charcoal layer 0.5 m thick, 8 m below ground surface, overlain by granite-and-andesite gravel layer and underlain by granitic clay.

N-138. Kyu Nawa **18,500 ± 400**
16,550 B.C.

Wood from Kyu Nawa, Nawa-machi, Saihaku-gun, Tottori pref., N side of Mt. Daisen (35° 29' N Lat, 133° 31' E Long), coll. from clay layer ca. 6 m below ground surface, overlain by mud flow and underlain by pumice.

N-139. Fukuo **18,000 ± 400**
16,050 B.C.

Wood from Fukuo, Daisen-cho, Saihaku-gun, Tottori pref., NW side of Mt. Daisen (35° 30' N Lat, 133° 28' E Long). coll. from bottom of mud flow 10 m below ground surface, overlain by lacustrine silt and underlain by clay.

Comment (T.K.): dates of N-138 and N-139 are unreasonably younger than dates of samples (GaK-225, Gakushuin II, and N-95, RIKEN I) found in gravel layers which are supposed to be stratigraphically higher.

Hanaizumi series

Mammal-bearing Hanaizumi formation was excavated 1958, 1959 and 1960 under leadership of I. Hayasaka, head of research party, at Kanamori, Hanaizumi-machi, Nishi-iwai-gun, Iwate pref. (38° 50' N Lat, 141° 10' E Long). Formation ca. 4 m thick, yielded abundant mammalian fossils including *Megaceros*, *Leptobison* and *Loxodonta*, mainly from base of its upper part, ca. 3 m thick, where silt, clay, and sand beds were intercalated by four plant beds, numbered 1st to 4th in descending order (Ueda, Iwai and Ozaki, 1962). These plant beds contained much driftwood and also cones and seeds of *Tsuga*, *Thuja*, *Larix*, *Picea*, *Pinus*, *Menyanthes*, etc. (Matsumoto *et al.*, 1959). Samples, all of *Picea maximowiczii* Regel (id. by S. Watari and F. Yamauchi), were coll. from SE section of excavation area in 1958. Coll. 1958 and subm. by N. Watanabe, Univ. of Tokyo.

N-132. Wood from 1st plant bed **11,900 ± 200**
9950 B.C.**N-133. Wood from 2nd plant bed** **23,100 ± 700**
21,150 B.C.

- N-141. Wood from 3rd plant bed** **29,300 \pm 1300**
27,350 B.C.
- N-142. Wood from 4th plant bed** **>36,800**
- N-143. Wood from layer under 4th plant bed** **>36,800**

Comment: other measurements on Hanaizumi formation: Y-594 (Yale V); St-476, 531, 533, 534, 534A and 534B (Stockholm IV). Dates, as expected, are of glacial age (Kanto Loam Research Group, 1961).

II. ARCHAEOLOGIC SAMPLES

A. Japan

- N-37. Takayagawa canoe** **3070 \pm 120**
1120 B.C.

Part of dug-out canoe of Late Jomon period from Takayagawa River at Yatsudai, Yokoshiba-machi, Sanbu-gun, Chiba pref. ($35^{\circ} 41' N$ Lat, $140^{\circ} 28' E$ Long), unearthed Dec. 1953 by J. Shimizu, Keio Univ. Pottery was of Kasori B type. Subm. by J. Shimizu through N. Watanabe, Univ. of Tokyo.

- N-38. Kamo canoe** **5290 \pm 140**
3340 B.C.

Fragment of dug-out canoe of Early Jomon period from peat formation at Kamo, Toyota-mura, Awa-gun, Chiba pref. ($35^{\circ} 1' N$ Lat, $139^{\circ} 50' E$ Long), unearthed Dec. 1948 by R. Fujita and N. Matsumoto of Keio Univ. (Matsumoto, *et al.*, 1952). Pottery was of Moroiso A type. Subm. by J. Shimizu through N. Watanabe. *Comment:* another wood material from same peat layer yielded 5100 ± 400 (M-240, Michigan I). Dates of shell samples associated with same type of pottery were given 4730 ± 90 , 4760 ± 90 (GaK-379a and GaK-379b, Gakushuin IV).

- N-103. Onedaira 1** **4340 \pm 130**
2390 B.C.

- N-104. Onedaira 2** **4180 \pm 190**
2230 B.C.

Charcoal from fireplace of Dwelling Pit 2 of Middle Jomon period at Nakaguchi, Tsugu-mura, Kita-shitara-gun, Aichi pref. ($35^{\circ} 10' N$ Lat, $137^{\circ} 38' E$ Long), excavated July 1952 by I. Natsume. N-103 and N-104 were from same fireplace. Pottery type was comparable to Kasori E in Kanto district. Coll. 1952 and subm. by I. Natsume through N. Watanabe.

- N-106. Marune** **870 \pm 100**
A.D. 1080

Charcoal from passage-way to stone coffin chamber of burial mound at Marune, Higashi-nagura, Shitara-machi, Kita-shitara-gun, Aichi pref. ($35^{\circ} 9' N$ Lat, $137^{\circ} 32' E$ Long). Burial mound, round in plan, was of later Kofun type. Coll. 1939 by H. Sawada; subm. by I. Natsume through N. Watanabe.

1950 ± 130**N-108. Nishimukai****A.D. 0**

Charcoal from dwelling pit of Late Yayoi period at Nishimukai, Naka-shitara, Toei-machi, Kita-shitara-gun, Aichi pref. (35° 5' N Lat, 137° 41' E Long), excavated Feb. 1954 by M. Okada. Coll. 1954 by M. Okada; subm. by I. Natsume through N. Watanabe.

1480 ± 130**N-109. Nishino****A.D. 470**

Charcoal from ceramic kiln of Early Kofun period at Nishino, Sakai city, Osaka pref. (34° 31' N Lat, 135° 33' E Long). Material from N one of two kilns excavated May 1963 by M. Suenaga and K. Mori, Kansai Univ. Coll. 1963 and subm. by N. Watanabe.

2820 ± 130**N-110. Yahatazaki****870 B.C.**

Walnuts from peat formation at Yahatazaki, Onoe-machi, Minami-tsugaru-gun, Aomori pref. (40° 37' N Lat, 140° 32' E Long), excavated Nov. 1962 by T. Esaka, Keio Univ. *et al.* Pottery was of Obora B type of Latest Jomon period. Coll. 1962 and subm. by N. Watanabe.

3680 ± 130**N-114. Oyu****1730 B.C.**

Charcoal fragments from base of black soil layer between two volcanic ash layers at central part of double concentric circles, ca. 40 m and 10 m in diam, consisting of many small stone structures, at Nonakado site Oyu-machi, Kazuno-gun, Akita pref. (40° 16' N Lat, 140° 48' E Long). Upper part of black soil layer contained Late Jomon potsherds, which were thought to be contemporary to stone constructions. Excavation by Comm. for the Protection of Cultural Properties (1953) July 1951. Coll. 1951 and subm. by N. Watanabe.

1430 ± 120**N-115. Hizamori****A.D. 520**

Charcoal from dwelling pit at Hizamori, Shichinoe-machi, Kamikita-gun, Aomori pref. (40° 43' N Lat, 141° 10' E Long), excavated Aug. 1954 by K. Narita. Haji pottery and corroded iron objects were found. Coll. 1954 and subm. by N. Watanabe.

Shinpukuji series

Peat formation at Shinpukuji, Iwatsuki city, Saitama pref. (35° 56' N Lat, 139° 43' E Long), was excavated Aug. 1940 by K. Hasebe, Univ. of Tokyo. Wooden artifacts and pottery of Latest Jomon period were found. Coll. 1940 and subm. by N. Watanabe.

2990 ± 130**N-116. Walnuts****1040 B.C.**

Associated with Angyo III type of pottery.

N-117-1. Wood **3020 ± 130**
1070 B.C.

N-117-2. Wood **2940 ± 130**
990 B.C.

From same peat layer which yielded N-116. In prepared samples, no visible rootlets remained in N-117-1, some remained in N-117-2.

Kurihara series

Eighteen dwelling pits of Yayoi and Kofun periods were excavated Dec. 1955 by S. Nakagawa, St. Paul's Univ. (1957) at Kurihara, Kami-itabashi, Itabashi-ku, Tokyo (35° 45' N Lat, 139° 41' E Long). Coll. 1955 and subm. by N. Watanabe.

N-121. Charcoal from House H-2 **1600 ± 120**
A.D. 350
Associated with Haji pottery of Late Kofun period.

N-122. Charcoal from House H-6 **2180 ± 130**
230 B.C.

Associated with Haji pottery of Kofun period. *Comment* (N.W.): too old compared to N-123 of Yayoi period.

N-123. Charcoal from House Y-3 **1830 ± 130**
A.D. 120
Associated with Yayoicho type pottery of Late Yayoi period.

N-124. Abiko **1940 ± 120**
A.D. 10

Charred timber of dwelling pit of Early Kofun period at Abiko-machi, Higashi-katsushika-gun, Chiba pref. (35° 52' N Lat, 140° 2' E Long). Material from House 4 excavated Jan. 1959 by S. Yoshida, Univ. of Tokyo (Yoshida and Tamura, 1961). Pottery was of Goryo type. Coll. 1959 and subm. by N. Watanabe. *Comment*: charcoal associated with same type of pottery at Goryo yielded 1890 ± 120 (N-68, RIKEN I).

N-125. Kameyama **1860 ± 120**
A.D. 90

Charred timber of dwelling pit of Late Yayoi period at Kameyama, Oji-machi, Kita-ku, Tokyo (35° 45' N Lat, 139° 44' E Long). Material from House 17B unearthed 1956 by S. Wajima, Yokohama Municipal Univ. Coll. 1956 and subm. by N. Watanabe.

N-126. Santonodai **2260 ± 120**
310 B.C.

Charcoal from dwelling pit of Late Yayoi period at Santonodai, Okamura-cho, Isogo-ku, Yokohama city, Kanagawa pref. (35° 25' N Lat, 139° 37' E Long). Material from House 3 excavated 1959 by S. Wajima. Pottery was of Kugahara type. Coll. 1958 and subm. by N. Watanabe.

1340 ± 100**N-127. Okuda****A.D. 610**

Charcoal from Ceramic Kiln 3 at Okuda, Higashi-hosoya-machi, Toyohashi city, Aichi pref. (34° 41' N Lat, 137° 29' E Long), excavated Oct. 1957 by H. Hisanaga. Associated with Latest Sue pottery. Coll. 1957 and subm. by N. Watanabe.

3250 ± 140**N-128. Seibuen****1300 B.C.**

Charcoal from dwelling pit of Late Jomon period at Seibuen park, Yamaguchi, Tokorozawa city, Saitama pref. (35° 46' N Lat, 139° 26' E Long), excavated Oct. 1958 by I. Kono and T. Otani. Pottery was of Horinouchi type. Coll. 1958 and subm. by N. Watanabe.

1390 ± 110**N-129. Kamegado****A.D. 560**

Charcoal from ceramic kiln at Kamegado, Narumi-machi, Aichi-gun, Aichi pref. (35° 6' N Lat, 137° 1' E Long). Excavation Oct. 1959 by H. Hisanaga. Associated with oldest type glazed pottery of Heian era. Coll. 1959 and subm. by N. Watanabe.

Kosai series

Samples from two ceramic kilns excavated 1958 by H. Hisanaga and party of Shizuoka Univ. at Kibi, Kosai-machi, Hamana-gun, Shizuoka pref. Associated pottery was of types from Late Kofun period to Nara era. Coll. 1958 by excavation party; subm. by N. Watanabe.

1420 ± 110**N-130. Osawa****A.D. 530**

Charcoal from Kiln 3 at Osawa (34° 42' N Lat, 137° 32' E Long).

1380 ± 110**N-131. Kawajiri****A.D. 570**

Charcoal from Kiln 1 at Kawajiri (34° 43' N Lat, 137° 32' E Long).

3340 ± 120**N-144. Hanaizumi****1390 B.C.**

Wood, *Acer* cfr. *palmatum* Koidzumi (id. by S. Watari and F. Yamauchi), from Kanamori formation at Kanamori, Hanaizumi-machi, Nishi-iwai-gun, Iwate pref. (38° 50' N Lat, 140° 10' E Long). Formation overlies fossil-bearing Hanaizumi formation from which Hanaizumi series in Geologic Samples were obtained. At collection site, ca. 200 m S of that of geologic samples, the formation, 20 to 50 cm thick, contained later Middle and early Late Jomon pottery (Matsumoto, *et al.*, 1964). Excavation Oct. 1962 by same research party that excavated Hanaizumi formation in 1958, 1959 and 1960. Coll. 1962 and subm. by N. Watanabe.

1140 \pm 110**N-145. Bodaino****A.D. 810**

Charred timber on floor of Dwelling Pit 9 at Bodaino, Karibu-mura, Kazuno-gun, Akita pref. (40° 15' N Lat, 140° 49' E Long). Associated with Haji pottery resembling Onitaka type in Kanto district, Nara or Asuka era in age. Excavation July 1951 by Comm. for the Protection of Cultural Properties (1953). Coll. 1951 and subm. by N. Watanabe.

Fugoppe series

Shell mound in Fugoppe cave, Yoichi-machi, Yoichi-gun, Hokkaido (43° 12' N Lat, 140° 50' E Long), was excavated 1953 by T. Natori, head of excavation party of the cave. Pottery was of Kohoku C type. Coll. 1953 and subm. by T. Natori through N. Watanabe.

1870 \pm 100**N-146. Charcoal****A.D. 80****1950 \pm 120****N-147. Charred walnuts****A.D. 0****1920 \pm 130****N-50-2. Charred walnuts****A.D. 30**

Charcoal from middle layer; charred walnuts from lower layer. N-147 and N-50-2 were from same source.

Nishishiga series

Material from bottom layer of shell mound at Nishishiga, Kita-ku, Nagoya city, Aichi pref. (35° 12' N Lat, 136° 55' E Long). Excavation Aug. 1947 by S. Yamanouchi, Univ. of Tokyo. Pottery was of Ongagawa type of Early Yayoi period. Coll. 1947 and subm. by N. Watanabe.

2520 \pm 140**N-120. Charcoal****570 B.C.****2220 \pm 120****N-161-1. Marine pelecypod shell (*Ostrea* sp.)****270 B.C.****2440 \pm 130****N-161-2. Marine pelecypod shell (*Meretrix* sp.)****490 B.C.****1620 \pm 120****N-164. Takikubo****A.D. 330**

Charcoal from dwelling pit at Takikubo, Kokubunji-machi, Kitatama-gun, Tokyo (35° 42' N Lat, 139° 28' E Long), excavated 1948 by I. Kono, Musashino Mus. Roof tiles of Musashi Kokubunji temple were used to construct furnace of the house. Documentary date of construction of Musashi Kokubunji temple is sometime after A.D. 741. Coll. 1948 by I. Kono; subm. by N. Watanabe.

1070 ± 120**N-165. Tengudai****A.D. 880**

Charred timber of dwelling pit at Tengudai, Wada, Tama-mura, Minami-tama-gun, Tokyo (35° 38' N Lat, 139° 26' E Long), excavated Dec. 1955 by F. Miki, Tokyo Nat. Mus. Associated with later Haji pottery. Coll. 1955 and subm. by N. Watanabe.

Araumi Shell Mound series

Fresh water and marine pelecypod shells from Araumi shell mound, Narita city, Chiba pref. (35° 50' N Lat, 140° 20' E Long). Shell layer, containing mainly *corbicula japonica*, was on black soil 20 to 40 cm thick overlying loam. Associated pottery is comparable to Obora A and A' type Latest Jomon period (Nishimura, 1960b, 1961). Coll. and subm. by M. Nishimura, Waseda Univ.

2260 ± 130**N-166-1. Fresh water shell (*Corbicula japonica*) 310 B.C.****2290 ± 120****N-166-2. Marine shell (*Meretrix lusoria*) 340 B.C.****2780 ± 110****N-166-3. Marine shell (*Mya japonica*) 830 B.C.****4540 ± 140****N-167. Saburosaku****2590 B.C.**

Marine pelecypod shell (*Meretrix lusoria*) from Saburosaku shell mound, Sawara city, Katori-gun, Chiba pref. (35° 52' N Lat, 140° 31' E Long). Material found 1 m below surface together with Middle Jomon pottery of Atamadai and Kasori E type (Nishimura, 1960a). Coll. and subm. 1965 by M. Nishimura. *Comment:* charcoal samples associated with same or comparable pottery type yielded 4340 ± 130, 4180 ± 190 (N-103, N-104, this list) and 4570 ± 150 (UCLA-279, UCLA III).

Nishinojo Shell Mound series

Material from ancient dwelling site at Nishinojo, Namiki, Kozaki-machi, Katori-gun, Chiba pref. (35° 53' N Lat, 140° 23' E Long). Dwelling pit dug in loam and accompanied by Earliest Jomon pottery of Igusa type. At S side of pit, shell layer, 50 to 79 cm thick and containing pottery of Natsushima type, was found in dark soil, 20 to 50 cm above loam (Nishimura *et al.*, 1955; Nishimura, 1965). Coll. and subm. 1965 by M. Nishimura.

8150 ± 180**N-168. Shell****6200 B.C.**

Fresh water shell (*Corbicula japonica*) from shell layer.

N-170. Charcoal**8240 \pm 190****6290 B.C.**

Baked soil containing powdered charcoal found on floor of pit. Floor is ca. 1.2 m below present ground surface.

General Comment: shell and charcoal associated with pottery of Natsushima type was dated and yielded 9450 ± 400 , 9240 ± 500 (M-769, M-770, Michigan V).

Tokisaki Shell Mound series

Fresh water and marine pelecypod shell from B trench of Tokisaki shell mound, Sawara city, Chiba pref. ($35^{\circ} 53' N$ Lat, $140^{\circ} 25' E$ Long). Shell layer, 40 to 90 cm thick, is underlain by loam, mixed with ash and accompanied by Earliest Jomon pottery of Hanawadai II type (Nishimura, 1958a; Nishimura and Kaneko, 1960). Coll. and subm. 1965 by M. Nishimura.

N-174-1. Fresh water shell (*Corbicula japonica*)**9190 \pm 200****7240 B.C.****N-174-2. Marine shell (*Meretrix lusoria*)****8740 \pm 190****6790 B.C.****N-175. Okitsu****4880 \pm 130****2930 B.C.**

Marine pelecypod shell (*Meretrix lusoria*) from Okitsu shell mound, Miho-mura, Inashiki-gun, Chiba pref. ($35^{\circ} 59' N$ Lat, $140^{\circ} 18' E$ Long). Shell layer, 40 to 60 cm thick, is 30 to 60 cm below ground surface and accompanied by later Early Jomon pottery of Okitsu type (Nishimura, 1957a). Coll. and subm. 1965 by M. Nishimura.

N-176. Mukoyama**4520 \pm 130****2570 B.C.**

Fresh water pelecypod shell (*Corbicula japonica*) from Mukoyama shell mound, Toride-machi, Kita-soma-gun, Ibaragi pref. ($35^{\circ} 56' N$ Lat, $140^{\circ} 1' E$ Long). Shell layer, containing mainly fresh water shell, 60 to 90 cm thick, is 20 to 30 cm below ground surface and accompanied by later Early Jomon pottery of Ukishima III type (Nishimura, 1958b). Coll. and subm. 1965 by M. Nishimura.

Kaigakubo Shell Mound series

Marine pelecypod and gastropod shell from Kaigakubo shell mound, Ukishima, Sakuragawa-mura, Inashiki-gun, Ibaragi pref. ($35^{\circ} 59' N$ Lat, $140^{\circ} 24' E$ Long). Shell layer, 40 to 80 cm thick, is found at NE slope of Ukishima hill, 30 to 50 cm below ground surface, and accompanied by later Early Jomon pottery of Ukishima type (Nishimura, 1956). Coll. and subm. 1965 by M. Nishimura.

N-177-1. Marine shell (*Meretrix lusoria*) **4920 ± 130**
2970 B.C.

N-177-2. Marine shell (*Meretrix lusoria*) **4900 ± 130**
2950 B.C.

Both samples are from same source.

N-178. Uebo **5340 ± 150**
3390 B.C.

Marine pelecypod shell (*Meretrix lusoria*) from Uebo shell mound, Kozaki-machi, Katori-gun, Chiba pref. (35° 52' N Lat, 140° 23' E Long). Shell layer, 70 to 80 cm thick, is on black soil 20 to 40 cm thick overlying loam and accompanied by Early Jomon pottery of Uebo type (Nishimura, 1955, 1957c). Coll. and subm. 1965 by M. Nishimura. *Comment:* site is 2 km S of Nishinojo (N-168 and N-170) and 3 km W of Tokisaki (N-174-1 and N-174-2). Presence of marine molluscs, when compared with predominance of fresh water molluscs in the latter two shell mounds, suggests transgression at that time.

Nado Shell Mound series

Fresh water and marine pelecypod shell from Nado shell mound, Taiei-machi, Katori-gun, Chiba pref. (35° 51' N Lat, 140° 24' E Long). Shell layer, 30 to 70 cm thick, is on dark soil 20 to 30 cm thick overlying loam and accompanied by Late Jomon pottery of Angyo II and IIIa type (Nishimura, 1957b). Coll. and subm. 1965 by M. Nishimura.

N-179-1. Fresh water shell (*Corbicula japonica*) **3130 ± 130**
1180 B.C.

N-179-2. Marine shell (*Meretrix lusoria*) **3050 ± 130**
1100 B.C.

General Comment: charcoal associated with same type of pottery yielded 3000 ± 120 (N-94, Riken I).

N-183. Ikazuchi **4280 ± 130**
2330 B.C.

Marine gastropod shell (*Rapana thomasi*) from Ikazuchi shell mound. Shirai, Omigawa-machi, Katori-gun, Chiba pref. (35° 49' N Lat, 140° 33' E Long). Shell layer, 2 to 3 m thick, contains early Middle Jomon pottery of Shimo-ono and Goryogadai type (Nishimura, 1952; Nishimura and Kaneko, 1954). Coll. and subm. by M. Nishimura.

Lake Nojiri series

Flake of wood and twig including a cone of *Picea* sp. from Sugikubo remains, NW side of lake Nojiri, Shinano-machi, Kami-minachi-gun, Nagano pref. (36° 50' N Lat, 138° 13' E Long), imbedded in lacustrine sediments, called Rokugatsu bed lying parallel to top of loam bed comparable to Tachikawa loam in Kanto district. The bed, associated with non-ceramic culture, was intercalated by three plant beds from which

samples were collected (Kamei, 1963). Coll. and subm. 1964 by T. Kobayashi, Kokugakuin Univ.

N-134. 25 cm below surface	18,300 ± 400
	16,350 B.C.
N-135. 35 cm below surface	30,700 ± 1800
	28,750 B.C.
N-136. 50 cm below surface	35,200 ± 3000
	33,250 B.C.

General Comment (T.K.): dates will serve to determine absolute age of non-ceramic culture in Japan. They also should be compared with dates of wood samples from neighboring Tachigahana remain which is associated with *Megaceros* and *Elephas namadicus naumanni* (GaK-267, 268 and 269, Gakushuin III).

N-74-a. Toro 4	2010 ± 120
	60 B.C.

Worked wooden plate for unknown use from dwelling site at Toro, Shizuoka city, Shizuoka pref. (34° 57' N Lat, 138° 25' E Long), excavated during 1945 to 1950. Sample was found 1 to 2 m below ground surface, in alluvial sand and clay at ancient bed of Abe River and associated with Yayoi pottery. Coll. by K. Mochizuki; subm. 1962 by O. Yamada. Date should be compared with those in the previous report (N-70, 71 and 73, RIKEN I).

N-140. Fushun	150 ± 90
	A.D. 1800

Worm-eaten wooden statue of peculiar expression from suburb of Fushun, Manchuria (37° N Lat, 124° E Long). Subm. 1964 by K. Toishi, Tokyo Cultural Properties Research Inst. *Comment* (K.T.): statue was supposed to be an ancient shamanistic idol, but date is too young.

B. Andes

Kotosh series

A mound of Kotosh (9° 56' S Lat, 76° 17' W Long), ca. 5 km from Huanuco city, central Peru, was excavated in 1960 and 1963 by Seiichi Izumi, head of Tokyo Univ. Scientific Expedition to the Andes. Mound accumulations were divided into 8 phases from surface downward as follows: Kotosh Higuera, Kotosh San Blas, Kotosh Sajarapatac, Kotosh Chavín, Kotosh Kotosh, Kotosh Wairajirca, Templo de los Nichitos (Construction I), and Templo de las Manos Cruzadas (Construction J) phases. All phases except Kotosh Higuera phase are thought to belong to Formative period of New World prehistory (Izumi and Sono, 1963). Coll. 1960 by the Expedition party; subm. by S. Izumi.

N-62. Kotosh Higuera (BC-24)	1880 ± 200
	A.D. 70

Charcoal from floor of a house, KTD-4, UR-11b.

	1350 ± 140
N-111. Kotosh Sajara-patac phase	A.D. 600
Charcoal from lower floor of a house, KTB-2.	
	1690 ± 130
N-63-2. Kotosh Sajara-patac phase (BC-26)	A.D. 260
Charcoal from KTD7B-3.	
	2820 ± 120
N-65-2. Kotosh Chavín phase (BC-27)	870 B.C.
Charcoal from KTC3-2.	
	2870 ± 230
N-66-a. Kotosh Kotosh phase (BC-28)	920 B.C.
Charcoal from KTC3-4.	
	2840 ± 170
N-67-2. Kotosh Kotosh phase (BC-29)	890 B.C.
Charcoal from KTD3A-8.	
	3100 ± 130
N-69-2. Between Kotosh Wairajirca and Construction I phases (BC-31)	1150 B.C.

Tumbes series

Several members of Tokyo Univ. Scientific Expedition to the Andes made excavations at Pechiche and Garbanzal ca. 10 km S of Tumbes city (3° 40' S Lat, 80° 30' W Long), northern Peru. Upper strata at Pechiche are considered to be contemporaneous with Garbanzal, belonging to Garbanzal culture, and the lower belong to Pechiche culture of Formative period of Central Andes and Ecuador (Izumi and Terada, in press). Coll. 1960 by N. Watanabe, K. Terada, *et al.*; subm. by S. Izumi.

	810 ± 150
N-72. Pechiche (BC-36)	A.D. 1140
Charcoal from central hearth of floor at Trench C.	
	785 ± 120
N-75. Pechiche (BC-37)	A.D. 1165
Charcoal from upper strata at Pechiche, Trench C.	
	2260 ± 130
N-80. Pechiche (BC-38)	310 B.C.
Charcoal from lowest layer at Pechiche, Trench C.	
	860 ± 110
N-82. Pechiche (BC-39)	A.D. 1090
Same material as BC-36.	
	910 ± 120
N-83. Pechiche (BC-40)	A.D. 1040
Same material as BC-37.	

N-84. Garbanzal (BC-41) **7510 ± 260**
5560 B.C.

Charcoal from a cemetery along Tumbes River, Garbanzal Site I. Accompanying pottery was of Garbanzal type.

N-85. Garbanzal (BC-42) **3680 ± 130**
1730 B.C.

Charcoal from Garbanzal II-C2. Accompanied with pottery fragments of the San Juan Coarse Incised type.

N-86. Ancón preceramic (BC-43) **3810 ± 150**
1860 B.C.

Plant fiber mixed with sand. Site is located ca. 40 km N of Lima, on central coast of Peru (11° 50' S Lat, 77° 10' W Long). Coll. by Museo Nacional de Antropología y Arqueología de Lima; subm. by S. Izumi.

N-87. Paracas (BC-44) **3660 ± 170**
1710 B.C.

Charcoal from Paracas, S coast of Peru (13° 50' S Lat, 76° 20' W Long). Coll. by the above Museo; subm. by S. Izumi.

N-88. Chavín de Huántar (BC-45) **550 ± 110**
A.D. 1400

Wood remain from Chavín de Huántar, N highland of Peru (9° 40' S Lat, 77° 10' W Long). Subm. by S. Izumi.

Chanapata series

Chanapata site, located near Cusco, S highland of Peru (13° 30' S Lat, 72° W Long), was excavated in 1960 by Manuel Chávez Ballón and two members of Tokyo Univ. Scientific Expedition to the Andes. Coll. by M. Chávez Ballón and N. Watanabe; subm. by S. Izumi.

N-89. Chanapata (BC-46) **2520 ± 150**
570 B.C.

Charcoal from an ash layer.

N-90. Chanapata (BC-47) **2360 ± 760**
410 B.C.

Charcoal from lowest layer. *Comment:* large error is due to shortage of material.

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NATIONAL PHYSICAL LABORATORY RADIOCARBON MEASUREMENTS IV

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The following list comprises measurements made since those reported in NPL III and is complete to the end of November 1965.

Ages are relative to A.D. 1950 and are calculated using a half-life of 5568 yr. The measurements, corrected for fractionation (quoted δC^{13} values are relative to the P.D.B. standard), are referred to 0.950 times the activity of the NBS oxalic acid as contemporary reference standard. The quoted uncertainty is one standard deviation derived from a proper combination of the parameter variances as described in detail in NPL III. These variances are those of the standard and background measurements over a rolling twenty week period, of the sample δC^{14} and δC^{13} measurements and of the de Vries effect (assumed to add an additional uncertainty equivalent to a standard deviation of 80 yr). Any uncertainty in the half-life has been excluded so that relative C^{14} ages may be correctly compared. Absolute age assessments, however, should be made using the accepted best value for the half-life and the appropriate uncertainty then included. If the net sample count rate is less than 4 times the standard error of the difference between the sample and background count rates, a lower limit to the age is reported corresponding to a net sample count rate of 4 times the standard error of this difference.

The description of each sample is based on information provided by the person submitting the sample to the laboratory.

The work reported forms part of the research program of the National Physical Laboratory and is published by permission of the Director of the Laboratory.

I. ARCHAEOLOGIC AND GEOLOGIC SAMPLES

A. England

NPL-104. Cow Down 1. Wiltshire

2480 \pm 90

530 B.C.

Wood charcoal (*Q. robur*) from post hole, probably from post itself, of house of Late Bronze Age or very Early Iron Age at Cow Down (51° 10' N Lat, 2° 10' W Long), Longbridge Deverhill, nr. Warminster, Wiltshire. Coll. 1958-60 by S. Hawkes; subm. by L. Biek, Ministry of Public Bldg. and Works. *Comment* (L.B.): although the associated pottery has remarkable affinities to French Bronze Age types of 8th-7th century B.C., result in fact confirms excavators' estimate of time occupation of this house. $\delta C^{13} = -25.0\%$.

+1850
8570 -1500

NPL-72. Mockerkin Tarn, West Cumberland

6620 B.C.

Wood fragment (probably *Betula pubescens*) from pollen zone

boundary VIIa/b of lake deposit, 270 cm below mud surface, Mockerkinn Tarn (54° 35' N Lat, 3° 25' W Long), West Cumberland. Coll. 1963 and subm. by W. Tutin, Univ. of Leicester. *Comment* (W.T.): result is more than 3000 yr greater than expected from sample position in profile. This discourages use of fragments of allochthonous organic matter as dating material (Clark and Godwin, 1962).

+830
8580 -755
6630 B.C.

NPL-86. Teignmouth, Devonshire

Peat from layer 5 cm thick underlying 74 cm of estuarine clay and 100 cm of sand off English Channel seaboard near Teignmouth (50° 31' 30" N Lat, 3° 25' 00" W Long), Devonshire, England. Coll 1964 and subm. by R. H. Clarke, Univ. of Bristol. *Comment* (R.H.C.): pollen analyses place sample at beginning of Zone VIa which with this C¹⁴ measurement substantiates assignment of Late Glacial-Postglacial (Flandrian) age to these submerged estuarine deposits. Sample lies approx. -78 ft O.D. and apparently underlain by a (terrestrial) soil, thus appearing to represent onset of brackish water at that point. Present tidal range at Teignmouth is 12.7 ft (Springs), so mean sealevel at that time was therefore approx. 85 ft. This agrees well with published information on Postglacial eustatic rise in sealevel (Godwin *et al*, 1958).

28,200 ± 500
26,250 B.C.

NPL-87. Brandon Terrace, Warwickshire

Twigs and leaves (*B. nana*) washed from vegetable debris in thin peat layer underlying 13-ft thick gravel deposit of Avon No. 2 terrace at Brandon (52° 22' 30" N Lat, 1° 26' 00" W Long), Warwickshire. Coll. 1964 and subm. by F. W. Shotton, Univ. of Birmingham. *Comment* (F.W.S.): sample was rolled mass from channel of peaty silts under 12 ft gravel belonging to Avon No. 2 river terrace. Insect fauna indicates cold conditions, and a peat with similar fauna and in same basal position from same terrace at Fladbury (Worcs.) gave age of 38,000 ± 700 (GRO-1269). Brandon sample is therefore younger than expected but this might be result of a long period of alluviation progressively upstream. $\delta C^{13} = -25.0\text{‰}$.

NPL-88. Austerfield, Yorkshire

>41,200

Wood fragments from peaty layer at depth of 6 ft 6 in. at Austerfield gravel pit (53° 27' 22" N Lat, 0° 59' 47" W Long), Yorkshire. Coll. 1964 and subm. by G. D. Gaunt, Geol. Surv. & Mus. *Comment*: it was hoped that measurement would provide useful information on which to base mapping of Humber basin deposits, hitherto estimated as Fluvio-glacial. $\delta C^{13} = -25.0\text{‰}$.

NPL-99. Isleworth 2 Middlesex

>42,900

Stem fragments in silt at base of gravels comprising a low terrace of the Thames at Isleworth (51° 27' 30" N Lat, 0° 20' 00" W Long), Mid-

dlex. Coll. 1959 and subm. by F. W. Shotton, Univ. of Birmingham. *Comment:* sample derived from deposit of organic silt underlying sands and gravels which produced numerous bones of bison and reindeer. Structure of gravels and enclosed fauna indicated cold conditions. Stratigraphy of gravels indicated that they were deposited at some time during Last (Weichselian or Würm) Glaciation. Insects from plant beds indicate temperate conditions and may thus have lived either during Last (Eemian) Interglacial or an interstadial in Last Glaciation (NPL-34, NPL II). $\delta C^{13} = -25.0\text{‰}$.

Romney Marsh series, Kent

Samples from clay and peat deposits at Scotney Court Farm ($50^{\circ} 57' \text{ N Lat, } 00^{\circ} 54' \text{ E Long}$), Lydd, Romney Marsh, Kent. Coll. 1964 and subm. by R. D. Green, Rothamsted Expt. Stn. *Comment:* NPL-91 establishes latest possible date for development of older parts of shingle beach complex of Dungeness. Roots of NPL-92 were clearly *in situ* and were certainly present before overlying clay sediments were deposited. Result suggests roots to be approx. contemporary with peat elsewhere in Romney Marsh (NPL-23, NPL II) and, with age of NPL-91, implies this thin peat not to be sedimentary but all *in situ*. Thus associated shingle ridges may not be "the shore formed when sealevel rose to near the present and drowned the 25 ft submerged forest", as previously suggested (Lewis and Balchin, 1940).

2050 \pm 90

NPL-91. Scotney Court Farm 1

100 B.C.

Peat from layer 2 in. thick, at depth of 48 in. overlying clay deposit with roots (NPL-92). $\delta C^{13} = -27.0\text{‰}$.

2740 \pm 400

NPL-92. Scotney Court Farm 2

790 B.C.

Roots from clay deposit, 30 in. thick, at depth of 50 in. underlying thin peat layer (NPL-91).

Channel Borehole series

Drift deposits from Channel Tunnel Site Investigation borehole P.040 (P3) ($51^{\circ} 06' 04'' \text{ N Lat, } 01^{\circ} 24' 08'' \text{ E Long}$), beneath sea bed $-34.7 \text{ m N.G.F. } (-113 \text{ ft O.D.})$ occupying shallow sinuous valley on submerged dip slope of Middle Chalk (Turonian) inclined gently to NNE. Coll. 1964 by Wimpey; subm. by E. R. Shephard-Thorn, Geol. Survey and Mus. *Comment* (E.R.S.T.): date for NPL-103 falls in pollen Zone III, that for NPL-101 in Zone IV, implying deposits to span conventionally accepted Late Glacial-Holocene boundary. Palynological evidence confirms this conclusion. In both samples tree pollen is dominated by pine and birch, but NPL-103 has higher proportion of herbaceous pollen; neither sample contains evidence of marine or estuarine deposition. Age and depth of deposits confirm that they predate Lower

Peat of the Netherlands (Jelgersma, 1961), and that there has since been a minimum relative sealevel rise of 120 ft; they also indicate their comparability with deeper moorlogs of North Sea (Godwin 1943, 1945, 1960).

NPL-101. Borehole P3 Sample A **9920 ± 120**
7970 B.C.

Peat from layer 1 ft thick, underlying 5 ft of medium gravel from sea bed surface. $\delta C^{13} = 25.0\text{‰}$.

NPL-103. Borehole P3 Sample B **10,530 ± 120**
8580 B.C.

Peat clay from layer 3 ft thick immediately underlying NPL-101. $\delta C^{13} = -25.0\text{‰}$.

B. Scotland

Scottish Highland series

This series of samples from east-central Highlands represents sites of both hill (NPL-94, 95) and basin (NPL-96, 111, 112) peat formation. Results support current view, suggested from palynological data, that the latter were first to begin formation (Synge, 1956). All samples coll. 1964 and subm. by J. M. Stewart, Macaulay Inst. for Soil Res.

NPL-94. Cruden 1 Aberdeenshire **5020 ± 95**
3070 B.C.

Amorphous peat from organic-mineral interphase at depth of 125 cm, 450 ft O.D. at Cruden ($57^{\circ} 27' 12''$ N Lat, $1^{\circ} 57' 6''$ W Long), Aberdeenshire Scotland. $\delta C^{13} = -25.0\text{‰}$.

NPL-95. Cairn o Mount, Kincardineshire **4040 ± 95**
2090 B.C.

Amorphous peat from organic-mineral interphase at depth of 237 cm, 1470 ft O.D. at Cairn a Mount ($56^{\circ} 55'$ N Lat, $2^{\circ} 34'$ W Long), Kincardineshire, Scotland. $\delta C^{13} = -21.0\text{‰}$.

NPL-96. Slack Burn, Kincardineshire **7220 ± 235**
5270 B.C.

Amorphous peat from organic-mineral interphase at depth of 810 cm, 1400 ft O.D. at Slack Burn ($56^{\circ} 55' 30''$ N Lat, $2^{\circ} 33' 0''$ W Long), Kincardineshire, Scotland. $\delta C^{13} = -22.3\text{‰}$.

NPL-111. Candyglirach, Aberdeenshire **9000 ± 135**
7050 B.C.

Amorphous peat from organic-mineral interphase at depth of 505 cm, 250 to 275 ft O.D. at Candyglirach ($57^{\circ} 06' 12''$ N Lat, $02^{\circ} 25' 00''$ W Long). Aberdeenshire, Scotland. $\delta C^{13} = -27.0\text{‰}$.

NPL-112. Cruden 2 Aberdeenshire **5580 ± 100**
3630 B.C.

Amorphous peat from organic-mineral interphase at depth of 206 cm, 350 to 400 ft O.D. at Cruden ($57^{\circ} 27' 18''$ N Lat, $01^{\circ} 57' 06''$ W Long), Aberdeenshire, Scotland. $\delta C^{13} = -30.4\text{‰}$.

C. Wales

37,310 ⁺¹⁵¹⁵
-1275

NPL-97. Tre-Llys, North Pembrokeshire

35,360 B.C.

Marine shell from gravel pit at Tre-Llys (51° 57' 45" N Lat, 5° 4' 25" W Long), nr. St. Nicholas, Fishguard, North Pembrokeshire, 200 ft O.D. Coll. 1964 and subm. by B. S. John, Univ. of Oxford. *Comment* (B.S.J.): this date and NPL-80 (37,960 ⁺¹⁷⁰⁰ ₋₁₄₀₀, NPL III) relate to outwash gravels laid down during melting of last Irish Sea ice sheet and indicate that gravels of so-called "South Wales End-moraine" of N Pembrokeshire are no younger than glacial deposits found 18 mi further S. Evidence suggests that interstadial boreal conditions persisted in Irish Sea 38,000 yr B.P. and that Last Glaciation of W Wales followed this interstadial phase, possibly as equivalent of European Main Würm glaciation (John, 1965; West, 1963; Mitchell, 1960; Zeuner, 1959; Charlesworth, 1929). $\delta C^{13} = -8.2\text{‰}$.

NPL-98. Aber-Mawr, North Pembrokeshire

>40,300

Wood (probably *Pinus* sp) from calcareous boulder clay at Aber-Mawr (51° 57' 40" N Lat, 5° 5' 30" W Long), nr. St. Nicholas, Fishguard, N Pembrokeshire. Coll. 1964 and subm. by B. S. John, Univ. of Oxford. *Comment* (B.S.J.): stratigraphic evidence suggests that this Irish Sea till is no older than shelly outwash at Mullock Bridge (NPL-80 37,960 ⁺¹⁷⁰⁰ ₋₁₄₀₀, NPL III) and Tre-llys (NPL-97) (Mitchell, 1960; Synge, 1961; Synge and Stevens, 1960; West, 1963; John, 1965).

D. Canada

6760 ± 140

NPL-82. R. aux-Roches Valley, Quebec

4810 B.C.

Shell (*Mya truncata* and *Hiatella arctica*) from side of A2 terrace at 148 ft O.D. in N bank R. aux-Roches Valley (62° 02' N Lat, 74° 32' W Long), near Deception Bay, Quebec, Canada. Coll. 1962 and subm. by Barry Matthews, McGill Univ. *Comment* (B.M.): as sample was obtained from the only marine deposit found 8 mi inland from Deception Bay, date suggests a valley glacier prevented incursion of sea into R. aux-Roches valley until well into "postglacial" times. $\delta C^{13} = -6.8\text{‰}$.

6660 ± 125

NPL-83. R. Renard-Noir Valley, Quebec

4710 B.C.

Marine shell (*Hiatella arctica*, *Mya truncata*, *Balanus balanus*, *Clino-cardium ciliatum*) from silt polygons immediately below scarp of 237/248 ft raised beach remnant, N side of R. Renard-Noir Valley (62° 07' N Lat, 74° 38' W Long), Deception Bay, Quebec, Canada. Coll. 1962 and subm. by Barry Matthews. $\delta C^{13} = -5.2\text{‰}$.

NPL-84. R. Renard-Noir Valley, Quebec**6660 ± 130
4710 B.C.**

Marine shell (*Hiatella arctica*, *Mya truncata*, *Macoma balthica*, *Macoma calcarea*), from 242 ft raised beach, S side of R. Renard-Noir Valley (62° 07' N Lat, 74° 38' W Long), Deception Bay, Quebec, Canada. Coll. 1962 and subm. by Barry Matthews. *Comment* (B.M.): despite difference of 47 ft in altitude and differing percentages of various mollusc species, deposits represented by NPL-83 and this sample appear to have formed at about same time but probably in different depths of water. Comparative richness of marine fauna in 242 ft deposit might indicate a warming of sea at ca. 6700 yr ago during early part of Hypsithermal Interval. $\delta C^{13} = -5.1\text{‰}$.

NPL-85. R. Renard-Noir Valley, Quebec**6970 ± 125
5020 B.C.**

Marine shell (*Hiatella arctica*, *Balanus* sp.) from sandy clay near surface of 297 ft raised beach, N side R. Renard-Noir Valley (62° 07' N Lat, 74° 38' W Long), Deception Bay, Quebec, Canada. Coll. 1962 and subm. by Barry Matthews. *Comment* (B.M.): although age is much younger than expected in view of previous determination of 10,450 ± 250 B.P. (I-488, Isotopes, Inc., unpub.) obtained from same raised beach, it is similar to other C^{14} dates (I-729, I-726, Isotopes, Inc., unpub.) of material from near post-glacial marine limit in northern Ungava. Considerable doubt is now cast on theory that Hudson Strait was free from ice during classical Wisconsin Maximum (Ives, 1963) or even 10,500 yr ago. It is also doubtful if E-W warping of raised marine beaches below 300 ft O.D. occurred during postglacial isostatic uplift since shells from a raised marine beach at a similar elevation but 100 mi to W at Wolstenholme are of comparable age, i.e. 6900 ± 130 yr B.P. (NPL-58, NPL III) (Matthews, 1964, 1963, 1962; Farrand and Gadjia, 1962). $\delta C^{13} = -1.9\text{‰}$.

*E. Egypt***NPL-5. Tarkhan, interlaboratory check****4310 ± 90
2360 B.C.**

Linen from 1st Dynasty mastaba (2050) at Tarkhan (29° 40' N Lat, 31° 13' E Long), near Cairo, Egypt. Material from W. M. Flinders Petrie Colln., Univ. College of London, is securely dated to Wadji, fourth king of this dynasty. Sample was measured at UCLA-739, 4265 ± 80, UCLA IV; descr. by Flinders Petrie (1914). $\delta C^{13} = -25.0\text{‰}$.

II. ATMOSPHERIC CO₂ MEASUREMENTS**NPL-90. Sizewell, Suffolk**

$\delta C^{14}\text{‰}$	$\delta C^{13}\text{‰}$	$\Delta\text{‰}$
907 ± 13	-12.0 ± 1	857 ± 13

Atmospheric CO₂ from Sizewell (52° 12' 30" N Lat, 1° 34' 00" W Long), Suffolk. Coll. July to October 1964 by F. E. Bentley; subm. by B. C. Godbold, Esq.

NPL-100. Berkeley, Gloucestershire $\delta C^{14}\text{‰}$ **882 ± 17** $\delta C^{13}\text{‰}$ **-11.8 ± 1** $\Delta\text{‰}$ **832 ± 17**

Atmospheric CO₂ from Berkeley (51° 41' N Lat, 2° 28' W Long), Gloucestershire. Coll. Autumn 1964 by K. E. White; subm. by B. C. Godbold, Esq.

III. REFERENCE MEASUREMENT

NPL-3. Heidelberg Sodium Carbonate Standard **10.224 ± 0.033**

Labeled sample H-522 distributed by K. O. Munnich. Result given is ratio of activity of this sample to 95% of oxalic acid standard. $\delta C^{13} = -9.8\text{‰}$.

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UNIVERSITY OF PENNSYLVANIA RADIOCARBON DATES IX

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INTRODUCTION

This date list includes those series of samples completed in this laboratory as of November, 1965. The B.P. ages are based upon A.D. 1950, and are calculated with a half-life value of 5568 yr. Errors quoted are those derived from measurements of sample, background, and modern-age calibration, and do not include any half-life error. All samples were pretreated with 3N HCl, and some, where noted, received additional pretreatment with 2% NaOH for the removal of possible humic contaminants.

Standard calibration samples are 110- to 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 $-25.7 \pm 1.3\%$ as measured on the University of Pennsylvania mass spectrograph.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES: NEAR EAST

A. Iran

Agrab Tepe series, Iran

Agrab Tepe (37° N Lat, $45^{\circ} 28'$ E Long), is located near Hasanlu Tepe in Solduz Valley of Azerbaijan Prov. of Iran. Coll. 1964 and subm. by R. H. Dyson, Jr., director of joint expedition of Univ. Mus., Univ. of Pennsylvania, Metropolitan Mus. of Art of New York City, and Archaeol. Service of Iran. These samples are all representative of Hasanlu Period IIIA (Pennsylvania III, VI, IX).

<p>P-895. Period IIIA, Section C, floor Charcoal from floor of Section C, Period IIIA.</p>	<p>2665 \pm 54 715 B.C.</p>
<p>P-894. Period IIIA, Section A Large lumps of charcoal, Section A, Period IIIA.</p>	<p>2582 \pm 55 632 B.C.</p>
<p>P-980. Period IIIA, Section D, center Charcoal and clay from center of room, section D, Period IIIA. <i>Comment:</i> NaOH pretreatment.</p>	<p>2540 \pm 56 590 B.C.</p>

P-979. Period IIIA, Section D, W wall**2457 ± 51****507 B.C.**

Charcoal from Section D, against W wall, Period IIIA. *Comment:* NaOH pretreatment.

P-879. Period IIIA, burned beam**2391 ± 54****441 B.C.**

Large lumps of charcoal from burned beam in Period IIIA. *Comment:* NaOH pretreatment. Roots present.

P-893. Period IIIA, reeds**2289 ± 47****339 B.C.**

Charred reeds from Section A, Period III. *Comment:* NaOH pretreatment. Roots present.

Hasanlu Tepe series, Iran

Hasanlu (37° N Lat, 45° 28' E Long), is located near town of Nagadeh in Azerbaijan Prov. of Iran, about halfway between Nagadeh and S shore of Lake Urmia, just S of small freshwater lake known as Shor Gol or Hasanligut. Coll. 1962 and subm. by R. H. Dyson, Jr., Director of the joint expedition of Univ. Mus., Univ. of Pennsylvania, Metropolitan Mus. of Art of New York City, and Archaeol. Service of Iran. Samples in this series represent Grey Ware phase (Hasanlu Period IV), represented by spouted pitchers, which was ended by sacking of the site, an event perhaps fitting historically with a known Urartian campaign in the area at end of 9th century B.C.; and Triangle Ware phase (Hasanlu Period III) which is thought to date to end of Median period, late 7th century B.C. (Dyson, 1958, 1959, 1960a, 1960b, 1962; Pennsylvania III, VI).

Grey Ware Phase (Periods IV, IVB)**P-905. Period IV, gate building****2700 ± 54****750 B.C.**

Charred barley from floor of gate building of Burned Building III, Period IV. *Comment:* NaOH pretreatment.

P-862. Period IV, under Tower 5**2665 ± 46****715 B.C.**

Charcoal from floor under Tower 5, Period IV. *Comment:* NaOH pretreatment.

P-906. Period IV, gate building floor**2648 ± 54****698 B.C.**

Charred grain, on floor of gate building of Burned Building III, Period IV. *Comment:* NaOH pretreatment. Compare P-905, above.

P-860. Period IVB**2718 ± 55****768 B.C.**

Charred grain mixed with charred reeds, on floor S of oven in Burned Building III, Period IVB. *Comment:* NaOH pretreatment.

- 2699 \pm 53**
749 B.C.
- P-907. Period IVB, grapes**
Dried grapes from vase on floor of Burned Building III, Period IVB, believed to date sacking of site.
- 2627 \pm 53**
677 B.C.
- P-861. Period IVB, floor**
Charred grain on floor of Burned Building III, Period IVB. *Comment*: NaOH pretreatment.
- 2604 \pm 55**
654 B.C.
- P-863. Period IVB, near grindstone**
Charred grain mixed with charred reeds on floor E of grindstone, Burned Building III, Period IVB. *Comment*: NaOH pretreatment.
- 2529 \pm 53**
579 B.C.
- P-865. Period IVB, citadel**
Charred wheat from Floor 3 of citadel, Period IVB. *Comment*: NaOH pretreatment. Sample undersized.
- Triangle Ware Phase (Period III)**
- 2521 \pm 52**
571 B.C.
- P-903. Period III, Pit 7**
Charred grain from Pit 7, associated with human skull, Period III.
- 5445 \pm 72**
3495 B.C.
- P-866. Rezaiyeh Road Tepe, Iran**
Charcoal from "Rezaiyeh Road Tepe (37° 40' N Lat, 45° 30' E Long), 79 km N of Hasanlu Tepe, near Geoy Tepe and town of Rezaiyeh, Azerbaijan, Iran. Coll. 1962 and subm. by R. H. Dyson, Jr., Univ. Mus., Univ. of Pennsylvania. *Comment*: sample from stratum containing materials resembling those of early Pisdeli Tepe levels; compare P-157, 4560 ± 160 (Pennsylvania III); P-505, 5638 ± 85 ; and P-504, 5518 ± 81 (Pennsylvania VI).
- 6264 \pm 70**
4314 B.C.
- P-931. Tall-i-Bakun B, Iran**
Ash from point in wall of Japanese trench at Tall-i-Bakun (30° N Lat, 52° 50' E Long), on Marv Dasht plain near Fars, SW of Persepolis, Iran. Associated with coarse straw-tempered pottery. Coll. 1964 and subm. by J. R. Caldwell, Illinois State Mus., Springfield (Langsdorf and McCown, 1942). *Comment*: compare P-438, 5990 ± 81 (Pennsylvania VI) from approx. same point in this mound.
- 7762 \pm 98**
5812 B.C.
- P-930. Tall-i-Ghazir, Levels 5 and 6**
Ash from Levels 5 and 6 of a step trench excavated by D. E. McCown in 1948 at Tall-i-Ghazir (31° 20' N Lat, 49° 29' E Long), 13 km NW of Ram Hormuz, Khuzistan, Iran. Coll. 1964 and subm. by J. R. Caldwell (McCown, 1955; Caldwell, mss.). *Comment* (J.R.C.): sample

should date upper range of painted buff ware at this site, and is believed contemporary in part with Susa A, and no earlier than LeBreton's "d" (1957). Date is apparently 2000 yr too old.

Tal-i-Iblis series, Iran

Tal-i-Iblis (29° 51' N Lat, 56° 41' E Long), lies in Mashiz Valley, 12 km SE of Mashiz and 70 km SW of Kerman, Iran. Coll. 1964 and subm. by J. R. Caldwell, who assigned six levels to the mound. Level "O" represents pre-mound occupation, with examples of earliest known ceramics of the region, a coarse and poorly-fired straw-tempered ware called Lahlezar Coarse. Levels 1 and 2 represent the Iblis period, with some resemblance in ceramic decoration to Sialk III and Hissar I, and evidence of copper melting or smelting. Level 3 permits no cultural assignment. Levels 4 and 5 are assigned to Ali Abad period, with larger and more carelessly drawn designs than those of Levels 1 and 2 (Stein, 1927; Caldwell, mss.).

P-924. Level 0, pre-mound occupation	5706 ± 70
	3756 B.C.

Charred seeds and small bits of charcoal. *Comment:* NaOH pre-treatment.

P-925. Level 1, Iblis period	5865 ± 72
	3915 B.C.

Charred seeds and small bits of charcoal.

P-926. Level 2, Iblis period	5857 ± 73
	3907 B.C.

Charcoal.

P-927. Level 3	5574 ± 58
	3624 B.C.

Charcoal and clay.

P-928. Level 4, Ali Abad period	5432 ± 57
	3482 B.C.

Charcoal and clay.

P-929. Level 5, Ali Abad period	4678 ± 55
	2728 B.C.

Charcoal and ash.

Susa series, Iran

Susa (32° 12' N Lat, 48° 20' E Long) lies near modern town of Shush, between Karkheh River and Karin River, ca. 40 mi W of Shush-tar, and 20 mi SW of Dezfoul, in Khuzistan, Iran. This citadel mound has been the subject of intermittent investigations and excavations since the mid-1800's, and contains levels dating from Neolithic to nearly modern times (McCown, 1955; LeBreton, 1957). Coll. 1963 by A. Ghirshman; subm. by P. Delougaz, Oriental Insti., Univ. of Chicago.

P-912. Locus 6, Apadana Charcoal and ash.	5418 ± 70 3468 B.C.
P-913. Locus 50, Level A/III houses Ash. <i>Comment:</i> sample undersized.	3703 ± 124 1753 B.C.

*B. Turkey***Gordion series, Turkey**

Gordion (39° 45' N Lat, 31° 55' E Long), on the Sangarius River, 70 mi SW of Ankara, Turkey, is site of a Phrygian kingdom which fell during Cimmerian invasion of early 7th century B.C. The City Mound (the town), rebuilt during period of Persian Empire, contains strata dating from Chalcolithic to Galatian periods, while burials in earth tumuli thus far excavated date from 740 B.C. through Hellenistic times. Excavations of the site by Univ. Mus., Univ. of Pennsylvania, have continued since 1950 under direction of R. S. Young. Subm. by E. Kohler (Kohler and Ralph, 1961; Pennsylvania III, V, VIII).

P-898. City Mound, Megaron 3, Room 3, seeds	2707 ± 52 757 B.C.
Charred seeds found in pot in burnt fill by S wall, Room 3 in Megaron 3, City Mound. Coll. 1959. <i>Comment:</i> NaOH pretreatment.	
P-899. City Mound, Megaron 3, Room 3, textile	2620 ± 50 670 B.C.
Charred textile fragments from burnt fill in E end of Room 3 in Megaron 3, City Mound. Coll. 1959. <i>Comment:</i> NaOH pretreatment.	
P-901. City Mound, Terrace B	2693 ± 54 743 B.C.
Charred reeds from roof, found burnt and smashed on floor of Room S-1, Terrace B, City Mound. Coll. 1961. <i>Comment:</i> NaOH pretreatment.	
P-902. Küçük Hüyük, Unit 2	2522 ± 53 572 B.C.
Burnt wood from short logs sunk under floor as support for vertical beam, a structural member in original mud brick wall of Unit 2, Küçük Hüyük, Gordion. Coll. 1963. <i>Comment:</i> NaOH pretreatment. Estimated age: ca. 550 B.C.	

Karataş series, Turkey

Karataş (36° 45' N Lat, 30° E Long), is a small Early Bronze Age site 8 mi E of Elmali on upland Plain of Elmali in the interior of ancient Lycia, Antalya, Turkey, Excavations were conducted by M. J. Mellink, Bryn Mawr College, Bryn Mawr, Pennsylvania, in 1963 and

1964. The mound is 3 to 4 m high, 100 m diam, and lies NE of a large necropolis. Coll. 1964 and subm. by Mellink (Mellink, 1964).

P-920. Karataş, E.B.II, Pit 6 **4274 ± 62**
2324 B.C.

Charcoal from Pit 6 in floor of burnt house.

P-923. Karataş, E.B.II, courtyard **4228 ± 62**
2278 B.C.

Charcoal from fill under burnt floor in courtyard, E side, burnt house.

P-917. Karataş, E.B.II, post hole **4221 ± 61**
2271 B.C.

Charcoal from post hole N2, burnt building.

P-921. Karataş, E.B.II, Pit 5 **4138 ± 62**
2188 B.C.

Charcoal from Pit 5 in floor of burnt house.

P-918. Karataş, E.B.II, floor **4130 ± 61**
2180 B.C.

Charcoal from floor level of burnt house, area S of bins.

P-919. Karataş, E.B.II, beam **4126 ± 60**
2176 B.C.

Charcoal from beam (juniper?) found on floor near spur wall.

General Comment: all samples received NaOH pretreatment. Average age of six samples is 2236 ± 25 B.C. (or 2362 ± 26 B.C., 5730 half-life). Estimated age: 2500 to 2400 B.C. (M.J.M.): The conflagration level on the main building at Karatas can be dated archaeologically to a late phase of Troy I period, or to end of Cilician Early Bronze II. Samples submitted came from same burnt level which was destroyed in one single catastrophe. There are two construction phases in the building from which samples were taken, but the interval between these phases was probably very brief—not more than one or two decades.

II. ARCHAEOLOGIC SAMPLES: MEDITERRANEAN

Shipwreck series, Mediterranean Sea

Samples in this series derive from sunken ships found at various places in the Mediterranean Sea, and explored and excavated by Peter Throckmorton, Univ. Mus., Univ. of Pennsylvania. Subm. by Throckmorton. Wood identifications made by Forest Products Lab., U. S. Dept. of Agriculture, Madison, Wisconsin.

Plainer wreck

The Planier wreck ($43^{\circ} 27' N$ Lat, $5^{\circ} 17' E$ Long), off S coast of France near Marseilles, is a Roman ship believed to date to 1st century B.C. (Benoit, 1962). Coll. 1962.

2164 \pm 52**P-848. Planier wreck, keel, No. 1**

214 B.C.

Wood from keel. *Comment:* sample kept in fresh water after raising. Sample pretreatment included additional boiling in H₂O and pre-charring in nitrogen atmosphere.

2035 \pm 51**P-853. Planier wreck, keel, No. 2**

85 B.C.

Wood from keel. *Comment:* sample pretreatment included additional boiling in H₂O and pre-charring in nitrogen atmosphere.

Albenga wreck

The Albenga wreck (43° 57' N Lat, 7° 57' E Long), was found off the Riviera coast of northern Italy. Cargo of amphorae dated archaeologically to 1st quarter of 1st century. B.C.

2192 \pm 52**P-849. Albenga wreck**

242 B.C.

Scraps of pine planks and oak tenons. *Comment:* sample pretreatment included additional boiling in H₂O.

Sparghi wreck

The Sparghi wreck (41° 18' N Lat, 9° 27' E Long), found off coast of N. Sardinia, is a Roman ship believed to date to end of 2nd century B.C. (120 to 100 B.C.). Coll 1957 (Lamboglia, 1958).

2254 \pm 52**P-850. Sparghi wreck, frame, No. 1**

304 B.C.

Wood, probably oak, from frame. *Comment:* sample pretreatment included pre-charring in nitrogen atmosphere.

2265 \pm 53**P-851. Sparghi wreck, frame, No. 2**

315 B.C.

Wood from frame. *Comment:* sample pretreatment included pre-charring in nitrogen atmosphere.

Grand Congloue wreck

The Grand Congloue wreck (43° 15' N Lat, 5° 20' E Long), was found off coast near Marseilles, France. Raised in 1952, wreck is believed to date between 220 and 130 B.C., and may have been ship of Maarko Sestios (Benoit, 1961). Other materials from this wreck have been dated as A-66, 2295 \pm 110 (Arizona I, solid carbon), and A-66-bis, 2160 \pm 150 (Arizona III, carbon dioxide).

2086 \pm 51**P-845. Grand Congloue wreck, planking, No. 1**

136 B.C.

Scrap of wooden planking. *Comment:* sample pretreatment included only standard 3N HCl; very difficult to purify.

2069 \pm 51**P-847. Grand Congloue wreck, planking, No. 2 119 B.C.**

Scrap of wooden planking. *Comment:* sample stored in fresh water for 2 yr after wreck was raised. Sample pretreatment included additional boiling in H₂O and pre-charring in nitrogen atmosphere.

2036 \pm 51**P-852. Grand Congloue wreck, planking, No. 3 86 B.C.**

Miscellaneous scraps of planking. *Comment:* sample pretreatment included additional NaOH; difficulty to purify.

1995 \pm 38**P-854. Grand Congloue wreck, frame or rib 45 B.C.**

Fragments of wooden frame or rib. *Comment:* sample stored in fresh water after raised. NaOH pretreatment; difficult to purify.

Antikythera wreck

The Antikythera wreck (35° 55' N Lat, 23° 22' E Long), was found off coast of Antikythera at W end of Sea of Crete, and is believed to have been sunk between 90 and 70 B.C. Coll. 1901 by persons unknown (Weinberg, *et al.*, 1965).

2115 \pm 42**P-846. Antikythera wreck, planking 155 B.C.**

Pieces of planking (*Ulmus* sp.), presumed to have been found lying on or just under surface of bottom sands. *Comment:* sample pretreatment included only 3N HCl; very difficult to purify.

San Pietro wreck

The San Pietro wreck (40° 17' N Lat, 17° 48' E Long), was found near Taranto, Italy. Cargo of sarcophagi were dated archaeologically to ca. A.D. 250, but it is believed that portions of a modern wreck may be involved here as well. Coll. 1965 (Throckmorton, mss.).

158 \pm 36**P-877. San Pietro wreck, frame A.D. 1792**

Fragment of wooden frame (*Ulmus* sp.) tightly wedged under Sarcophagi 18 and 19 at S end of wreck at sea bottom level. *Comment:* sample pretreatment included only standard 3N HCl pretreatment. Date apparently confirms suspicion of modern wreck at same site.

III. ARCHAEOLOGIC SAMPLES: EASTERN CANADA

*A. Nova Scotia***Debert series, Nova Scotia**

The Debert site (BiCu-1) (45° 25' N Lat, 63° 26' W Long), is a Paleo-Indian occupation site ca. 10 mi W of Truro, Nova Scotia, ca. 3 mi N of shore of Minas Basin. Formal excavations were conducted in 1963 and 1964 under direction of D. S. Byers, R. S. Peabody Found.,

Andover, Massachusetts (Borns, 1965a, b; Byers, 1965; MacDonald, 1965; Stuckenrath, 1964, 1965). Wood identifications were made by Forest Products Lab., U. S. Dept. of Agriculture, Madison, Wisconsin.

P-744. Feature 1 **5019 ± 70**
3069 B.C.

Charcoal (*Picea* sp.) from charred root or resin cinder, not associated with artifacts. Coll. 1963 by R. Stuckenrath.

P-740. Feature 3 **7671 ± 92**
5721 B.C.

Charcoal (*Picea* sp.) from hearth in Feature 3, associated with Paleo-Indian artifacts. Coll. 1963 by R. Stuckenrath. *Comment:* NaOH pretreatment. Date is nearly 3000 yr younger than all other archaeologically-oriented samples from this site, and sample is presumed to include more modern materials.

P-743. Feature 4 **10,452 ± 128**
8502 B.C.

Charcoal (*Picea* sp.) from hearth in Feature 4, associated with Paleo-Indian artifacts. Coll. 1963 by J. MacDonald. *Comment:* NaOH pretreatment.

P-739. Feature 7, Pit A **10,642 ± 134**
8692 B.C.

Charcoal from Pit A in Feature 7, associated with Paleo-Indian artifacts. Coll. 1963 by J. MacDonald.

P-741. Feature 7, Pits A, B, C, and D **10,531 ± 126**
8581 B.C.

Charcoal from Pits A, B, C, and D in Feature 7, associated with Paleo-Indian artifacts. Coll. 1963 by B. Powers. *Comment:* NaOH pretreatment.

P-966. Feature 7, No. 3 **10,557 ± 121**
8607 B.C.

Charcoal from hearth in Feature 7, associated with Paleo-Indian artifacts. Coll. 1964 by D. Hakas.

P-967. Feature 7, No. 4 **10,626 ± 244**
8676 B.C.

Charcoal from hearth in Feature 7, associated with Paleo-Indian artifacts. Coll. 1964 by D. Hakas. *Comment:* sample undersized, diluted with "dead" CO₂ from anthracite coal.

P-970. Feature 11, hearth No. 1 **10,477 ± 90**
8527 B.C.

Charcoal from Feature 11, hearth No. 1, associated with Paleo-Indian artifacts. Coll. 1964 by R. Inglis and R. Stuckenrath. *Comment:* half of sample received standard 3N HCl pretreatment (P-970, 10,503 ± 120), while other half received additional NaOH pretreatment (P-970A, 10,452 ± 118), difference was not significant, and average is quoted here.

- P-971. Feature 11, hearth No. 2** **10,758 ± 226**
8808 B.C.
Charcoal from Feature 11, hearth No. 2, associated with Paleo-Indian artifacts. Coll. 1964 by R. Inglis and R. Stuckenrath. *Comment:* sample undersized, diluted with "dead" CO₂ from anthracite coal.
- P-972. Feature 12** **10,496 ± 120**
8546 B.C.
Charcoal from hearth in Feature 12, associated with Paleo-Indian artifacts. Coll. 1964 by B. Rogers.
- P-973. Feature 15** **10,637 ± 114**
8687 B.C.
Charcoal from hearth in Feature 15, associated with Paleo-Indian artifacts. Coll. 1964 by M. Shaw *et al.*
- P-974. Feature 16** **10,824 ± 119**
8874 B.C.
Charcoal from hearth in Feature 16, associated with Paleo-Indian artifacts. Coll. 1964 by D. Fitts. *Comment:* NaOH pretreatment.
- P-975. Feature 17** **11,011 ± 225**
9061 B.C.
Charcoal from hearth in Feature 17, associated with Paleo-Indian artifacts. Coll. 1964 by D. Maclean. *Comment:* NaOH pretreatment. Sample undersized, diluted with "dead" CO₂ from anthracite coal.
- P-977. Feature 19** **10,113 ± 275**
8163 B.C.
Charcoal from hearth in Feature 19, associated with Paleo-Indian artifacts. Coll. 1964 by S. Maclean. *Comment:* sample undersized, diluted with "dead" CO₂ from anthracite coal.
- P-978. Section G root** **5790 ± 132**
3840 B.C.
Charred root, not associated with artifacts, from Section G. Coll. 1964 by R. Powers. *Comment:* sample undersized, diluted with "dead" CO₂ from anthracite coal.
- P-859. Shoreline peat bog, 6 ft** **3377 ± 51**
1427 B.C.
Peat, lowest 2 in. of core from 6 ft bog (N 45° 23' N Lat, 66° 33' W Long), SW of Debert site along N shore of Minas Basin, 6 ft above storm high tide. Bog surface roughly circular, 120 ft diam. *Comment:* sample believed contaminated by drainage from local barnyard.
- P-867. Glenholme peat bog, 19 ft** **7208 ± 83**
5258 B.C.
Peat, lowest 2 in. of core from 19 ft bog (63° 32' N Lat, 45° 23' W Long), SW of Debert site, near Glenholme, Nova Scotia. Bog located in kettle hole in glacial outwash.

10,664 \pm 101
8714 B.C.

P-951. Folley Lake peat bog, 26 ft

Peat, lowest 3 in. of core from 26 ft bog (45° 33' N Lat, 63° 33' W Long), NW of Debert site in kame-and-kettle complex bordering N end of Folley Lake, Colchester County, Nova Scotia. Bog fills lower 26 ft of 75 ft deep kettle. *Comment:* NaOH pretreatment.

B. Newfoundland

Port aux Choix-2 series, Newfoundland

Port aux Choix-2 (50° 43' N Lat, 57° 24' W Long), is a spring-summer seal-hunting site of middle Dorset culture located on outer shore of Cape Riche, Newfoundland, facing N to Strait of Belle Isle. Site lies on a 3 acre meadow crossed by minor beach lines prominent at 15 ft and 25 ft above present sealevel. Coll. during excavations directed by Elmer Harp, Jr., Dartmouth College Mus., Hanover, New Hampshire. Subm. by Harp (Harp, 1951; Stuckenrath and Anderson, 1966).

1859 \pm 50
A.D. 91

P-682. House 2, charred fat

Charred fat and sand from primary occupation layer in central area of House 2, a dark soil stratum 4 in. below present surface, in association with fragments of steatite cooking pot bearing traces of same charred material. Coll. 1961. *Comment:* NaOH pretreatment.

1593 \pm 49
A.D. 357

P-683. House 2, charcoal

Charcoal from primary occupation layer in SW quadrant of House 2, a dark soil stratum covered by layer of stones. Coll. 1961.

1736 \pm 48
A.D. 214

P-692. House 2, charcoal, midden top

Charcoal from uppermost stratum of House 2 midden, 8 in. below present surface. Coll. 1962.

1659 \pm 48
A.D. 291

P-693. House 2, charcoal, midden bottom

Charcoal from lowermost stratum of House 2 midden, 15 in. below present surface. Coll. 1962.

1580 \pm 54
A.D. 370

P-727. House 4, charcoal

Charcoal from primary occupation layer in House 4, a black-soil stratum 4 in. below present surface, and covered by layer of stones. Coll. 1963.

1502 \pm 49
A.D. 448

P-676. House 5, charcoal

Charcoal from primary occupation layer in House 5, a dark soil stratum 6 in. below present surface. Coll. 1961.

P-678A. House 6, charred fat, primary layer **1986 ± 51**
36 B.C.

Charred fat and sand from primary occupation layer in central area of House 6, a dark soil stratum 6 in. below present surface, associated with steatite cooking pot. *Comment:* half of sample (P-678, 1734 ± 49) received standard 3N HCl pretreatment, while other half received additional NaOH pretreatment (P-678A, 1986 ± 51); difference in ages (252 ± 71 yr = 3.5 sigma) is significant, and age of P-678A is quoted here.

P-679. House 6, charcoal, secondary **1623 ± 47**
A.D. 327

Charcoal from secondary occupation layer in SW quadrant of House 6, a mixed sand stratum 24 in. below present surface. Coll. 1961.

P-694. House 10, charcoal, 10 to 15 in. **1602 ± 49**
A.D. 348

Charcoal from base of black soil stratum in depression within House 10, 10 to 15 in. below present surface. Coll. 1962.

P-695. House 10, charcoal, 8.5 in. **1712 ± 40**
A.D. 238

Charcoal from base of black soil stratum in House 10, 8.5 in. below present surface. Coll. 1962.

P-696. House 11, charcoal **1509 ± 47**
A.D. 441

Charcoal from base of black soil stratum in House 11, 4 to 5 in. below present surface. Coll. 1962.

P-729. House 12, charred wood **1538 ± 55**
A.D. 412

Charred wood fragments, believed associated with infant burial in House 12, 10 in. below present surface. Coll. 1963. *Comment:* NaOH pretreatment.

P-730. House 12, charred fat **1886 ± 46**
A.D. 64

Charred fat and sand from 3 in. below surface of central fire pit in House 12, associated with two human burials. *Comment:* NaOH pretreatment.

P-731. House 13, charred fat **1891 ± 56**
A.D. 59

Charred fat and sand from front sector of House 13, 8 in. below present surface. Coll. 1963. *Comment:* NaOH pretreatment.

P-732. House 15, charred fat **2294 ± 51**
344 B.C.

Charred fat and sand from point near firebox of House 15, 8 in. below present surface. Coll. 1963. *Comment:* NaOH pretreatment.

P-733. House 16, charcoal, midden **1565 \pm 53**
A.D. 385

Charcoal from midden deposit of House 16, 10 in. below present surface. Coll. 1963. *Comment:* NaOH pretreatment.

P-734. House 17, charcoal **1465 \pm 51**
A.D. 485

Charcoal from beside central firepit in House 17, 6 in. below present surface. Coll. 1963. *Comment:* NaOH pretreatment.

P-735. House 17, charred fat **1817 \pm 51**
A.D. 133

Charred fat and sand found next to small fire pit in House 17, 12 in. below present surface. Coll. 1963.

P-736. House 18, charcoal **1683 \pm 49**
A.D. 267

Charcoal from House 18, 6 in. below present surface. Coll. 1963.

P-737. House 20, charcoal **1321 \pm 49**
A.D. 629

Charcoal found on sterile sand in House 20, 6 in. below present surface. Coll. 1963.

General Comment: reader will note a discrepancy in dates corresponding to sample materials dated: charcoal samples average A.D. 370 ± 13 , while charred fat samples average 6 ± 21 B.C. The difference (376 ± 34 yr = 11.1 sigma) is certainly significant, but the reason therefore is not so obvious since all samples are believed to represent one general occupational phase.

C. Labrador and Quebec

Strait of Belle Isle series, Labrador and Quebec

This series of samples is from Strait of Belle Isle, along S coast of Labrador and Quebec. Samples were collected from Boreal Archaic sites excavated in 1961 under direction of Elmer Harp, Jr., Dartmouth College Mus., Hanover, New Hampshire (1951). Arranged below by site, these samples provide the first prehistoric dates from this region.

a. Forteau Bay-1

Forteau Bay-1 ($51^{\circ} 29' N$ Lat, $56^{\circ} 58' W$ Long), is a Boreal Archaic site in the shore dunes just W of the settlement on tip of Buckle Point, Labrador. Coll. 1961.

P-691. Forteau Bay-1 **5399 \pm 58**
3449 B.C.

Charcoal and sand from a buried turf layer exposed in a blowout in highest dunes of the site, and associated with artifacts.

b. Forteau Bay-3

Forteau Bay-3 (51° 29' N Lat, 56° 53' W Long), is a Boreal Archaic site on L'Anse aux Morts about 0.25 mi N of the present beach line, Labrador. Coll. 1961.

**P-687. Forteau Bay-3, 20 to 40 in. 6086 ± 73
4136 B.C.**

Charcoal and sand from buried soil horizon, 20 to 40 in. below present surface in large central blowout lying between two brooks. *Comment:* NaOH pretreatment.

**P-688. Forteau Bay-3, 40 in. 5993 ± 74
4043 B.C.**

Charcoal from turf 1 in. thick, buried 40 in. below present surface, from a point midway along W wall of large central blowout lying between two brooks, and associated with flint chips. *Comment:* NaOH pretreatment.

**P-689. Forteau Bay-3, 40 ft beach terrace 1335 ± 46
A.D. 615**

Sandy peat from turf line buried 8 in. below present surface at E end of site on second beach terrace, 40 ft above present sealevel, and associated with flint chips.

c. Blanc Sablon-1

Blanc Sablon-1 (51° 26' N Lat, 57° 09' W Long), is a Boreal Archaic site on W bank of Blanc Sablon R ca. 1 mi W of Labrador border, Quebec. Coll. 1961.

**P-690. Blanc Sablon-1, 9 in. 2013 ± 49
63 B.C.**

Charcoal and sand from horizon containing flint chips, buried 9 in. below present surface, ca. 80 ft S of road and 0.25 mi W of Blanc Sablon R.

**P-684. Blanc Sablon-1, 21 in. 1068 ± 45
A.D. 882**

Charcoal, peat, and soil from horizon containing flint chips, buried 21 in. below present surface, ca. 250 ft S of road on W bank of Blanc Sablon R. *Comment:* NaOH pretreatment.

d. Blanc Sablon-4

Blanc Sablon-4 (51° 26' N Lat, 57° 09' W Long), is a Boreal Archaic site ca. 600 ft W of Blanc Sablon R, and ca. 0.25 mi N of road, 1 mi W of Labrador border, Quebec. Coll. 1961.

**P-686. Blanc Sablon-4 1223 ± 45
A.D. 727**

Sandy peat from soil horizon containing Boreal Archaic implements and flint chips, buried 18 in. below present surface. *Comment:* NaOH pretreatment.

D. Northwest Territories

Baffin Island series, Canada

This series represents pre-Dorset and Dorset occupations at six sites on Baffin Island, N.W.T., excavated as a joint project of Natl. Mus. Canada, Michigan St. Univ., and Natl. Sci. Found., under direction of M. S. Maxwell, Michigan State Univ. Coll. 1962 and subm. by Maxwell. The sites are in two groups: Annawalk (P-708) and Killilugak (P-699) sites ($62^{\circ} 44' \text{ N Lat}$, $69^{\circ} 41' \text{ W Long}$), are near Okalivialuk at the mouth of the fjord leading to Lake Harbour; Loon (P-710), Closure (P-707), Tanfield (P-698), and Nanook (P-704, P-706) sites ($62^{\circ} 39' \text{ N Lat}$, $69^{\circ} 39' \text{ W Long}$), are on Cape Tanfield on S coast of Baffin Island, 15 mi SE of Lake Harbour (Collins, 1956, 1957; Maxwell, 1962; Meldgaard, 1960; Pennsylvania IV; Rainey and Ralph, 1959; Stuckenrath and Anderson, 1966; Taylor, 1959).

3814 \pm 69
1864 B.C.

P-708. Annawalk site, pre-Dorset

Cinder-like material of charred animal (seal?) fat and sand from Annawalk (KeDr-1) site, 60 ft above present sealevel. *Comment*: many small rootlets present. (M.S.M.) Pre-Dorset typology and elevation suggest date of 2000 to 900 B.C. Compares culturally with Igloodik materials associated with P-207, 3958 ± 168 ; P-208, 3650 ± 123 ; P-209, 3906 ± 133 ; and P-210, 2898 ± 136 (Pennsylvania IV).

3577 \pm 69
1627 B.C.

P-710. Loon site, pre-Dorset

Cinder-like material of charred animal (seal?) fat and sand from upper limit of permafrost at Loon (KdDq-10) site, 50 ft above present sealevel. *Comment* (M.S.M.): pre-Dorset typology and elevation suggest date of 1200 to 1000 B.C. Compares culturally with Igloodik materials associated with P-209, 3906 ± 133 ; and P-210, 2898 ± 136 (Pennsylvania IV).

4067 \pm 73
2117 B.C.

P-707. Closure site, pre-Dorset

Cinder-like material of charred animal (seal?) fat and sand from upper permafrost in W trench of Closure (KdDq-11) site, 40 ft above present sealevel. *Comment*: some small roots present. (M.S.M.) Pre-Dorset typology and elevation suggest date of 1100 to 800 B.C.; date is apparently too old. Compares culturally with Igloodik materials associated with P-210, 2898 ± 136 (Pennsylvania IV).

3043 \pm 63
1093 B.C.

P-699. Killilugak site, early Dorset

Cinder-like material of charred animal (seal?) fat and sand from layer above permafrost at Killilugak site (KeDr-3). *Comment*: some small roots present. (M.S.M.) Typological assessment may be interpreted

as early Dorset (pre-900 B.C.) or as very late Dorset (A.D. 800 to 900); date confirms the former.

P-698. Tanfield site, early Dorset

**2608 \pm 50
658 B.C.**

Cinder-like material of charred animal (seal?) fat and sand from heavily encrusted cooking rock below upper permafrost at Tanfield site (KdDq-7), 23 ft above present sealevel. *Comment*: some small roots present. Half of sample received standard 3N HCl pretreatment, other half received additional 2% NaOH pretreatment; difference in ages was not significant, and average is quoted here. (M.S.M.) Typology and elevation suggest date of 600 to 400 B.C. Expected to be slightly younger than Collins' T-1 site, and compares culturally with materials from that site: P-74, 2183 \pm 122; P-75, 2632 \pm 128; and with Igloolik materials associated with P-212, 2404 \pm 137; and P-213, 2910 \pm 129 (Pennsylvania IV).

P-704. Nanook site, middle Dorset, sod

**1916 \pm 61
A.D. 34**

Dried sod and grasses associated with animal skins and branches of possible sleeping platform from permafrost layer, between component Layers 1 and 2 at Nanook site (KdDq-9-2). *Comment* (M.S.M.): expected date of 400 to 200 B.C. Compares culturally with materials from Collins' T-3 site, associated with P-77, 2191 \pm 120 (Pennsylvania IV).

**P-706. Nanook site, middle Dorset,
willow twigs**

**1827 \pm 61
A.D. 123**

Willow twigs associated with animal skins and dried sod and grasses of P-704, this series.

IV. ARCHAEOLOGIC SAMPLES: ALASKA AND KODIAK ISLAND

A. Alaska

P-611. Late Choris, Choris Peninsula

**2190 \pm 51
240 B.C.**

Charcoal from Choris site (66° 16' N Lat, 161° 52' W Long), near end of Choris Peninsula, Kotzebue Sound, Alaska. Sample is from Area 3, two beaches forward of the Choris "house beach," and believed to be Late Choris culture. Coll. 1958 and subm. by J. L. Giddings, Haffenreffer Mus., Bristol, Rhode Island (Rainey and Ralph, 1959; Pennsylvania IV; Stuckenrath and Anderson, 1966).

Cape Prince of Wales series, Alaska

Agulaak and Kugzruk sites (65° 40' N Lat, 168° 15' W Long), are located on Cape Prince of Wales, Alaska. Coll. 1959 and subm. by J. L. Giddings, Haffenreffer Mus., Bristol, Rhode Island, who considers the sites to be of Norton culture (Rainey and Ralph, 1959; Pennsylvania IV; Giddings, 1964; Stuckenrath and Anderson, 1966).

2402 \pm 43
452 B.C.

P-599A. Agulaak site, Norton hearth

Charcoal from Norton hearth on third beach line, Agulaak site.
Comment: NaOH pretreatment.

2306 \pm 38
356 B.C.

P-629. Kugzruk, Norton post

Wood from post in pond, associated with Norton houses. *Comment:* sample very difficult to purify. Half of sample was given standard 3N HCl pretreatment, while other half received additional NaOH pretreatment; difference in ages was not significant, and average is quoted here.

2566 \pm 53
616 B.C.

P-598. Kugzruk, Norton House 2, No. 1

Charcoal and sand from Norton stratum in House 2.

2583 \pm 60
633 B.C.

P-592. Kugzruk, Norton House 2, No. 2

Charcoal and charred sand from Norton stratum in House 2, ca. 1 m below sod. *Comment:* glass container broken in shipment, contents mixed with cotton packing; solid lumps of sample removed and cleaned for dating, remainder discarded.

Cape Krusenstern series, Alaska

The samples listed here are from a beach-ridge site on shore of Cape Krusenstern (67° 06' to 08' N Lat, 163° 46' W Long), Alaska. Coll. and subm. by J. L. Giddings (Stuckenrath and Anderson, 1966).

906 \pm 56
A.D. 1044

P-613. Birnirk-Thule Burial 6

Bits of skin and wood from floor of Birnirk-Thule burial No. 6. Coll. 1960.

1441 \pm 58
A.D. 509

P-612. Ipiutak House 17

Charcoal from fireplace of Ipiutak House 17. Coll. 1959.

1499 \pm 57
A.D. 451

P-597A. Ipiutak House 30, No. 1

Charcoal from charred timber of burned Ipiutak House 30. Coll. 1960. *Comment:* NaOH pretreatment.

1944 \pm 52
A.D. 6

P-595A. Ipiutak House 30, No. 2

Charcoal from burned Ipiutak House 30, ca. 1 m below sod covering. Coll 1960. *Comment:* NaOH pretreatment.

1730 \pm 61
A.D. 220

P-596A. Ipiutak House 60

Wood and charcoal from hearth 1 m below sod covering of Ipiutak House 60. Coll. 1961. *Comment:* NaOH pretreatment.

Old Whaling culture series, Alaska

Samples of this series are from a beach ridge site (67° 06' to 08' N Lat, 166° 46' W Long), on Cape Krusenstern, Alaska, excavated in 1960 and 1961 by J. L. Giddings. The samples are believed to derive from one cultural period identified by Giddings as the Old Whaling culture (Stuckenrath and Anderson, 1966).

P-618. House 24, wood, No. 1 **2865 ± 49**
915 B.C.

Wood from wall post of House 24, ca. 1 m below sod covering. *Comment:* wood in crumbling condition. Half of sample was given standard 3N HCl pretreatment, while other half received additional NaOH pretreatment; difference in ages was not significant, and average is quoted here.

P-404. House 24, wood, No. 2 **2829 ± 63**
879 B.C.

Wood from wall post of House 24 at floor level.

P-617. House 24, wood and charcoal **2989 ± 50**
1039 B.C.

Wood and charcoal from hearth of House 24, ca. 1 m below sod covering. *Comment:* half of sample received usual 3N HCl pretreatment, while other half received additional NaOH pretreatment; difference in ages was not significant, and average is quoted here.

P-400. House 24, charcoal, No. 1 **3678 ± 53**
1728 B.C.

Charcoal from hearth in House 24, ca. 1 m below sod covering.

P-403. House 23, wood, No. 1 **2850 ± 63**
900 B.C.

Wood from wall post of House 23.

P-621. House 23, wood, No. 2 **2859 ± 63**
909 B.C.

Wood from wall post of House, ca. 1 m below sod covering.

P-615A. House 23, wood, No. 3 **2907 ± 55**
957 B.C.

Wood from wall post of House 23, ca. 1 m below sod covering. *Comment:* half of sample received usual 3N HCl pretreatment (P-615, 2765 ± 63), while other half received additional NaOH pretreatment (P-615A, 2907 ± 55); difference in ages is significant (142 ± 84 yr = 1.7 sigma), and age of P-615A is quoted here.

P-623A. House 23, wood and charcoal **3291 ± 65**
1341 B.C.

Charcoal and partly charred wood from top of hearth in House 23, ca. 1 m below sod covering. *Comment:* NaOH pretreatment.

- 3571 \pm 66**
1621 B.C.
- P-624. House 23, charcoal, No. 1**
Charcoal from top of hearth in House 23, ca. 1 m below sod covering.
- 3630 \pm 53**
1680 B.C.
- P-401. House 23, charcoal, No. 2**
Charcoal from hearth in House 23.
- 3583 \pm 65**
1633 B.C.
- P-405. House 22, charcoal, No. 1**
Charcoal from hearth in House 22.
- 3647 \pm 53**
1697 B.C.
- P-626. House 22, charcoal, No. 2**
Charcoal from hearth in House 22, ca. 1 m below sod covering.
Comment: half of sample was given usual 3N HCl pretreatment, while other half received additional NaOH pretreatment; difference in ages was not significant, and average is quoted here.
- 3084 \pm 63**
1134 B.C.
- P-402. House 21, charcoal and wood**
Charcoal and wood from House 21.
- 2775 \pm 50**
825 B.C.
- P-627. House 20, wood**
Wood from wall post of House 20, ca. 1 m below sod covering.
Comment: half of sample was given usual 3N HCl pretreatment, while other half received additional NaOH pretreatment; difference in ages was not significant, and average is quoted here.
- 2998 \pm 62**
1048 B.C.
- P-616. Summer Lodge 4, wood and charcoal**
Wood and charcoal from hearth in Summer Lodge 4, immediately under sod covering.
- 3024 \pm 51**
1074 B.C.
- P-619. Summer Lodge 5, charcoal**
Charcoal from hearth in Summer Lodge 5, immediately under sod covering. *Comment:* half of sample was given usual 3N HCl pretreatment, while other half received additional NaOH pretreatment; difference in ages was not significant, and average is quoted here.
General Comment: wood samples of this series derive from wall posts, all slender (ca. 5 cm diam) saplings presumed to have been cut locally. Average age of wood samples (2848 ± 23) and tight clustering of those dates would support this hypothesis. Charcoal samples are all from hearths within the houses, with average age of 3625 ± 24 . Even if hearth charcoal derive from driftwood collected on local beaches, studies of driftwood in this area indicate that driftwood time lags are seldom more than 200 yr (Giddings, 1952), hardly enough to account for the difference between wood and charcoal averages of 700 to 800 yr. Age of the

charcoal samples meets archaeological expectations, and we are unable to account for the sample material discrepancy.

B. Kodiak Island

Kodiak Island series

Samples of this series were collected at eight sites on Kodiak Island in an attempt to establish the cultural and chronologic sequence of that island. Coll. 1961 to 1964 in excavations by Univ. of Wisconsin; subm. by W. S. Laughlin, Univ. of Wisconsin (Clark, 1966).

a. Sitkalidak Roadcut site, No. 438

Sitkalidak Roadcut site ($57^{\circ} 06' N$ Lat, $153^{\circ} 11' W$ Long) is located at Ocean Bay, Sitkalidak Island in the Kodiak Island group. Coll. 1963 by D. W. Clark.

P-1034. Ocean Bay I, base **5503 \pm 78**
3553 B.C.

Charcoal, diffusely spread within 15 cm of base of component, 125 to 150 cm below ground surface. Associated with artifacts of Ocean Bay I phase, apparently the earliest known culture in the Kodiak group. *Comment:* NaOH pretreatment.

P-1036. Ocean Bay II, middle **3929 \pm 65**
1979 B.C.

Charcoal from middle of Ocean Bay II component, 55 to 75 cm below ground surface. Total depth of component reached 100 cm below ground surface, with majority of artifacts occurring in lower half. *Comment:* NaOH pretreatment.

b. Kiavak site, No. 419

This Kiavak site, No. 419 ($57^{\circ} 01' N$ Lat, $153^{\circ} 36' W$ Long), lies on Kiavak Bay, Kodiak Island. Coll. 1963 by D. W. Clark.

P-1038. Pre-Old Kiavak Occupation C **4698 \pm 71**
2748 B.C.

Charcoal from 180 cm below ground surface in sandy matrix 35 cm below nominal base of Old Kiavak component, C. Believed to date occupation of the site before inception of continuous refuse accumulation attributed to Old Kiavak component. *Comment:* NaOH pretreatment.

P-1039. Old Kiavak Component C, base **3263 \pm 61**
1313 B.C.

Charcoal from 70 cm below ground surface, at base of major artifact frequency. *Comment:* NaOH pretreatment.

P-1041. Ceramic Component B, top **937 \pm 49**
A.D. 1013

Charred material scraped from potsherds found in upper level of site.

c. Three Saints site, No. 401

The Three Saints site, No. 401 ($57^{\circ} 07' \text{ N Lat}$, $153^{\circ} 29' \text{ W Long}$), lies on Three Saints Bay on Kodiak Island. Three Saints component is believed to date to about same time as Kachemak Bay III in Alaska (see antler sample date, P-138, 1369 ± 102 , Pennsylvania IV; Rainey and Ralph, 1959; Stuckenrath and Anderson, 1966). Coll. 1962 by D. W. Clark.

2028 \pm 55**P-1042. Three Saints, base****78 B.C.**

Charcoal from base of Three Saints component, 172 cm below ground surface, associated with shallow clay-lined basin and fire-box.

1119 \pm 49**P-1043. Three Saints, top****A.D. 831**

Charcoal from upper portion of Three Saints component, 75 cm below ground surface.

d. Kiavak site, No. 418

This Kiavak site, No. 418 ($57^{\circ} 01' \text{ N Lat}$, $153^{\circ} 36' \text{ W Long}$), lies quite close to Kiavak site No. 419 on Kiavak Bay, Kodiak Island. This SW ceramic variant of the Koniag phase is expected to be of about same age as that from Rolling Bay site (P-1047, P-1048), and younger than ceramic component of Kiavak site 419 (P-1041). Coll. 1963 by D. W. Clark.

280 \pm 44**P-1044. SW Koniag phase, base, No. 1****A.D. 1670**

Charcoal from base of site and SW Koniag phase, A.D. 1670, 215 cm below ground surface. *Comment:* NaOH pretreatment.

391 \pm 48**P-1045. SW Koniag phase, base, No. 2****A.D. 1559**

Charcoal from kitchen refuse layer at base of site and SW Koniag phase, 200 to 225 cm below ground surface. *Comment:* NaOH pretreatment.

e. Rolling Bay site, No. 420

The Rolling Bay site, No. 420 ($57^{\circ} 02' \text{ N Lat}$, $153^{\circ} 19' \text{ W Long}$), lies on Sitkalidak Island of Kodiak group, NE of Sitkalidak Roadcut site (P-1034, P-1036). Samples are expected to date elder portion of this ceramic site. Coll. by D. W. Clark.

393 \pm 40**P-1047. SW Koniag phase, base, No. 1****A.D. 1557**

Charcoal from hearth near base of SW Koniag component, ca. 200 cm below ground surface, in lowest quarter of stratigraphic sequence. Coll. 1961.

P-1048. SW Koniag phase, base, No. 2 **353 ± 44**
A.D. 1597

Charcoal from same hearth as P-1947. Coll. 1963.

f. Monashka Bay site

The Monashka Bay site (57° 50' N Lat, 152° 22' W Long), is located on Monashka Bay, near town of Kodiak on Kodiak Island. Coll. 1961 by D. W. Clark.

P-1049. Monashka Bay, aceramic **298 ± 44**
Koniag component **A.D. 1652**

Charcoal from middle of B component of this site, an aceramic variant of the Koniag, 84 to 99 cm below datum, and 46 to 61 cm below base of the A.D. 1912 volcanic ash layer. *Comment:* NaOH pretreatment.

g. Chirikof Island site, No. 9

Chirikof site, No. 9 (55° 50' N Lat, 156° 44' W Long), is in SW Anchorage of Chirikof Island in the Kodiak Group. This is a single-component site, probably occupied as a camp for a short period of time. Coll. 1963 by D. W. Clark.

P-1050. Chirikof Island site, No. 9 **4029 ± 63**
2079 B.C.

Charcoal from two points within this site: (a) 10 to 40 cm below ground surface within the cultural horizon; and (b) from an apparent structure pit in a thicker portion of the cultural horizon, 54 to 76 cm below ground surface. *Comment:* date is apparently equal to or older than Ocean Bay II (P-1036), but younger than Ocean Bay I (P-1034).

h. Anton Larsen Bay site, No. 241

The Anton Larsen Bay site, No. 241 (55° 52' N Lat, 152° 40' W Long), is near mouth of W entrance of Anton Larsen Bay on NE shore of Kodiak Island. Coll. 1964 by D. W. Clark.

P-1057. Anton Larsen Bay site, No. 241 **2033 ± 52**
83 B.C.

Charcoal from a massive burned timber which formed part of a burnt and collapsed structure, 130 to 180 cm below datum. Comparative typology suggests that this material, the main component at this site, may be correlated with that from Three Saints Bay; date is equivalent of that for base of Three Saints component (P-1042).

V. ARCHAEOLOGIC SAMPLES: SOUTH AMERICA

A. Peru

Rio Nazaratique series, Peru

This series of samples derives from cluster of three sites (10° 30' S Lat, 74° 30' W Long), on the Rio Nazaratique, Dept. of Pasco, Peru.

Coll. 1964 by W. A. Allen; subm. by D. W. Lathrap, Univ. of Illinois, Urbana.

P-990. Site PAC-14, 4.5 to 5 ft **3368 ± 100**
1418 B.C.

Charcoal from site PAC-14, 4.5 to 5 ft, associated with rough brown ware and poorly burnished ware, earliest ceramic material thus far encountered in the area. *Comment:* sample undersized and diluted with "dead" anthracite carbon dioxide.

P-991. Site PAC-14, 4 to 4.5 ft **3728 ± 100**
1778 B.C.

Charcoal from site PAC-14, 4 to 4.5 ft, associated with a fine sand-tempered brown ware. *Comment:* sample undersized, diluted with "dead" anthracite carbon dioxide.

P-992. Site PAC-14, 3.5 to 3.75 ft **3587 ± 100**
1637 B.C.

Charcoal from Site PAC-14, 3.5 to 3.75 ft, associated with rough plain sand-tempered ware. *Comment:* sample undersized and diluted with "dead" anthracite carbon dioxide.

P-993. Site PAC-14, 3.25 to 2.5 ft **3225 ± 68**
1275 B.C.

Charcoal from Site PAC-14, 3.25 to 3.5 ft, associated with a crude sand-tempered ware.

P-995. Site PAC-14, 1 to 1.5 ft **1346 ± 100**
A.D. 604

Charcoal from Site PAC-14, 1 to 1.5 ft, associated with ceramics similar to Late Tutishcainyo defined by Lathrap at Yarinacocha, Peru. *Comment:* sample undersized. and diluted with "dead" anthracite carbon dioxide. Compare Y-1546, 670 ± 100 B.C., from depth of 2.25 to 2.75 ft, this site.

P-996. Site PAC-12 **1249 ± 51**
A.D. 701

Charcoal from Site PAC-12, associated with a presumed burial feature, and with thick ceramics displaying brushed and incised decoration.

P-997. Site PAC-16, 1 to 1.25 ft **1426 ± 100**
A.D. 524

Charcoal from Site PAC-16, 1 to 1.25 ft, associated with ceramics displaying a fine-line incising within alternating triangles. *Comment:* sample undersized and diluted with "dead" anthracite carbon dioxide.

B. Venezuela

P-953. El Ranchon site, Venezuela **1086 ± 45**
A.D. 864

Charcoal from El Ranchon (M1) site (9° N Lat, 71° W Long), located on shore of Lake Maracaibo near Zancudo River, Venezuela,

Sample comes from level of the Zancudo phase, Level 4, the first geologic stratum above lacustrine sediments, and antedates formation of tropical forest cover in this area. Soils analyses indicate a grass vegetation for this level. Coll. 1964 and subm. by Mario Sanoja O., Univ. de Los Andes, Mérida, Venezuela. *Comment* (M.S.O.): cultural traits link Zancudo phase with Valencia phase on north-central coast of Venezuela, and with late ceramic cultures in Colombian-Venezuelan highlands. Compare Y-630, 1000 ± 70 ; Y-631, 980 ± 110 ; and Y-632, 1000 ± 100 (Yale VI) from the La Mata site in Venezuela, where samples were associated with pottery of Valencia style.

VI. ARCHAEOLOGIC SAMPLES: CENTRAL AMERICA

*A. British Honduras***P-1028. Altun Ha, British Honduras****1544 \pm 62****A.D. 406**

Carbonized material, perhaps copal, from lower portion of distinctive two-piece chimneyed incensario found in tomb excavated in small group of small mounds just S of center of Altun Ha, a Maya site at Rockstone Pond ($17^{\circ} 45' N$ Lat, $88^{\circ} 21' W$ Long), 30.5 mi N of Belize, 9 mi W of sea coast, British Honduras. Coll. 1964 by D. M. Pendergast, Field Director of Royal Ontario Mus. Project; subm. by A. D. Tushingham, R.O.M. Site is believed to have been occupied from late pre-Classic to terminal Classic times, and sample derives from earliest of three tombs found in Mound E-1 (Pendergast, 1965).

*B. Guatemala***Tikal series, Guatemala**

Tikal ($17^{\circ} 13' N$ Lat, $89^{\circ} 39' W$ Long), in El Peten, Guatemala, is the site of extensive excavations and restorations of the Lowland Maya Pre-Classic to Post-Classic periods by the University Mus., Univ. of Pennsylvania, in collaboration with the government of Guatemala. The samples listed below were coll. from 1961 to 1964, and subm. by W. R. Coe, Director of the Tikal Project. The following discussion is presented by Coe in order to provide the necessary understanding of sample derivation and date significance in the archaeologically complex North Acropolis (Pennsylvania V).

The radiocarbon results reviewed here pertain to two series of samples submitted to the Radiocarbon Lab. of the Univ. of Pennsylvania by the writer (W.R.C.). The results of both are calculated on the basis of a 5568 half-life. The first series (P-535, P-560 through P-563, P-565 through P-567, and P-569 through P-575) were dated in 1962, and the second (P-768, P-750 through P-759) in 1964. All but one of these (P-759) derive from excavations of the North Acropolis at Tikal.

The long, extraordinarily complex architectural evolution of the North Acropolis has been outlined elsewhere (Coe, 1965a, b; Coe and

McGinn, 1963). It consists essentially of a series of great superimposed platforms, each of which sustains various buildings of a ceremonial nature. The majority of radiocarbon samples considered here are charcoals recovered from the fills employed in construction. Such charcoals occur in fill as randomly as potsherds and other cultural material. The true source of this charcoal is difficult if not impossible to isolate. This is basically true of the actual fills. We assume that the cultural detritus and charcoal found in such fills ultimately derive from household middens, workshop scrap, and from other accumulations of trash resulting from daily living at Tikal. The fill matrix ranges from limestone rubble, to demolished prior constructions, marl scraped from bedrock, and earths and clays. A serious drawback in assessing sources is the extent to which the old was demolished to make way for the new at Tikal. This is partly evidenced by physical fits between cultural items separated by almost a millennium of constant building activity (Coe, 1965a, p. 1409). Old materials were obviously projected ahead in time at such constructionally dynamic sites as Tikal. When we estimate that a fill was laid down and a structure built, say, at A.D. 100, we ought not to be surprised that we receive a date centuries earlier for the charcoal recovered from the fill. The ceramicist faces the same problem of controlling redeposition as he evaluates the sherd material from constructional fill. The fact is that the sherds, charcoal and other collected contents of fill can and probably often do have countless disparate sources in time and space. They finally end up in a fill at a certain date, but here they are physically in association by pure chance. A great deal remains to be explored regarding differing degrees, if any, to which charcoal and sherds are susceptible to redeposition and anachronism. Often the ceramicist judges a sherd collection from a particular fill as homogenous and approximately contemporary in manufacture and breakage with the filling operation; yet charcoal from this same fill can give a radiocarbon date centuries too early.

The point is simply that the content of a fill matrix at Tikal cannot be assumed to express contemporary reality, ceramic, or otherwise. A pot must be broken, a hearth extinguished and cold before the products of both are available as constructional fill. This requires that we date a fill in terms of having been collected and laid down no earlier than the time of the latest material within it. In submitting charcoal to a laboratory for radiocarbon determination, we are aware of how limited our control of the sample is. Granted, we may well control a sample in terms of its sequential or stratigraphic provenience and we often know the nature of the pottery with which it is physically associated. However, there remain a number of clearcut, potentially significant variables that can color the radiocarbon results treated in this paper.

Post-sample error ("PSG"). As shown by Satterthwaite and Ralph (1960), this phrase indicates the growth-time interval between the "death" of the organic source of the sample and the "death" of the or-

ganic matrix of the source (cf. also Coe and Stuckenrath, 1964, p. 18). The PSG time-span can be considerable between pith wood and cambium growth. Zapote wood, commonly used in construction at Tikal and prized as firewood today (and probably anciently as well), offers a case in which PSG can amount to a few centuries (cf. Ralph, 1965). The error becomes more difficult to estimate when a charcoal sample historically derives from multiple organic sources (see PH, below). Similarly, the greater the life-span of the sample's matrix (e.g., tree), the greater the potential is for significant PSG. While it is possible to have wood charcoals identified as to contributing genera, there appears to be little reliable data on differing life-spans of tropical trees. In an attempt to minimize significant PSG error, one might exclude the larger pieces of charcoal in a sample and submit only the smallest pieces in the hope that the latter derive from the youngest growth of the trees represented in the sample. While this is logical, it is hard to practice. In the case of soft-wood samples (thus, from trees relatively short-lived), it probably makes little difference whether trunk pith or lofty twigs are run. Moreover, twigs are difficult to recognize and often disintegrate with collection, bagging and transportation.

Placement history ("PH"). The total interval that may be termed the PH of the sample (Coe and Stuckenrath, 1964, p. 18) allows for the time between the death carbonization of the source and final archaeological placement. It is a gap that is either infinitesimal or huge; a gap of almost a millennium has been discovered between fitting monument fragments at Tikal, and cyclical trash reclamation and renewed building can affect radiocarbon results to at least an equal degree.

Average death-rate ("X"). If a charcoal sample is botanically inhomogeneous, the radiocarbon result is either an average of the death-dates of the original sources, or is based on a portion not necessarily representative of the total. A part of each Tikal sample is usually submitted to the U. S. Dept. of Agriculture, Forest Products Lab. for expert identification (for this we are indebted to B. Francis Kukachka and Robert C. Keoppen). Presumably, generic identification refers only to the preponderant genus, and the average death-date or "X" variable is potentially present.

Contamination. The occasions for contamination, aboriginal and present-day, are innumerable but probably for the most part identifiable. Knowing the porosity of limestone masonry at Tikal, one can see how later burnings could, with rains, infect stratigraphically earlier samples. Rootlets penetrate to surprising depths in Tikal architectural contexts. Contamination, nevertheless, is probably a minor source of error within the group of samples treated in this paper.

Sigma. There are two out of three chances that X (average death-date) falls within the one-sigma date-spread yielded by the analysis of the sample (Coe and Stuckenrath, 1964, p. 18). The chances that the exact value lies outside the one-sigma date-spread are one in three, and one in

twenty outside a two-sigma spread (Satterthwaite and Ralph, 1960, p. 168).

Others. As noted, a half-life value of 5568 is used to calculate the dates discussed in this paper. Were the results to be given in terms of the 5730 half-life, they would be older by some 240 yr.

Finally, there is the special matter of Maya-Christian calendrical correlation. The 600- or 700-yr-long Classic Period of the lowland Maya is replete with inscriptions in the Maya system, providing a Maya dating framework for construction, pottery, etc. Most lines of evidence, including radiocarbon tests on Maya-dated wood (Satterthwaite and Ralph, 1960; Ralph, 1965), indicate Correlation B to be the most likely. Correlation A, the next most favored contender, places a Maya event about 260 yr earlier in time than does Correlation B. It is assumed in the following that Correlation B is correct. However, when a phenomenon is expected to date A.D. 700 and we receive a date on "associated" charcoal of A.D. 450, we can rationalize the discrepancy by invoking PH, PSG, X, or Correlation A.

The samples discussed here are presented in accord with their estimated sources of deposition, with the exception of No. 2 which appears according to ceramic position. In Fig. 1, each radiocarbon result has been plotted in time, each with its one-sigma date-spread. The archaeological sources of the samples (except No. 2) are also shown in Fig. 1, a diagram of the pertinent portion of the North Acropolis sequence. This diagram is vertically oriented (by Correlation B) to time and to the Tikal ceramic sequence. The symbol X is used to plot estimated dates of deposition of the samples, departures of circles from the line representing disagreement between what was anticipated and what radiocarbon analyses give us. Positions X are based upon what seems reasonable, knowing the stratigraphic order, the contemporaneity of certain samples, the ceramic sequence, and calculated dates and spans of architectural components. Impressed by the volume of construction in the North Acropolis, we originally were inclined to see a certain feature built, say, at 300 B.C. If the radiocarbon results point to 150 B.C., perhaps only a romantic tendency to over-estimate age makes us shy from the results.

2538 ± 53

P-750. North Acropolis, Ref. No. 1

588 B.C.

Tikal, North Acropolis, pit in bedrock containing trash and human remains. Excavated as 12P-Lot 151. Ceramic content is pure Eb. Charcoal, randomly scattered as small pieces in trash, is believed to have been deposited by an Eb domestic occupation of the North Acropolis area. The simple architecture of this occupation appears to have been totally dismantled for later construction. The charcoal was identified simply as hardwood. The result is consistent with current estimates of roughly

Fig. 1. Diagram of North Acropolis sequence, Tikal, related (by Correlation B and by C^{14} ages computed from the 5570-yr half life) to the ceramic sequence.

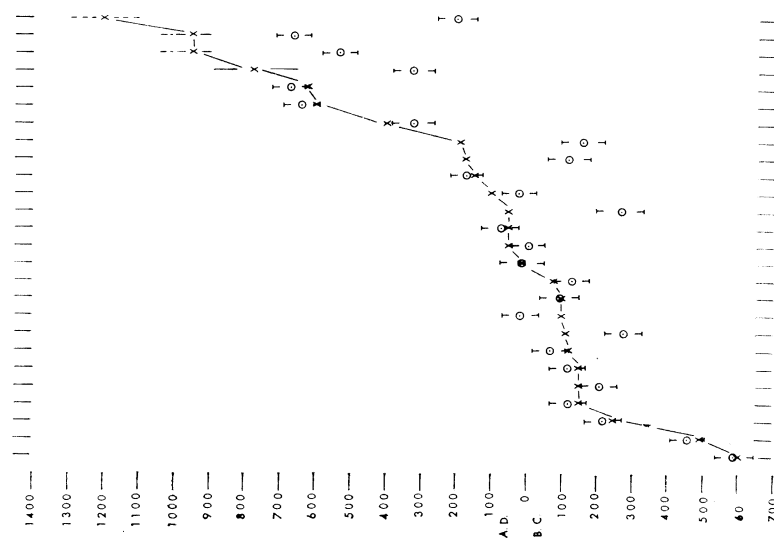
NORTH ACROPOLIS, STRATIGRAPHIC ORDER OF SAMPLES

TIKAL
CERAMIC
COMPLEXES

SAMPLE NO. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

REF.

1400 — 1300 — 1200 — 1100 — 1000 — 900 — 800 — 700 — 600 — 500 — 400 — 300 — 200 — 100 — 0 — 100 — 200 — 300 — 400 — 500 — 600 — 700 —



POSTCLASSIC | LATE CLASSIC | EARLY CLASSIC | PRECLASSIC

? CABAN EZNAB IMIX IK MANIK ? MULUC (CIMI) CAUAC CHUEN TZEC EB

A.D.
0
B.C.

where Eb ceramics belong in a middle Preclassic framework. This one date helps us to place Eb material about or within the 6th century B.C.

P-759. 71F-Lot 57, Ref. No. 2

**2406 \pm 47
456 B.C.**

Tikal, midden buried beneath platform sustaining Structures 5F-17 and 18. Excavated as 71F-Lot 57. Charcoal is scattered in this midden, and the latter produces an excellent sample of Tzec ceramic complex material. Deposit underlies deposits of Chuen material by more than a meter. The uniqueness of this deposit and the smallness of the charcoal sample required that the whole sample be submitted for radiocarbon analysis. Thus, the nature of the charcoal is unknown. This sample was approx. 10% undersized. The known sequential position of Tzec (Mamom) pottery makes this date acceptable.

P-751. North Acropolis, Ref. No. 3

**2169 \pm 52
219 B.C.**

Tikal, North Acropolis, Chultun 5D-6, ash-banded dark fill, deliberately placed. Excavated as 12P-Lot 164. Chultun probably but not certainly sealed by Str. 5D-Sub. 14-1st, -2nd, or -3rd but definitely sealed by Floor 15 platform. Associated large sherd sample is mixed but the latest material is of the Chuen complex. Charcoal, id. as hardwood, was abundant and occurred throughout the fill up to 2 cm in size. Keeping ceramic and stratigraphic data in mind, I would favor a date of ca. 250 B.C. for the filling and sealing of this Chultun. The oldest limit within 1-sigma of the result, 271 B.C., approximates this estimate.

P-753. North Acropolis, Ref. No. 4

**2068 \pm 52
118 B.C.**

Tikal, North Acropolis, fill of Str. 5D-Sub. 14-1st. Excavated as 12P-Lot 152. Charcoal scattered in fill, one interesting component of which is many lumps of painted, burned plaster from a prior construction (possibly from Str. 5D-Sub. 14-2nd). Chuen ceramics are latest in this fill. Three burials (122, 123, 126) in this same fill have Chuen vessels with them. Charcoal identified as *Manilkara* (= *Achras*) *zapote*, a hardwood. A date of 150 B.C. for construction of this feature is not unreasonable. This estimate is within the 1-sigma date-spread of the result. However, PSG and PH are theoretically pertinent here.

P-752. North Acropolis, Ref. No. 5

**2157 \pm 52
207 B.C.**

Tikal, North Acropolis, ballast of Floor 16 laid against Str. 5D-Sub. 14-1st during its use. Excavated as 12P-Lot 143. Chuen sherds are latest in this small lot. Small, randomly occurring pieces of charcoal, id. as *Leguminosa* (hardwood), entered the floor ballast at a later time than the deposition date of No. 4. A date of ca. 150 B.C. is reasonable for the laying of Floor 16. It is practically allowable by the 1-sigma date-spread of the result, through the potential effects of PSG and PH must be kept in mind.

2064 ± 52**P-756. North Acropolis, Ref. No. 6****114 B.C.**

Tikal, North Acropolis, packed earth level just S of Floor 15 platform and predating it. Excavated as 12P-Lot 116. This level is stratigraphically the equivalent of Floors 16-20 to the N and may be the decomposed weathered remains of one or more of these floors. Charcoal identified as *Manilkara* (= *Achras*) *zapote*, a hardwood. An estimated age of 150 B.C. for this level is within the 1-sigma date-spread of the result. PSG and PH however could be effective. The Chuen sherds from this fill were of early types and markedly weathered, suggesting a significant ceramic PH.

2017 ± 52**P-754. North Acropolis, Ref. No. 7****67 B.C.**

Tikal, North Acropolis, fill of Floor 15 platform, the first major construction in the North Acropolis sequence. Excavated as 12P-Lot 138. Charcoal occurred randomly in fill and identified as *Bursera*, a hardwood. The ceramic content of this fill was Chuen with little earlier admixture. An estimated construction date of ca. 120 B.C. is within the 1-sigma date-spread of the result.

2225 ± 55**P-755. North Acropolis, Ref. No. 8****275 B.C.**

Tikal, North Acropolis, probable firepit sealed within fill of semicircular masonry addition against face of Floor 15 platform (cf. No. 7). Pit contained a scorched wall, ash, charcoal, and flint. Excavated as 12P-Lot 120. Construction during a time of Chuen production. Charcoal identified as unspecified hardwood. The result provides only a lower limit date for construction. PSG and PH are surely operable if we accept No. 7. Perhaps structural members from dismantled earlier construction were burned here.

1930 ± 51**P-757. North Acropolis, Ref. No. 9****A.D. 20**

Tikal, North Acropolis, earth level overlying level producing No. 6; level is a S base of the Floor 15 platform and was accumulated after the construction of the semicircular addition to it (cf. No. 8). Charcoal was collected from the surface of this level; some ash was present, but no evidence of *in situ* burning. Excavated as 12P-Lot 114. Definitely sealed by Floor 13 platform built during a time of Chuen production. Charcoal identified as *Bursera*, a hardwood. This result must be compared with that of No. 10. It is extremely doubtful that Floor 13 platform was built as late as No. 9 would indicate. I would estimate 100 B.C. as a reasonable construction date. To achieve this, it is necessary to allow either for contamination or operate within a 3-sigma date-spread.

2040 ± 53**P-758. North Acropolis, Ref. No. 10****90 B.C.**

Tikal, North Acropolis, fill of Floor 13 platform (cf. No. 9). Charcoal was collected over a period of a month of excavation of this fill. Ex-

cavated as 12P-Lot 89, which contains a very large amount of pure late Chuen complex material. Charcoal identified as simply hardwood. An estimated rough construction date of 100 B.C. for this platform is well within the 1-sigma limits of the result.

2075 \pm 49

P-560. North Acropolis, Ref. No. 11

125 B.C.

Tikal, North Acropolis, marl fill of Str. 5D-Sub. 3-5th, built upon the second of two grading floors laid on Floor 13 platform (cf. No. 10). Excavated as 12P-Lot 68. The randomly occurring charcoal is identified as hardwood. The associated sherd material could be either late Chuen or early Cauac complex. This structure was built close in time to Burial 166 with its large number of Cauac vessels. A date of ca. 75 B.C. would be acceptable and this is within the 1-sigma date-spread of the radiocarbon result.

1934 \pm 63

P-535. North Acropolis, Ref. No. 12

A.D. 16

Tikal, North Acropolis, Burial 85. This important Cauac complex burial is stratigraphically later than Burial 166 (cf. No. 11). Burned slivers of wood, id. as *Pinus* sp., were found in a bowl. Excavated as 12P-Lot 78. Since pine is relatively short-lived and the pieces of it appear to have been deliberately placed as burned pieces in the bowl, PSG and PH are probably minimal. We conclude that Burial 85 was made somewhere in time ca. A.D. 1. This is a primary reference point in the North Acropolis series of dates.

1951 \pm 46

P-561. North Acropolis, Ref. No. 13

1 B.C.

Tikal, North Acropolis, sealed deposit directly in front of and post-dating the construction of Str. 5-D-Sub. 2-1st, the later of two platforms over and thus postdating Burial 85 (cf. N. 12). This deposit, excavated as 12P-Lot 74, lay within a pit and consisted of concentrated charcoal up to sizes suggesting the burned remains of a pole and thatch building on the platform designated as Sub. 2-1st (known to have carried such a building). The charcoal submitted for identification is hardwood, unspecified. If this is the immediate source of the charcoal, a date of A.D. 25 is considered a reasonable construction date for Sub. 2-1st. This lies within the 1-sigma range of the result. The presumed burning of the building might have taken place at ca. A.D. 50 (cf. No. 14). This estimate is also within the 1-sigma limits of the result.

1874 \pm 54

P-562. North Acropolis, Ref. No. 14

A.D. 76

Tikal, North Acropolis, unsealed pit in floor of W portion of front room of Str. 5D-Sub. 1-1st. Excavated as 12G-Lot 26. Charcoal occurred in this pit with signs of *in situ* burning. The situation suggests a terminal fire sacrifice in relation to the abandonment of this building and almost the entire contemporary stage of the North Acropolis (followed by a

massive filling operation; cf. No. 15). Charcoal identified as hardwood. The act of burning probably contemporary with deposition of No. 13. Abandonment of this stage of the Acropolis is best placed at ca. A.D. 60, an estimate that falls within the 1-sigma limits of the C¹⁴ result.

2217 ± 63

P-563. North Acropolis, Ref. No. 15

267 B.C.

Tikal, North Acropolis, fill, maximally 5 m thick, consisting of local demolition debris and especially deposited fill from elsewhere, the whole laid over a major stage of the North Acropolis, sealing Nos. 12, 13, and 14. Plentiful charcoal scattered randomly in this fill, up to thumb-nail size. Identified as hardwood. Excavated as 12P-Lot 55. The ceramic material of this fill was preponderantly Cauac, with nothing later. Admixture of earlier materials quantitatively slight. T. Patrick Culbert, Project ceramicist, believes that the fill derives in part from middens not much earlier than the fill in the North Acropolis. If so, the C¹⁴ result is ca. 250 yr too early. PH, though conceivably a factor, does not seem to be significantly operable here in ceramics. This massive fill was laid down in blocks surrounded by fill-retaining walls, and charcoal may therefore be derived from relatively early middens.

1926 ± 48

P-565. North Acropolis, Ref. No. 16

A.D. 24

Tikal, North Acropolis, deposit of sherds, charcoal and ash sealed by front stairway of Str. 5D-26-4th and laying on demolished stairway of 26-5th; both structures were built on Floor 8. The deposit probably represents a terminal ceremony in connection with the abandonment of -5th and the decision to build -4th. Excavated as 12P-Lot 58. The charcoal is hardwood. The latest of the associated pottery is of the Proto-classic late facet (Cimi) of the Cauac complex. A construction date of ca. A.D. 100 for 26-4th seems proper and this is almost a quarter century younger than the youngest 1-sigma limit of the radiocarbon result. No. 16 presumably pertains to -5th. Therefore, in relation to building -4th, PH is operable and perhaps PSG as well.

1777 ± 45

P-768. North Acropolis, Ref. No. 17

A.D. 173

Tikal, North Acropolis, Burial 125 upper pit fill, cut through Floor 7 (laid during use of Str. 5D-26-4th; cf. No. 16) and through stairway base of Str. 5D-22-4th-B and sealed by -4th-A. Considerable lensed charcoal occurred in the burial pit upper fill along with charred structural plaster matching the charred stairway of 22-4th-B, suggesting that the charcoal derives from a burned perishable building of -B. The charcoal, id. as *Manilkara* (= *Achras*) *zapote*, might derive from wood cut as structural members for -B. A date of A.D. 150 is not unreasonable and is within the 1-sigma limits of the radiocarbon result. It pertains to a time of Cimi ceramic production.

2065 ± 62**P-566. North Acropolis, Ref. No. 18****115 B.C.**

Tikal, North Acropolis, fill of str. 5D-26-3rd, built on Floor 7 (laid against str. 5D-22-4th-B; cf. No. 17). Excavated as 12P-Lots 21 and 29. Randomly occurring fill charcoal identified as hardwood. Cimi ceramics abundant in these and other contemporary lots; information on degree or earlier admixtures lacking. A date of ca. A.D. 175 would be reasonable for the building of 26-3rd. The radiocarbon result is much too old, suggesting PH and possibly PSG as causes of the discrepancy.

2107 ± 63**P-567. North Acropolis, Ref. No. 19****157 B.C.**

Tikal, North Acropolis, thick fill or ballast of Floor 6 which abuts Str. 5D-26-3rd and covers its substructure (cf. No. 18) and abuts Str. 5D-22-4th-A (cf. No. 17). Excavated as 12P-Lots 22 and 23. Cimi pottery is the latest material within these and/or stratigraphically equivalent lots; Cauac admixture occurs. The randomly occurring charcoal bits are identified as hardwood. Sequence and No. 17 lead to an estimated date of ca. A.D. 190 for the laying of Floor 6 (cf. No. 26). The C¹⁴ result is far too early for this event and would indicate the extent to which PH and probably PSG are operable.

1625 ± 60**P-571. North Acropolis, Ref. No. 20****A.D. 325**

Tikal, North Acropolis, Str.. 5D-26-1st, fill of first secondary floor which was laid over raised masonry cap of intruded Burial 22 producing late Early Classic Manik ceramic complex vessels (basal flange bowls, etc.); the floor was also laid over the smashed remains of an Early Classic cache vessel. Excavated as 12H-Lot 27. Sample identified as hardwood. If PSG and PH were not factors in this case, we could apply the result as a lower dating limit for the placement of the important Early Classic Burial 22.

1308 ± 49**P-569. North Acropolis, Ref. No. 21****A.D. 642**

Tikal, North Acropolis, fill of heavily razed Str. 5D-20-2nd, sealed by -20-1st; the construction of -2nd correlates with the laying of Floor 2 which is secondary to all North Acropolis Early Classic buildings. Excavated as 12I-Lots 17 and 19. Charcoal occurred as small pieces in fill, the ceramic content of which was small and inconclusive. In view of No. 22, a date of ca. A.D. 600, on the borderline between Early and Late Classic, would not be impossible for the construction of -2nd and it is within the 1-sigma date-spread of the result.

1274 ± 50**P-570. North Acropolis, Ref. No. 22****A.D. 676**

Tikal, North Acropolis, fallen vault beam, rear room, Str. 5D-20-1st, which, with its twin, Str. 5D-21-(1st), was built on Floor 1 and shows a number of Late Classic constructional features, although it carries on

certain Early Classic ones as well. Collected as 12I-Lot 3. The sample is identified as hardwood, perhaps logwood (*Haematoxylon*). The sample is believed to consist of outer wood. A construction date of very early 7th century is preferred and this is permitted within the 1-sigma date-spread of the result.

1624 ± 61

P-572. North Acropolis, Ref. No. 23

A.D. 326

Tikal, North Acropolis, fill of W bench of rear central room of Str. 5D-26-1st; the bench was built definitely later than the deposition of No. 20 and during a time of production of Imix complex pottery. Excavated as 12H-Lot 40. The unweathered Imix sherds and thumbnail-sized pieces of charcoal come from a dark mud fill within the bench. Charcoal identified as hardwood. A date between A.D. 650 and 900 is expectable, assuming duration of about two and one-half centuries for Imix pottery. The radiocarbon result is clearly too early. PH and possibly PSG have to be invoked to explain this discrepancy. By itself, the result favors Correlation A, but stratigraphic relation to No. 20 must be kept in mind.

1416 ± 52

P-573. North Acropolis, Ref. No. 24

A.D. 534

Tikal, North Acropolis, sealed refill of disturbed Burial 22 (cf. No. 20), Structure 5D-26-1st. Robbery, refilling, and patching over of cut were events definitely postdating the bench providing No. 23. Excavated as 12M-Lot 15. This lot contains considerable charcoal, far in excess of normal incidental inclusions. Physical fits between ceremonial items found on the room floor and in the patched-over tomb refill, as well as other considerations, suggest the act of robbing to be Post classic, that is, after but not long after A.D. 900. The room floors were overlain also by considerable charcoal. The charcoal from the tomb refill is identified as *Pinus* sp. The radiocarbon result well antedates the expected date for the deposition of the charcoal. Pine is considered to be a relatively short-lived tree. PH is a definite possibility here but details are a matter for speculation (cf. No. 25). Previously published sample P-279 (Pennsylvania V) from Str. 5D-34 of the North Acropolis, is believed to have been deposited at about this time (post-A.D. 900) and under similar conditions of depredation. No. 24 should be evaluated along with No. 25.

1285 ± 52

P-574. North Acropolis, Ref. No. 25

A.D. 665

Tikal, North Acropolis, central beach of rear central room of Str. 5D-26-1st and, specifically, from a refilled and rebuilt cut used to rob Burial 22 (cf. No. 24) and to rob a wooden-roofed cist cache made through the latest room floor just prior to building the bench; this same floor sustains the bench that yielded No. 23. Excavated as 12H-Lot 16. Charcoal identified as *Pinus* sp. It is probable that No. 24 and No. 25 have a common source. Despite the slight difference between them, it is conceivable that charcoal resulted from the burning of the roofbeams of

the cist. A date of ca. A.D. 700, even 650, would be entirely acceptable for this cache. We are, however, postulating pine beams, to our mind unexpected but hardly impossible. PH here must be considerable and this tentative reconstruction of its details may or may not be correct.

1749 \pm 59**P-575. North Acropolis, Ref. No. 26****A.D. 201**

Tikal, North Acropolis, Str. 5D-26-1st, E room, hearth and partial human skeleton (disarticulated) partly on the room floor and partly on collapsed vault material. The charcoal, which was plentiful and concentrated in a small area of *in situ* burning, presumably a hearth, was identified as simply hardwood. Excavated as 12H-Lot 21. Since the sources of Nos. 24 and 25 were beneath similar collapsed vaulting in the central room, it was expected that the hearth dated even later in Postclassic times. A date in the twelfth or thirteenth century seemed likely for the deposition of No. 26. *Comment:* result, perhaps a millennium too early, forces us to rely on PH and possibly PSG to account for the discrepancy. If we knew the charcoal to be zapote or logwood, we might assume Postclassic use of timber from 26-1st as firewood, and this seems the most probable explanation. A construction date of A.D. 250 for 26-1st is supported by the fact that it occupies the same stratigraphic position as Str. 5D-23-1st, which has provided three dates (Ralph and Stuckenrath, 1962), all from vault beams: P-294, 295, and 296. The results are, respectively, A.D. 602 \pm 52, 208 \pm 50, and 232 \pm 61. The latter two are interpreted with other evidence as indicating original construction ca. A.D. 250, while the first would then reflect substitution of a new beam. It is not impossible that Early Classic vaulted buildings were being constructed by ca. A.D. 250 at Tikal, as 23-1st and 26-1st each overlies an earlier version and these four, among others, rest on Floor 5 which is estimated to have been laid early in the 3rd century A.D. In turn laying of this floor probably post-dates by a very small interval the appearance of Early Classic elements in the Tikal ceramic inventory.

General Comment: one result of this review is that most of these dates make sense. Admittedly, we have done everything possible to make them fall into a sequential pattern. However, results that fall beyond, both above and below, the X-line in Fig. 1 cannot be simply rejected. Those below the line are old for reasons specifiable, among others, as PSG, PH, and probably, in some cases, X. Doubtless, more would fall so had we additional radiocarbon dates. No 1 is a case in point: we estimated (and found) 600 B.C. as a date falling within the production span of Eb ceramics, but a radiocarbon result pointing to 800 B.C. would not have dumbfounded us. Date-spreads within 1-sigma that fall above the line (too young) require different explanations. Only Nos. 5 and 9 occur above this line and only No. 9 seriously so. Intrusion of these samples (and all others) is precluded by the record. Although we invoke contamination to explain this discrepancy, this is evasive since we really have no idea

of what it may consist. Nine of the samples fall significantly below the line, while only one lies above it.

Twenty-five of the results are from the stratigraphically well-controlled North Acropolis (the reader must take this on faith until full publication appears). Twenty-four of these are derived from a relatively rapid sequence. Actually, only 11 of the later, however manipulated, express what we hoped they would when the samples were submitted. If, among the samples from ceramically Preclassic sources, we had submitted only Nos. 8, 15, 18 and 19, a distorted chronological scheme would have emerged. The point is that somewhat less than 50% of the North Acropolis samples make the depositional sense expected of all. This may be a useful statistic; it may be that at other complex sites half the results on charcoal are merely useful for detecting error in the other half.

Most of the samples were excavated by the writer. For instance, in the excavation of No. 23, I could detect nothing that would deny a true, temporal association of context (a masonry bench), sherds, and charcoal. The charcoal and freshly broken sherds occurred in a mud fill. The charcoal was recovered as small but easily extractable pieces, not as wispy specks that required a penknife to remove. In submitting the charcoal, I was hoping to get a date on benches at Tikal that, almost without exception, are secondary additions during the time-span of the Imix ceramic complex. Imix ceramics could not have been made during a time indicated by the radiocarbon results *if* we accept Correlation B. I see nothing at Tikal, either in its known sequence or in the *general* run of radiocarbon results that points to the validity of any other correlation. In submitting No. 23, I felt confident that PH was insignificant (as in the case of No. 12). I was wrong, and the experience is humbling as well as informative.

Throughout this review I have been willing to accept, when at all reasonable, the results handed me by the laboratory. I realize that anyone can make what he wishes (fortunately, within certain limits) of the results given here.

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PACKARD INSTRUMENT COMPANY RADIOCARBON DATES II

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The measurements reported in the following date list have been made in the Low Level Counting Laboratory of Packard Instrument Company during 1965 and are a continuation of the work reported previously (Packard I). This counting procedure for these dates has remained unchanged — a 5 ml volume of benzene counted in a Packard Tri-Carb® Liquid Scintillation Spectrometer Model 3214. The sample is converted chemically from its original form to benzene in the Packard Tri-Carb Benzene Synthesizer. This instrument was described in a general fashion in our previous publication.

The chemical reactions involved in the conversion of the sample to benzene are as follows:

- 1) organic sample + $O_2 \rightarrow CO_2 + H_2O$
or
inorganic sample + $HCl \rightarrow CO_2 + H_2O$
- 2) $2CO_2 + 10 Li \rightarrow Li_2C_2 + 4 Li_2O$
- 3) $Li_2C_2 + H_2O_2 \rightarrow C_2H_2 + 2 Li OH$
- 4) $3 C_2H_2 \xrightarrow{\text{catalysis}} C_6H_6$

These chemical procedures are essentially the same as have been used by this laboratory since it began operations in the fall of 1963. During the past year, however, a considerable amount of time was devoted to research work on a new catalyst to be used for the condensation of acetylene to benzene. This is the most inefficient procedure in the entire chemical conversion.

The catalyst which had been used previously was a cracking catalyst which had to be activated with the highly flammable and toxic gas, diborane. Although the catalyst was commercially available from Packard Instrument Company in its activated form, it was expensive and difficult to handle since contact with oxygen would cause deactivation. The chemical yields for the synthesis were in the range of 35-55%.

During the past year, it was discovered that the Isotope Center in Copenhagen, Denmark had used a different catalyst for benzene synthesis. The work in Denmark, however, was preliminary and had been abandoned after a short time. It was continued in our laboratory and a new procedure was developed which proved to be far superior to the previous one.

This new acetylene to benzene conversion catalyst which is now commercially available (Packard Instrument Co. catalog No. 6008077 for 600 gms or No. 6008078 for 1200 gms) is also a cracking catalyst and produces the reaction in much the same way as the old catalyst. The catalyst beads are poured into a glass catalyst column. The entire

column is heated by a heating jacket to 300°C for 1½ hrs. During this period a vacuum is applied to the column through a glass trap which is cooled with a dry ice-isopropyl alcohol slurry. This allows moisture from the catalyst to be frozen into the cold trap. When all moisture has been removed, the entire column is allowed to cool to room temperature while vacuum conditions are maintained. This column is then heated to slightly above room temperature and the acetylene, which had been frozen into a cold trap, is allowed to sublime onto the evacuated column. When all the acetylene has been taken up by the catalyst, the column is heated to 150°C while a vacuum is again applied, the trap now being cooled with liquid nitrogen. This allows pure benzene to be frozen into the trap.

We have found this new method to be superior, in that (1) conversion efficiencies have increased from 35-50% to 60-80%, (2) the cost of the catalyst is reduced by one-half, and (3) no precautions need be taken to protect the catalyst from atmospheric oxygen.

The dates reported here have been calculated using the Libby half-life value for C¹⁴ of 5570 ± 30 yr with 1950 as the standard year of reference.

ACKNOWLEDGMENTS

Samples were contributed and dates evaluated by Robert C. Becker of the Artic Aeromedical Laboratory, U. S. Air Force, Ft. Wainwright, Alaska; William H. Taft of the University of South Florida, Tampa, Florida; W. J. Wayne, Dept. of Geology, Indiana University, Bloomington, Indiana; and I. L. Barnes of the University of Hawaii.

Mr. Tony Mrkvicka assisted in the chemical preparation of the samples and Miss Mary Hollenback assisted with manuscript preparation.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Ready Bullion Creek series

Samples from exposure of Pleistocene muck 10 mi W of Fairbanks, Alaska, in Ready Bullion Creek Valley (64° 51' N Lat, 148° 01' W Long). Permafrost at this location is being continuously thawed and washed down the creek, exposing bedrock below. There is definite line of demarcation (color change) between bottom of Wisconsin silt and top of Illinoian layer. Wisconsin layer is approx. 34 ft thick at this exposure.

The first group of samples from this series was reported in the previous publication from this lab.

All samples coll. 1964 by T. L. Péwé and R. C. Becker; subm. by R. C. Becker, Artic Aeromedical Lab., Ft. Wainwright, Alaska.

PIC-11. Ready Bullion Creek 6**7530 \pm 265****5580 B.C.**

Wood from 2 ft below surface, 6 in. above base of engineer muck (perennially frozen). *Comment:* dates early part of engineer muck and was estimated at 3000-5000 yr. Since date obtained in lab. was considerably older than estimate, sample was analyzed a second time and a date of 7665 ± 220 yr was obtained. This agreed closely with the first lab. date (7530 ± 265 yr). In addition, a sample (PIC-5) reported in our previous publication was taken 6 to 12 in. below this sample in 1963 from a nearby location and gave age of 8080 ± 165 yr so that the field estimate is probably in error.

PIC-12. Ready Bullion Creek 7**27,580 \pm 950****25,630 B.C.**

Wood fragments from 29 ft below surface, 4 ft below base of muck layer. *Comment:* sample dates top of "barren" loess layer. There was no estimate of sample age but since this sample was taken from a point farther below surface than previous samples in this series, it is not inconceivable that it would give the oldest date. However, a sample taken from below this point (PIC-13, this date list), though estimated to be 38,000 yr, was dated as $18,252 \pm 1130$ yr.

PIC-13. Ready Bullion Creek 8**18,250 \pm 1130****26,300 B.C.**

Twigs from 38 ft below surface. Dates loess layer which is perennially frozen. *Comment:* estimated at more than 38,000 yr. Laboratory analysis showed this sample to be more recent than both the estimated date and samples PIC-12 and PIC-14 which were located closer to the surface.

PIC-14. Ready Bullion Creek 9**35,475 \pm 3250****33,525 B.C.**

Wood pieces taken from slightly higher than 29 ft below surface. *Comment:* sample collected in 1965 from same approx. point as PIC-12. Purpose of sample was to be certain that PIC-12 and PIC-13 were not reversed. This "rough" date showed that samples were not mixed, but does not decide whether PIC-13 was contaminated or if there was a shift in the earth's layers.

PIC-15. Yellow Bank, Bahamas 1**2410 \pm 120****460 B.C.**

Partially cemented limestone taken from 2 in. below sediment/water interface near Yellow Bank, Bahamas ($24^{\circ} 55' N$ Lat, $77^{\circ} 2' W$ Long). Water depth 17 ft. Coll. 1964 by W. H. Taft; subm. 1965 by William H. Taft, Univ. of South Florida, Tampa, Florida. Sample dates rise of sea-level and age of cementation. *Comment:* date is only slightly older than estimated age of 1800 yr.

PIC-16. Yellow Bank, Bahamas 2 **4810 ± 130**
2860 B.C.

Partially cemented limestone taken from 36 in. below sediment/water interface near Yellow Bank, Bahamas (24° 55' N Lat, 77° 2' W Long). Water depth is 17 ft. Coll. 1964 by W. H. Taft; subm. 1965 by William H. Taft. Sample dates rise of sealevel, age of cementation, and rate of sedimentation. *Comment:* date is slightly older than estimated age of 4000 yr.

PIC-17. Hendricks County, Indiana **19,930 ± 990**
17,980 B.C.

Wood from road cut along Indiana 136 in northwestern Hendricks County, Indiana, from fossiliferous silt bed between Cartersburg and Center Grove tills. Coll. and subm. by W. J. Wayne, Dept. of Geology, Indiana Univ., Bloomington, Indiana. *Comment:* confirms estimated age of 19,000-20,000 yr.

PIC-18. Montgomery County, Indiana **21,340 ± 1860**
19,390 B.C.

Wood from alluvial sands and silts below Wisconsin till in stream cut in Montgomery County, Indiana. Coll. and subm. by W. J. Wayne. *Comment:* confirms estimated age of 20,000-24,000 yr.

II. ARCHAEOLOGIC SAMPLES

PIC-19. Hane Dune Site **Modern <187**

Charcoal from a fisherman's habitation site on top of dune at Hane, Uahuka Island, Marquesas, French Polynesia. Site is located on back of beach ca. 60 m from shore and 10 m above sealevel (8° 55' 36" S Lat, 139° 32' 3" W Long). There were three floor pavements in succession. Two were near the top and the third, in which eight human burials were found, was below 1 m sand. Sample taken from fireplace on Level III below second paved floor, thought to indicate beginning of Marquesas Classic Period. Coll. 1964 by Y. Sinoto and M. Kellum, Bernice P. Bishop Mus., Honolulu, Hawaii; subm. 1964 by I. L. Barnes, Univ. of Hawaii, Honolulu, Hawaii. *Comment:* tidal waves hit the site area which could cause contamination. A portion of the same sample was dated by Dr. Kunihiro Kigoshi, Gakushuin Univ., Tokyo, Japan as Gak-538, Modern <180 (Gakushuin V). This agreement with the Packard date indicates the sample, estimated at 450 yr, was contaminated.

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CAMBRIDGE UNIVERSITY
NATURAL RADIOCARBON MEASUREMENTS VIII

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INTRODUCTION

The dates and activity measurements given below have been obtained during 1964 and 1965, and have been made with CO₂ at 3 atm pressure in a proportional gas-counter as described in previous contributions from this laboratory. We have continued to concentrate chiefly upon research projects pursued in the University Sub-department of Quaternary Research.

We particularly wish to acknowledge the help of G. A. Sutton, Technical Assistant in the Radiocarbon Dating Laboratory and of M. A. Hall, Scientific Assistant. For most of the samples fractionation errors have been determined mass-spectrometrically by N. J. Shackleton, Senior Assistant in Research; these have been stated in the text and taken into account in calculating the presented data. The corrections have been made with respect to the Cambridge standard wood sample (1850). The values for fractionation are calculated to the P.D.B. standard.

SAMPLE DESCRIPTIONS

BRITISH ISLES

A. Late Weichselian

Q-816. Redkirk Point, Dumfriesshire 1A **12,290 ± 250**
10,340 B.C.

Peat (Grid ref. 35/056680; 54° 59' N Lat, 3° 28' W Long), from the same locality as Q-637 and Q-815. Below the (estuarine) Carse Clay is a peat-bed dated 8135 ± 150 (Q-637), and below this grey sandy clays which at one point overlie a peat bed containing a boreal beetle fauna and dated 10,300 ± 185 (Q-815). This soft detritus peat of bed 1A lies ca. 4 ft below the upper peat; it lenses out to the E and thickens to W; like the lower peat Q-815 it rests on grey to pink sands over boulder-clay. Pollen analyses by R. Andrew have a strongly Late-Weichselian character with Be, Pi, Sa as the only arboreal pollen and abundant herbaceous pollen including *Selaginella*, *Empetrum*, *Thalictrum* and cf *Saussurea alpina*. Coll. W. W. Bishop, Uganda Museum, Kampala, 1962. $\delta C^{13} - 31.1\%$. *Comment:* date confirms the pollen-analytic findings, and indicates an age greater than that of the lower peat at Q-815: it is understandable that on the irregular surface of the boulder clay on this coast there should be Late-glacial peat deposits of varying ages.

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B. Post-glacial vegetational history

Q-682. Chat Moss, Lancashire, Site 11A, 14-16 cm **3070 ± 150**
1120 B.C.

Peat (Grid ref. 959.694, 53° 27' N Lat, 2° 27' W Long) from a site 200 yd from completed pollen-analytic sequence through the raised-bog. From a deep pit a monolith was recovered crossing a pronounced recurrence surface traceable throughout the bog and dated pollen-analytically to the onset of Zone VIII (Birks, 1963-4). Stratigraphy as follows: 0 to 7 cm, unhumified *Sphagnum cuspidatum* pool peat with a little *Cladium*, *Rhynchospora alba*, *Andromeda* and *Eriophorum angustifolium*; 7 to 9 cm, *Eriophorum vaginatum*; 9 to 14 cm, unhumified *Sphagnum* hummock peat (H = 4); 14 to 20 cm, moderately humified *Sphagnum* peat; 20-, highly humified *Sphagnum* peat (H = 8).

Samples Q-682 and 683 bracket the main shift to increasing wetness and correspond to the onset of a pronounced forest clearance phase leading to a mainly pastoral economy. Coll. J. Birks, Sidney Sussex College, Cambridge, 1962. δC^{13} -28.4‰.

Q-683. Chat Moss, Lancashire Site 11a, 3-5 cm **2645 ± 100**
695 B.C.

Peat (Grid ref. 959.694, 53° 27' N Lat, 2° 27' W Long) from same monolith as Q-682 above. Coll. J. Birks, 1962. δC^{13} -31.0‰. *Comment:* samples Q-682 and 683 that span the consistent major recurrence surface on Chat Moss yield dates consistent with one another and with the pollen analytic results. They confirm the conjecture (Birks, 1963/4) that the important forest clearance phase was referable to Late Bronze Age or Early Iron Age. The date is similar to that for the main flooding horizon in the raised bogs of the Somerset Levels (Cambridge I) and to that of the main recurrence surface in Tregaron bog, Cardiganshire (Q-388, 389: Cambridge II).

C. Land- and Sealevel Changes

Continuing the research of the Univ. Sub-dept. of Quaternary Research, Cambridge there are seven samples from the East Anglian Fens land basin and adjacent coast and a series from the south coast at Southampton all submitted by D. W. Churchill, and two further samples add to the series from SW Scotland. These extend the coastal datings given in Cambridge, I, III, V, VI, VII.

Welney Wash series, Norfolk

D. M. Churchill carefully reinvestigated the stratigraphy of the former Romano-British river channel (the roddon) at Welney Wash (52° 29' N Lat, 0° 21' E Long) at the site excavated by C. W. Phillips in 1935 (Phillips, 1936a, b). Two separate periods of Romano-British occupation were identified within the mineral deposits of the levée. These are shown by faunal and floristic remains to be at least partially marine in origin. They are continuous with the so-called 'upper silts' that occupy

large parts of the seaward side of the Fenland basin, and like them overlie the so-called 'upper peat' which began to form ca. 2400 B.C. It has been unclear when marine transgression put an end to this peat formation, some radiocarbon dates e.g. Q-547 being as early as 1355 ± 120 B.C., and other e.g. Q-806 being as late as 325 ± 100 B.C. (Cambridge VII). To give more precision to the date of the onset of this transgression pits were dug to obtain samples Q-819, Q-820 for radiocarbon dating at the uneroded surface of the upper peat. The contamination by secondarily intruded *Phragmites* stems from above was investigated by the further samples Q-823 and Q-829. Coll. D. M. Churchill, University Sub-dept. of Quaternary Research, Cambridge, 1964.

1970 \pm 100
20 B.C.

Q-819. Welney Wash, Norfolk, No. 4

Peat from pit beside bore 8 at 110 to 120 cm from surface, the top inch of peat directly below ca. + 20 cm O.D., underlying without discontinuity a thin *Phragmites* clay that is overlain by the (estuarine) silts of the roddon. $\delta C^{13} -32.5\%$. *Comment*: contamination by younger *Phragmites* rhizomes evident.

1940 \pm 130
A.D. 10

Q-820. Welney Wash, Norfolk, No. 1

Peat from pit beside bore 14 ca. 80 cm from the surface, from the top of the upper peat at ca. + 40 cm O.D., where it directly underlies the grey estuarine clay with *Hydrobia* and *Cardium edule*. $\delta C^{13} -32.5\%$. *Comment*: contamination by younger *Phragmites* rhizomes evident (see below, Q-823).

1212 \pm 154
A.D. 738

Q-823. Welney Wash, Norfolk, No. 2

Phragmites rhizomes mostly horizontal and not penetrated by root-lets, part of the sample from which Q-820 was taken, separated from the matrix and carefully washed. $\delta C^{13} -33.6\%$. *Comment*: the rhizomes are clearly younger than the peat into which they have intruded (see below, Q-829).

2227 \pm 90
277 B.C.

Q-829. Welney Wash, Norfolk, No. 3

Residues of the peat of Q-823 after removal of the *Phragmites* rhizomes were treated with NaOH to remove the soluble humic acid fraction that constitutes the bulk of the peat. The reprecipitated material was dated. $\delta C^{13} -32.5\%$.

Comment on Welney Wash series: Q-819 and 820 clearly give dates that are too young because of contamination by more recent *Phragmites* rhizomes (Q-823) though there is no trace of where these penetrated the overlying clay. Sample Q-829 is free from visible remains of *Phragmites* and gives a minimal age of 317 B.C. for the top of the peat bed, but it could still contain some alkali-soluble material derived from the contaminant material, but probably not so much as to equal the effect of

visible *Phragmites* (i.e., 300 yr). Therefore adding a further 300 yr to that of the alkali-soluble fraction (Q-829) should give an approximate older limit for the age of the top of the upper peat, which therefore at Welney should lie between ca. 600 and 300 B.C. This argument is that developed by D. M. Churchill who adduced other Fenland data conforming with this determination.

1464 \pm 154

Q-713. Hockwold, Norfolk

A.D. 486

Decayed wood (52° 27' 30" N Lat, 0° 30' E Long) from Hockwold, a Roman settlement on the edge of the fens overlooking the Ouse River. A cesspit was part filled with chalky mud and clay and light sand on which rested pottery dated A.D. 190 to 250. The pottery layer at 6 ft 3 in. O.D. was overlain by silty chalk mud containing seeds and leaves of plants of wet swampy and waste ground; grey chalky silt extended to +8 ft O.D., where it was succeeded by the wood peat now sampled. Coll. P. Salway, Sidney Sussex College, Cambridge, 1962. δC^{13} -36.9% . *Comment:* date agrees with that of the pottery. The deposits between the pottery and the dated wood peat were formed in fresh water which accumulated as landward floods in the 3rd Century.

Chapel Point, Lincolnshire series

The exposition of the provenance and purpose of samples in the series was set out in Cambridge VI, p. 129.

3943 \pm 100

Q-685. Chapel Point, Lincolnshire, No. 1

1993 B.C.

Peat (53° 14' N Lat, 0° 20' 30" E Long) from the contact of the lower peat with the overlying *Triglochin* (salt-marsh) clay at -6 ft O.D. Neolithic implements found by S. H. Warren appear to have been contemporaneous with this peat (Swinerton, 1931). Pollen-analyses are referred to the (Fenland) Zone VIIb, equivalent to the lower peat in the southern Fenlands (Godwin, 1940). Smith (1958) referred the bed to the Bronze Age. Coll. D. M. Churchill. δC^{13} -31.0% . *Comment:* on present information the radiocarbon date would fall within the Late-Neolithic rather than the Bronze Age, but the change from fresh water to marine conditions that it dates, corresponds with a change in the opposite sense (Fen Clay to Upper Peat) in the Cambridgeshire Fenland.

2815 \pm 100

Q-844. Chapel Point, Lincolnshire, No. 5

865 B.C.

Phragmites peat (53° 14' N Lat, 0° 20' 30" E Long) grown in salt marsh from the top of the Upper Peat (+ 5 in O.D.) at the contact with the overlying *Scrobicularia* clay. Sample is from the same monolith as Q-686 which dated the base of the upper peat at 3340 ± 110 B.P. Coll. D. M. Churchill, Oct. 1961. δC^{13} -32.5% .

Comment on Chapel Point series: all dates from this site show a consistent time/depth sequence, as below:

(salt marsh deposits)	
Channel in upper peat (+ 1.3 ft) shell	2630 \pm 110
Top of upper peat (+ 5.0 ft)	2815 \pm 100
Base of upper peat (c. O.D.)	3340 \pm 110
Top of lower peat (— 6.0 ft)	3943 \pm 100

The upper peat at Ingoldmells on the same coast, dated 2455 \pm 110 (Q-81) appears to be part of another intertidal marsh sequence. These results contradict the correlation suggested (Godwin, 1940) between these deposits and the peat/clay alternation in the southern Fenland basin.

Fawley, Hampshire series

In building a power station at Fawley, near Southampton on the W bank of the Solent (50° 49' N Lat, 1° 19' 30" W Long), a coffer dam was sunk into a sequence of estuarine clays and freshwater peat beds overlying sands and gravels stratified as follows: estuarine blue-grey clay with *Scrobicularia plana* and *Hydrobia* sp. from —4 ft to —9 ft O.D.; peat from —9 ft to —14 ft O.D. (samples Q-831, 832); blue-grey estuarine clay as above from —14 ft to —23 ft O.D.; sandy gravel. At one place only a small channel was cut into the surface of the gravel and then the above sequence continued downwards: blue-grey estuarine clay to —23.5 ft; laminated silty *Phragmites* peat from —23.5 ft to —24.5 ft O.D. (sample Q-834); sand with pieces of drifted *Quercus* wood from —24.5 ft to 25 ft O.D. (sample Q-835); gravel from —25 ft to at least —35 ft O.D. Coll. D. M. Churchill, July, 1964.

Q-831. Fawley, Hampshire, No. 2	3689 \pm 120
	1739 B.C.

Phragmites peat from the top in. of peat below the contact with overlying estuarine clay at —9 ft O.D., Pollen-zone VIIa. Dates freshwater to estuarine transition. δC^{13} —33.0‰.

Q-832. Fawley, Hampshire, No. 3	3563 \pm 96
	1613 B.C.

Betula wood under 2 in. diam from *Betula-Phragmites* fen-wood peat at —13.5 ft to —14 ft O.D., overlying khaki-coloured *Phragmites* clay which grades downward into soft blue-grey estuarine clay. Dates estuarine to freshwater transition. δC^{13} —30.5‰.

Q-834. Fawley, Hampshire, No. 5	6366 \pm 124
	4416 B.C.

Silty *Phragmites* peat with fragments of charcoal at —24 ft O.D., the most peaty of a series of laminated peaty silty clays overlain by shingle at

—23 ft O.D. at the base of the estuarine clay from which Q-832 was collected. Sample overlies sand and gravel, Pollen-zone VIIa. δC^{13} —31.5‰.

6318 ± 134
4368 B.C.

Q-835. Fawley, Hampshire, No. 6

Quercus wood from sand overlying gravel at —25 ft O.D. in bottom of small channel from which Q-834 was taken 1 ft higher. δC^{13} —32.5‰. *Comment on Fawley series:* whereas dates for Q-834 and Q-835 show the expected close agreement with one another, there is discordance between Q-831 with 3689 B.P. at the top of the peat bed and Q-832 with 3563 B.P. 5 ft lower at its base: the peat bed may have formed quickly but it seems likely that one of the two dates is suspect. Churchill (1965) shows that relative to sites in Wales and SW England there must have been relative crustal downwarping of more than 10 ft at Fawley since 6500 B.P.

SW Scotland series

In continuation of the series reported in Cambridge V (p. 59) we add new samples to supplement determination of the age of the “25 ft raised beach” of Northern Britain.

3656 ± 150

Q-666. Heathershot, Bridge of Allan, Perthshire 1706 B.C.

Wood fragments and shells of *Corylus* (56° 8' 30" N Lat, 3° 58' W Long) from left bank of Teith R, 500 ft NWN of Heathershot, about 1.5 mi W of Bridge of Allan. Beneath ca. 10 ft of beds taken to be “Carse Clays” is a layer 1.5 ft thick of carbonaceous matter from which the sample was taken: this rested upon 1 ft gravel over clay. Coll. B. M. Shipley, Macaulay Inst., Aberdeen, and W. A. Read, Geol. Survey, Edinburgh, 1961. Survey index No. U3895. δC^{13} —32.5‰.

3249 ± 160
1299 B.C.

Q-667. Littleward, Kippen

Flattened wood (56° 9' N Lat, 4° 11' W Long) from left bank of Forth R, 1350 ft E 20° S of Littleward Wester, and immediately SE of Flanders Moss. Grid ref. NS 65499692, from immediately below beds taken to be “Carse Clays”. Coll. B. M. Shipley and W. A. Read, 1961. Survey index No. U3896. δC^{13} —30.0‰.

Comment: these dates are far younger than any so far obtained for the peat/clay contact below the Carse Clays, namely Q-421 Eastfield of Dunbarney, 8421 ± 157; Q-422 Broombarns, 8354 ± 143; Q-280 Airth Colliery, 8421 ± 157, dates supported by those beneath the “25 ft raised beach” in SW Scotland and N Ireland. Indeed the two dates now given are younger than samples dated from the *upper* surface of the Carse Clay at Flanders Moss which lies very closely adjacent (Q-533, 5492 ± 130), and for one above the “25 ft raised beach” (Q-638, Lochar Moss, 6645 ± 120). One would suspect that the “Carse Clays” from these latest samples are the result of a later phase of cutting and redeposition.

D. Archaeologic samples

Q-647. Abbott's track, Westhay Level, Somerset **4810 ± 120**
2660 B.C.

Wood (51° 10' N Lat, 2° 50' W Long) from prehistoric track known to extend for a considerable distance ca. 82° W of N from Westhay towards Catcott Burtle. First exposed in 1834, excavated and described in 1873, it reappeared in fresh peat diggings in 1961. It has been carefully examined subsequently by Dr. J. M. Coles, Cambridge Univ. Dept. of Archaeol. and Anthropol. It lies close to the base of a thick layer of well-humified *Sphagnum-Calluna* peat not far above a layer of wood peat that represents a vegetational transition from *Cladium-Phragmites* fen. This stratigraphic position strongly indicates a Neolithic age for the track which is unusually elaborate and massive for this period. Coll. H. Godwin, June 1961. *Comment:* date confirms the Neolithic age of the track and agrees closely with the radiocarbon age for two slighter tracks in the same locality and at the same stratigraphic level, Honeygore track, Q-431, 4750 ± 130; Honeycat track, Q-320, 4065 ± 130; Q-427, 4326 ± 130; Q-429, 4215 ± 130 (see Cambridge II; Godwin, 1960; Dewar & Godwin, 1963).

3393 ± 210
1443 B.C.
3506 ± 110
1556 B.C.
Q-837. North Ferriby, Yorkshire, No. 3

Wood (53° 42' 48" N Lat, 0° 29' 52" E Long) from site on foreshore of N bank of Humber, a slat and tie found beneath one of two prehistoric 'sewn' boats excavated in 1941 (E. V. & C. W. Wright, 1947). The slat and tie are artefacts and may be presumed to date the vessel. Coll. E. V. Wright, 1941; subm. D. M. Churchill, 1965. $\delta C^{13} -32.5\%$. *Comment:* the two independent assays agree but both are significantly older than BM-58 at 2700 ± 150 (British Museum II) which was from oak sealing strips found near the site of boats No. 1 and 2 but not collected until 1954; they are also older than Q-715 at 3120 ± 105 (Cambridge VII) for the wooden platform upon which rested remains of a third prehistoric boat of the same type and in the same stratigraphic situation. The wide spread of the dates is not understood although it covers the age expected on other grounds.

12,950 ± 240
11,000 B.C.
Q-836. North Ferriby, Yorkshire, No. 4

Corylus wood (53° 42' 48" N Lat, 0° 29' 52" E Long) from site on foreshore of N bank of Humber, a withe loop found projecting from surface of estuarine clay within 6 ft of E end of prehistoric boat No. 3 and at same stratigraphic level as boat. Coll. E. V. Wright, 1963; subm. D. M. Churchill, 1965. $\delta C^{13} -30.0\%$. *Comment:* it was supposed that the wood was an artefact contemporary with the boats. Date appears to disprove this, but equally 12,950 B.P. is Late-Weichselian when *Corylus avellana* is unknown in Britain.

2950 \pm 150

Q-764. Ashgrove Farm, Methilhill, Fifeshire 1000 B.C.

Vegetable matter (56° 11' 16" N Lat, 3° 2' 38" W Long) ca. 1 mi inland from N shore of Firth of Forth, 1¼ mi NNW of Buckhaven (Grif ref. 352990). A mat of dicotyledonous leaf fragments, bark, twigs, charcoal and *Sphagnum* moss, ca. 1 ft wide and 1 in. thick was found on the chest of a human skeleton in a cist grave, along with a late beaker and bronze dagger with horn hilt and bone pommel (Early Bronze Age). Pollen analyses are remarkable for extremely high values of lime (*Tilia cordata*) not regarded as native in Scotland, and possibly due to flowering branches buried with the body, and of meadow sweet (*Filipendula hexapetala*), a strongly scented flower possibly also introduced in the same way. There are also clear indications of forest clearance. The burial corresponds with the first phase of the Wessex Culture in Southern England and hence the estimated age is 16th century B.C. Coll. Prof. L. H. Butler, 1963; subm. Miss H. Henshall, Nat. Mus. Antiquities Scotland, Edinburgh. δC^{13} -36.0‰. *Comment:* radiocarbon age is unexpectedly late.

2133 \pm 110

Q-814. Llanafan, Cardiganshire, No. 1 183 B.C.

Charcoal (52° 19' N Lat, 3° 55' W Long), Nat. Grid Ref. SN 690711 from a layer in the B horizon of a soil of the Denbigh series, on a sloping hillside in Central Wales. The charcoal, 0.5 in. thick, is exposed for 3 ft laterally, is overlain by 2 ft of yellowish brown silt loam, and is apparently *in situ* above a thin burned layer (1.5 in.) above shattered shale a few inches thick over solid rock. Coll. C. C. Rudeforth, Soil Survey of England and Wales, 1962; subm. R. M. S. Perrin, Univ. School of Agriculture, Cambridge. Sample is intended to date the episode by which the top 2 ft of mineral soil was deposited over the charcoal burnt-soil surface (Rudeforth, 1963). Some living rootlets and humus penetrated the charcoal layer, but these were as far as possible removed in pre-treatment of the sample. *Comment:* date agrees with the possibility that forest clearance and husbandry in the pre-Roman Iron Age induced erosion in this locality.

ANTARCTICA

1843 \pm 96

Q-801. Signy Island, South Orkney Islands, No. 1 A.D. 107

Polytrichum-Dicranum moss (60° 40' S Lat, 45° 40' W Long) from NW coast above Spindrift Rocks, between 150 and 200 ft above sealevel. From one of the largest of the frozen banks of moss in the island, taken at the base, 5 ft to 5 ft 8 in. from the surface. About half the island is covered with permanent ice and snow and only two flowering plants are native to the island; the moss is living at the surface. Pollen analyses at 6 in. intervals through the bank have given substantial frequencies of different S. American plants from more than 500 mi distance (D. M. Churchill anal.). Coll. M. Holdgate, Falkland Islands Dependencies Sur-

vey, Feb. 1962. δC^{13} -27.5% . *Comment*: date suggests a mean rate of growth of the moss bank ca. 1 in. in 30 yr: the age calculation has assumed however the standard atmospheric activity.

Q-825. Signy Island, South Orkney Islands, No. 2 $\Delta C^{14} = + 83.14$

Drepanocladus-Polytrichum-Dicranum moss ($60^{\circ} 40' S$ Lat, $45^{\circ} 40' W$ Long). Living moss from surface of moss bank, Hut Bank, 50 ft above sealevel. Intended to provide a check on modern radiocarbon activity. Coll. M. Holdgate, British Antarctic Survey, Dec. 1963-Feb. 1964. *Comment*: result indicates an increase due to bomb carbon effect, probably diluted by an unknown amount of earlier moss in the sample which may represent 30 to 60 years growth.

JORDAN

3950 ± 150

Q-729. Wadi Hasa, Terrace, III, No. 1

2000 B.C.

Charcoal ($30^{\circ} 51' 15'' N$ Lat, $35^{\circ} 55' 15'' E$ Long) from upper Wadi Hasa, near Qa'lat el Hasa (Grid ref. 239028, sheet 2 of 1/250,000 map of Jordan, 1949). From a lens of charcoal 1 m below surface of Terrace III, the main valley floor which is in places 1 km wide and trenched by present-day stream. The terrace surface is underlain by fine, buff, well-bedded alluvium that contains artefacts identified by Dr. D. A. E. Garrod as Kebaran (Late Upper Palaeolithic), and is 4 m thick at the sampling point, resting directly on eroded bedrock (Vita-Finzi, 1964). Coll. C. Vita-Finzi, St. John's College, Cambridge, 3 Jan. 1963 (see Vita-Finzi, 1963). *Comment*: carbon date shows that deposition which had begun in or after late Upper Palaeolithic times, continued into the 2nd millenium B.C.; it had ceased by the time classical pottery became available, although it was temporarily resumed in post-classical times to produce Terrace IV (C.V-F.).

NEW ZEALAND

Swampy Hill series, near Dunedin

An extensive peat formation (blanket bog) covers the summit of Swampy Hill ($45^{\circ} 47' 40'' S$ Lat, $170^{\circ} 28' 45'' E$ Long), and at N end of this area, ESE of the Trig. point at 2433 ft above sealevel a deep peat section was cut to the underlying basaltic surface. Pollen samples at 10 cm intervals and samples for radiocarbon dating were collected 11 Sept. 1963 by D. J. McIntyre and I. C. McKellar, New Zealand Geol. Survey. The site is probably equivalent to locality 4 of Cranwell and von Post (1936). Pollen analyses by D. J. McIntyre disclose an important sequence of vegetational changes which the radiocarbon samples are chosen to date. The diagram is divisible into three zones: I, 385 to 295 cm representing herbaceous and shrubby vegetation; II, 295 to 160 cm, forest with *Podocarpus* spp (mainly *P. ferrugineus* type), *Dacrydium bidwillii-biforme* and *Phyllocladus*; III, 160 to 0 cm, forest as before but supplemented by *Dacrydium cupressinum*, and *Nothofagus* spp in low frequency, *Centrolepidaceae* less abundant.

**Q-795. Swampy Hill, Dunedin (S 164/546) 11,481 ± 150
9531 B.C.**

Decomposed plastic reddish brown peat, 370 cm from surface just over contact with basaltic debris. Pollen spectrum notable for absence of trees and abundance of *Coprosma*, *Ericales*, *Umbelliferae*, *Myrsine*, *Compositae*, *Gramineae*, *Cyperaceae* and *Centrolepidaceae*: basal part of Zone I. $\delta C^{13} -29.7\%$.

**Q-796. Swampy Hill, Dunedin (S 164/547) 11,024 ± 150
9074 B.C.**

Decomposed plastic reddish brown peat, 300 cm from surface: upper part of Zone I immediately preceding great expansion of arboreal pollen, especially of *Podocarpus* spp. $\delta C^{13} -34.0\%$.

**Q-797 Swampy Hill, Dunedin (S 164/548) 7299 ± 120
5349 B.C.**

Small lenses of fibrous plant material in decomposed plastic reddish brown peat, 200 cm from surface and two thirds up Zone II. $\delta C^{13} -28.3\%$.

**Q-798. Swampy Hill, Dunedin (S 164/549) 5427 ± 110
3477 B.C.**

Fibrous root layer at top of decomposed plastic reddish brown peat, 100 cm from surface and one third up Zone III at level where substantial amounts of rimu (*Dacrydium cupressinum*) and small but consistent amounts of *Nothofagus* spp. occur. $\delta C^{13} -27.1\%$.

General comment on Swampy Hill series: C^{14} dates fix the occurrence of treeless vegetation type prior to 11,000 B.P. in SE South Island, New Zealand, a result consonant with the final retreat of the Otiran glaciers starting at ca. 14,000 to 15,000 B.P. The expansion of podocarp forest between 11,000 and say 10,000 B.P. in the broadest sense parallels forest expansion in W Europe after the Late-Weichselian. It is premature to attempt correlation of this vegetational phase or that which succeeds it until there are more numerous carbon-dated pollen sequences from other parts of New Zealand. Extrapolation of the time scale provided by the four dates indicates that from above the present surface a considerable depth of peat has been removed, probably by fire and erosion. This is important in any attempted correlation with accepted systems of zoning New Zealand pollen diagrams.

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UNIVERSITY OF ROME CARBON-14 DATES IV

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The list includes age measurements carried out from December 1964 to October 1965. As in the previous list (Rome III) the samples dated are almost all of archaeological interest and are drawn from Italian and some European and Asiatic territories.

The chemical and physical techniques and instruments used for these measurements are essentially the same as those used previously (Bella and Cortesi, 1960; Alessio, Bella and Cortesi, 1964). The same two counters are still being used and each sample is measured by both. For dating small samples a counter is used similar to the others but of smaller volume (Alessio, Allegri and Bella, 1960); its characteristics are efficient volume 0.5 L, length of the wire 160 mm, diam of the wire 0.05 mm, internal diam of the counter 60 mm, supply voltage 8,200 volts, background 2.40 ± 0.08 counts/min, counting rate for modern carbon 10.43 ± 0.15 counts/min. The errors, quoted as in Rome III, are the 1σ statistical errors. Ages have still been calculated using Libby's half life of 5568 ± 30 yr with 1950 as the standard year of reference. As in Rome II and Rome III measurements, the same modern wood grown near Rome between 1949 and 1953 has been used as modern standard; recently its activity has been once again carefully checked and judged satisfactory.

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Italy

Caverna delle Arene Candide series

Charcoal from Caverna delle Arene Candide deposit on southern side of Mt. Caprazoppa, a small promontory of Ligurian Riviera near Finale Ligure Marina 25 km SW Savona, Liguria ($44^{\circ} 09' 42''$ N Lat, $8^{\circ} 19' 34''$ E Long, 90 m above sealevel). Cave No. 34 in "Catalogo Speleologico Ligure." Coll. 1939-1950 and subm. 1957 by L. Cardini, Ist. Italiano di Paleontologia Umana. Cave is reckoned the most important prehistoric settlement in Liguria; the succession of cultures in its stratigraphy (from Upper Paleolithic to Iron Age) is fundamental to study

the prehistory both of this region and neighbouring ones (Po Plain, Western Mediterranean, etc.). Exploration of deposit was begun by G. B. Amerano and A. Issel at end of 19th century; systematic excavation was carried out in 1939-1950 by L. Cardini and L. Bernabò Brea, Soprintendente alle Antichità della Sicilia Orientale, formerly Soprintendente alle Antichità della Liguria. From surface downward the following archaeological layers were identified: I, Iron Age, Levels 1-4; II, Bronze Age, Levels 5-8; III, Late Neolithic, Lagozza culture, Levels 9-14; IV, Middle Neolithic with square-mouthed pots (2nd phase) and quadrilobate-mouthed pots (1st phase), Levels 16-24; V, Early Neolithic with printed pottery, Levels 25-26; VI, Epipaleolithic, Epigravettian type industry; VII, Upper Paleolithic, Late Aurignacian type industry. Hearths and numerous tombs of various types have been found in Middle Neolithic strata and at bottom of Epipaleolithic level (Bernabò Brea, 1946, 1956; Cardini, 1941, 1942, 1946, 1955).

5075 ± 45
3125 B.C.

R-104. Arene Candide III

Charcoal from Levels 12-13, 1.60 to 1.80 m below surface. Late Neolithic, Lagozza culture.

5465 ± 50
3515 B.C.

R-103. Arene Candide IV-2

Charcoal from Levels 16-19, 1.90 to 2.20 m below surface. Middle Neolithic, square-mouthed pots culture. Remains of domestic animals and scarce wild fauna.

5335 ± 50
3385 B.C.

R-102. Arene Candide IV-1

Charcoal from Levels 21-24, 2.45 to 3.05 m below surface. Middle Neolithic, quadrilobate-mouthed pots with notched rim, 1st phase of square-mouthed pots culture. Remains of domestic animals and scarce wild fauna.

6220 ± 55
4270 B.C.

R-101. Arene Candide V

Charcoal from Levels 25-26, 3.05 to 3.30 m below surface. Early Neolithic, printed pottery together with remains of domestic and wild animals, numerous shells of marine molluscs, food refuse.

10,330 ± 95
8380 B.C.

R-100. Arene Candide VI

Charcoal from Epipaleolithic layer, 3.50 to 4.50 m below surface. Italian Epigravettian industry.

General Comment: R-104 date, Lagozza culture, agrees well with C¹⁴ date obtained for Lagozza di Besnate, province of Varese, Lombardy, locality where this typical Upper Neolithic culture was revealed: Pi-34, 4794 ± 90 (Pisa II). R-103 date, square-mouthed pots culture, is in good agreement with age of a charcoal sample from the same levels (Level

No. 20) measured at Pisa: Pi-27, 5435 ± 135 (or ± 200) (Tongiorgi *et al.*, 1959; Emiliani *et al.*, 1964). Deposits at other localities of North Italy containing square-mouthed pots, gave similar C¹⁴ dates: Isola Virginia, or Isolino, Lake of Varese, Lombardy, Pi-4, 5534 ± 144 ; Pi-38, 5326 ± 180 (Pisa I; Tongiorgi *et al.*, 1959; Emiliani *et al.*, 1964); Grotta Aisone, Valle Stura, Piedmont, 5825 ± 75 (Rome III). R-102 date, similar to R-103 date, seems somewhat young, though there is no convincing archaeological reason for holding quadrilobate-mouthed pots to be much older than square-mouthed ones. However, partial mixing in the deposit itself with charcoal of Levels 19-16 might be postulated. On the other hand, the age of ca. 6500 yr attributed by others to quadrilobate-mouthed pots is perhaps too old: 6450 ± 25 (Emiliani *et al.*, 1964); Pi-27b, 6487 ± 175 (Tongiorgi *et al.*, 1959). This latter dating refers to Level 25 which in actual fact belongs to Lower Neolithic containing printed pottery and suspected of being mixed to some extent with overlying strata (Tongiorgi *et al.*, 1959). R-101 date, Early Neolithic, printed pottery (Levels 25-26), can be compared with Pi-27b. R-100 age agrees well with date expected for the Epigravettian industry of the layer.

Grotta del Santuario della Madonna series

Excavation of Grotta del Santuario della Madonna deposit at foot of Mt. Vingiolo in village of Praia a Mare on Tyrrhenian coast of Calabria, 297.9 km along state road No. 18 (Tirrena Inferiore), province of Cosenza, Calabria ($39^{\circ} 53' 43''$ N Lat, $15^{\circ} 47' 11''$ E Long, ca. 52 m above sealevel) was begun in 1959-1960 by the late A. C. Blanc, Ist. Italiano di Paleontologia Umana, and L. Cardini (Blanc and Cardini, 1957, 1958-61; Blanc *et al.*, 1958-61) and continued in 1962-65 by L. Cardini, who coll. samples 1962-63 and subm. Dec. 1962-April 1965. Through the deposit excavated hitherto, 10.30 m thick, ten archaeological layers have been identified containing pottery, flint implements, charcoal, bones of domestic and wild animals and mollusc shells, food refuse. From top downward: I, Roman period; II, Middle Bronze Age, Apennines culture; III, Eneolithic, Piano Conte culture; IV, Culture not yet defined; V, Late Neolithic, Diana culture; Middle Neolithic: VI, 3rd phase, Serra d'Alto culture; VII, 2nd phase, Capri culture; VIII, 1st phase, printed pottery painted with red bands; IX, Mesolithic; X, Upper Paleolithic, Gravettian industry (Tinè, 1965; Cardini and Cassoli, 1966; Cardini, Cassoli and Biddittu, 1966; Cardini, Taschini and Cassoli, 1966). Samples dated belong to IV, IX, and X layers.

R-189. Grotta della Madonna IV

**4770 \pm 55
2820 B.C.**

Charcoal from sections 20-25 of Layer IV, 2.70 to 3.30 m below surface. Undefined cultural elements probably of alien origin, beneath Piano Conte culture; bones of domestic animals.

R-188. Grotta della Madonna IXa**9070 \pm 80****7120 B.C.**

Charred bones from middle level of Layer IX, sections 45-46, 5.10 to 5.30 m below surface, Mesolithic. This layer, 60 m thick, contains coarse flint implements and scarce bone industry; only bones of wild holocenec animals were found together with numerous shells of marine (*Patella*, *Trochus*) and fresh water molluscs, (*Helix ligata*), food refuse.

R-187. Grotta della Madonna IXb**8735 \pm 80****6785 B.C.****R-187 α . Grotta della Madonna IXb****8875 \pm 85****6925 B.C.**

Charcoal found in Layer IX, Mesolithic, together with charred bones sample R-188. Sample R-187 was given only standard pre-treatment by dilute HCl; sample R-187 α is the insoluble residue of an additional leaching with 6% NH₄OH. Difference between two ages is not very significant.

R-186. Grotta della Madonna Xa**10,030 \pm 90****8080 B.C.**

Charred bones of middle level of Layer X, sections 57-58, 6.30 to 6.50 m below surface. The layer, 1.70 m thick, contains an Upper Paleolithic industry of Gravettian type, wild pleistocenec fauna with extinct species together with numerous shells of fresh water (*Helix ligata*) and scarce marine molluscs.

R-185. Grotta della Madonna Xb**10,120 \pm 70****8170 B.C.**

Charcoal found in Layer X, Upper Paleolithic, together with charred bones R-186.

General Comment: R-189 date suggests attribution of undefined industry in Layer IV to Late Neolithic. R-188, R-187 and R-187 α dates (Layer IX) and R-186 and R-185 dates (Layer X) agree with the type of industry at these levels. Furthermore for each level dates of charcoal and charred bones are in good agreement. As regard charred bones, material for dating purposes was accurately chosen; after careful washing, the bones' mineral components were completely destroyed by treatment with dilute HCl, the residual blackish matter being wholly soluble by 6% NH₄OH. Dating of other layers of deposit is being carried out.

Grotta del Romito series

Charcoal from Grotta del Romito deposit near Papasidero, 51.6 km W Castrovillari, province of Cosenza, Calabria (39° 52' 12" N Lat, 15° 54' 23" E Long). Coll. 1963-1964 and subm. January 1965 by P. Graziosi, President of Ist. Italiano di Preistoria e Protostoria. In 1961 a fine engraving of a bull together with others of a paleolithic type were found on a block of half-buried limestone in rock shelter deposit at entrance

of cave (Graziosi, 1961, 1962a, 1962b, 1962c, 1964a). In 1963 and 1964 systematic excavation of deposit in both cave and shelter carried out by the Ist. Italiano di Preistoria e Protostoria with the collaboration of Soprintendenza alle Antichità della Calabria brought to light (a) upper layers with pottery datable, upon a first examination, to Middle and Late Neolithic and (b) lower layers devoid of pottery with Upper Paleolithic or Epipaleolithic industries, perhaps of an Epigravettian type. In these layers (b), moreover, four buried human skeletons were found (Graziosi, 1963, 1964b).

R-223. Romito I**6420 ± 70****4470 B.C.**

Charcoal from upper layers with Neolithic pottery.

R-221. Romito II**10,960 ± 350****9010 B.C.**

Charcoal from lower layers with Upper Paleolithic or Epipaleolithic industry.

General Comment: respective dates obtained can agree with the type of industry or pottery found in the layers.

Arslantepe series*B. Turkey*

In 1961, 1962 and 1964 an Italian Archaeol. Mission (Head: P. Meriggi, Univ. of Pavia; Director of excavations: S. M. Puglisi, Ist. di Paleontologia, Univ. of Rome), sponsored by the Centro Italiano per le Antichità e la Storia dell'Arte del Vicino Oriente, carried out excavations of the *höyük* of Arslantepe near the city of Malatya, Anatolia, Turkey (38° 21' N Lat, 38° 22' E Long). The *höyük* of Arslantepe is an artificial hill 30 m high mainly formed of the accumulating remains of walls and buildings belonging to the super-imposed ancient Hittite cities of Malatya and of a successive Roman-Byzantine settlement. Digging has brought to light the following archaeological levels: I, Roman-Byzantine level; II, a transitional level with features that are not well defined; III, IV, held to be, respectively, neo-Hittite and Hittite-Imperial levels; V, Early Bronze Age; VI, Late Chalcolithic. In addition, surface pottery finds are proof of an Islamic settlement (Puglisi, 1962a, 1962b, 1964a, 1964b, 1965). Samples submitted to our lab. belong to intermediate levels.

R-214. Arslantepe C 1**2835 ± 70****885 B.C.****R-214β. Arslantepe C 1****2795 ± 60****845 B.C.**

Charred wood from area of Imperial Gate, C 1 of excavation map. Coll. 1964 and subm. Oct. 1964 by E. Castaldi, Ist. di Paleontologia, Univ. of Rome. Wood belonged to a destruction level caused by fire covering ruined masonry of a monumental gate attributed, on basis of archaeol-

ogical data, to Hittite-Imperial period (16th-12th centuries B.C.). Further archaeological evidence indicates that when fire broke out gate was already ruined and despoiled (see Puglisi, 1965, p. 122). The Imperial Gate underlies the so-called Gate of the Lions belonging to enclosure wall of the neo-Hittite citadel unearthed during previous excavations and now destroyed (Delaporte, 1940). R-214 was given only dilute HCl pre-treatment; R-214 β represents the abundant humic fraction of charcoal separated through additional leaching by 6% NH₄OH and precipitated again by dilute HCl. Difference between R-214 and R-214 β dates is not significant and shows that sample was not contaminated, as suspected.

R-218. Arslantepe B2 IIIc	2895 \pm 60 945 B.C.
R-219. Arslantepe B2 IVc	2655 \pm 70 705 B.C.
R-219β. Arslantepe B2 IVc	2770 \pm 120 820 B.C.

Charcoal from levels of dwellings in E Area B2, IIIb and IVc, of excavation map. Coll. 1964 and subm. Oct. 1964 by A. Palmieri, Ist. di Paleontologia, Univ. of Rome. Site is outside citadel walls and stratigraphy is somewhat deranged since foundations of these buildings have altered original arrangement of the *hüyük*, cutting through previous deposits. As for R-214 sample, R-219 and R-219 β (humic fraction) dates show that sample was not contaminated as suspected.

General Comment: R-214 date, younger than age attributed to Imperial Gate, confirms Puglisi's view, quoted above, that fire occurred when the gate was already in ruins. R-218 and R-219 dates are similar and give a first indication of age for an uncertain level in the eastern side of the *hüyük*.

Various archaeological mounds scattered throughout Turkey have so far been dated through the systematic work carried out by the Univ. of Pennsylvania Lab. (see Pennsylvania III, p. 46-47; Pennsylvania V, p. 145-146; Pennsylvania VIII, p. 191-194). The Hacilar site was dated also at British Mus. Lab. (see British Museum II, p. 29-30; British Museum IV, p. 107-108). First dates for Turkey, Alhisar site, were measured at Chicago (Chicago I, C-115 and C-183).

C. Afghanistan

Sponsored by IsMEO (Ist. Italiano per il Medio ed Estremo Oriente), the Italian Archaeol. Mission at Samangan, Afghanistan, has, since 1961, been carrying out researches and excavations in the archaeological area of Hazār Sum Valley, 16 km NW Samangan (= Aibaq), province of Mazar-i-Sharif, North Afghanistan (ca. 36° 15' N Lat, 68° 05' E Long). These were entrusted by G. Tucci, President of IsMEO and Head of Italian Archaeol. Missions IsMEO in Asia, to S. M. Puglisi. Abundant

finds of stone implements prove valley was inhabited by Paleolithic and Neolithic peoples who found refuge in the very numerous rock shelters and caves bordering the valley (Hazār Sum = thousand caves). Hazār Sum site consists of a vast and complex archaeological area of urban type containing three different form of constructions: characteristic megalithic monuments, constructions with dry walls, and dwellings hewn out of the rock (cave dwellings). Relationship and chronology of air buildings and cave-dwellings have not been well explained; all seem to belong to various historic peoples. On the remains of these preceding civilizations from 7th century A.D. onwards, Islamic peoples everywhere built their own buildings in mud bricks, the location of which is shown today by numerous so-called "Islamic mounds" formed from their ruins (Puglisi, 1963; Castaldi, 1963). As Islamic center, Hazār Sum reached its maximum importance as a junction on the old caravan route in Samanid age (10th century A.D.), as archaeological finds have confirmed.

Hazār Sum, Islamic layers series

Charcoal from Islamic layers in F 7-8 area of Hazār Sum Map (see Puglisi, 1963, fig. 9). Coll. 1963 and subm. 1964 by E. Castaldi.

1155 ± 40

R-208. Hazār Sum, Islamic Layer II

A.D. 795

Charcoal from the upper Layer II with numerous islamic pottery.

925 ± 60

R-212. Hazār Sum, Islamic Layer IV

A.D. 1025

Charcoal from lower Layer IV, beneath barren Layer III, with scanty potsherds showing different characteristics from upper islamic pottery.

915 ± 45

R-213. Hazār Sum, Islamic Layer IVa

A.D. 1035

Charcoal from another portion of same Layer IV.

General Comment: after pre-treatment by dilute HCl, an additional leaching with 6% NH_4OH was not deemed necessary since a separate test showed that all charcoal of the Hazār Sum site was devoid of humic acids. R-208 date agrees with expected Islamic age. R-212 and R-213 dates proved too late and confirm, as suspected, that layer was altered and material mixed with upper one (surface Layer I).

Hazār Sum, funeral cave series

Charcoal from deposit of a cave in F 7-8 area of Hazār Sum map (see Puglisi, 1963, fig. 9). Coll. 1963 and subm. Oct. 1964 by E. Castaldi. Access to this small underground cave is by way of a corridor with steps. At bottom of deposit, separated from overlying strata by layer of stones, a human skeleton was found, hence name given to the cave. Charcoal comes from upper part of deposit that represents discarded material assumed to be Islamic.

875 ± 40

R-211. Hazār Sum, funeral cave 1 **A.D. 1075**

Charcoal from deposit inside cave above layer of stones covering skeleton.

680 ± 80

R-210. Hazār Sum, funeral cave 2 **A.D. 1270**

Charcoal from part of deposit that filled the corridor of cave.

General Comment: R-211 date confirms attribution of this level of deposit to Islamic period; R-210 date shows that the filling-in of the cave continued till more recent times.

So far in Afghanistan territory there have been few C¹⁴ dates. Two notable archaeological sites have been dated at Hannover Lab: a) Char-i-Mir, a prehistoric site in North Afghanistan on roughly the same lat. as, and not too far W of, (66° 45' E Long) Hazār Sum; b) Quala Shaharak, an Islamic settlement in Central Afghanistan whose age agrees with that obtained for Islamic period of Hazār Sum (Hannover III, p. 263-264). Furthermore the prehistoric site of Mundigak prov. of Kandahar, Bronze age, was dated at Chicago (Chicago IV, C-815) and age of a Paleolithic shelter at Kala Kamar was measured at USGS Lab. (USGS III, W-224, 226).

D. Pakistan

In 1956, the Italian Archaeol. Mission in Pakistan, sponsored by IsMEO and entrusted by G. Tucci to D. Faccenna, Head of Mus. of Oriental Art in Rome, began archaeological campaigns in state of Swat, W Pakistan, following an agreement with Dept. of Archaeol. of Pakistan. Swat is a region of great archaeological importance rich in extensive remains of past civilizations. Excavations by the Italian Mission have so far brought to light urban settlements, necropolises and Buddhist sacred sites (Buddhist Stupas). Radiocarbon dates are of great interest for these finds, since archaeological evidence is often scarce or of slight significance. So far dates that follow are the first for Swat.

2425 ± 40

R-194. Butkara II **475 B.C.**

Burnt human bones from seven cremation tombs of pre-Buddhist necropolis of Butkara II on left bank of Jāmbīl River 1.5 km upstream from Mingora, Swat, Pakistan (ca. 34° 44' N Lat, 72° 20' E Long). Coll. 1960-1961 by M. Taddei, Director of Butkara excavation, and subm. May 1964 by D. Faccenna, Head of Italian Archaeol. Mission in Pakistan, on behalf of G. Tucci. Excavated graveyard is only part of necropolis. Altogether, 48 cremation and inhumation tombs were found, all belonging to same period. In cremation tombs burnt bones, reduced to tiny pieces, were placed together with grave goods in a kind of terracotta funerary jar covered with a lid. Both in cremation and inhumation tombs handsome pottery with offerings and bronze objects were found.

Part of necropolis area was later occupied by a Buddhist sanctuary (Silvi Antonini, 1963; Faccenna, 1964). *Comment:* bits of bones were carefully chosen and their mineral components were completely destroyed by treatment with dilute HCl; in this case black residual matter was insoluble in 6% NH_4OH . Date obtained agree with presumed age of necropolis that is believed to belong to Iron age.

Barama I series

Charcoal from Barama I settlement in a fluvial terrace on right side of Jāmbīl River 0.5 km SE Mingora, Swat, Pakistan (ca. $34^\circ 44'$ N Lat, $72^\circ 20'$ E Long). Coll. 1963 and subm. May 1964 by D. Faccenna on behalf of G. Tucci. The 1963 excavation campaign brought to light a portion of the settlement and clearly revealed five main periods of reconstruction of the buildings which are set one above the other. Beneath them another level with evidence of human habitation, probably a hut-settlement (6th period) which rests directly on clayey soil of the terrace (Faccenna, 1964-65).

R-195. Barama I 5a

2320 \pm 45
370 B.C.

Fragments of charcoal from Trench I beneath the superimposed buildings of Period 1-4 in Stratum 5a, belonging to Floor P. 4a, and consisting of potsherds, stones, rubble and similar discarded material.

R-196. Barama I 8

2585 \pm 80
635 B.C.

Fragments of charcoal from Trench I in the filling of one of small pits (Pit 2) cut into clayey soil beneath lower human settlement. Filling consists of loose earth containing a mixture of floury stuff, particles of charcoal, chaff and potsherds. Pits seem to suggest erection of huts.

General Comment: dates of R-195 and R-196 give a first indication of age for two different periods of this settlement; they are consistent and seem to agree with expected age.

II. GEOLOGIC SAMPLES

A. Italy

Alban Hills series

Wood embedded in "peperino" of Albano crater, from N slope of Albano Lake along road leading to lake shore, 24.5 km SE of Rome ($41^\circ 45' 40''$ N Lat, $12^\circ 39' 38''$ E Long). R-135 and R-135 α represent a branch of a tree trunk brought to light in 1959 by road works; it was consigned at this time to M. Tofini and subm. 1960 by him. R-135A, R-135B and R-135C are fragments of wood coll. later in same locality by M. Fornaseri and C. Cortesi, Ist. di Geochimica, Univ. of Rome, and subm. by them. R-135B was *Ulmus* and R-135C was *Quercus ilex* (id. by M. Follieri, private commun.).

R-135.	Alban Hills	>37,000
R-135α.	Alban Hills	>37,000
R-135A.	Alban Hills	>37,000
R-135B.	Alban Hills	>37,000
R-135C.	Alban Hills	>37,000

General Comment: peperino is considered to be one of the latest volcanic products of the Alban Hill district (Sabatini, 1900; Fornaseri, Scherillo and Ventriglia, 1963). Peperino is local name for a gray granular, more-or-less coherent tuff, containing variable amount of inclusions of eruptive and sedimentary rock fragments. By correlations with sedimentary formations, oldest tuffs have been assigned to Late Riss and to Inter-glacial Riss/Würm. As dated tuff is younger but still too old for C¹⁴ dating, eruption of the peperino in this locality was probably Early Würm. However, wood fragments coll. 1957 by M. Fornaseri and C. Cortesi in the same peperino formation near Marino were dated at Groningen Lab. as GrN-1496, 29,720 \pm 400 (Hl. DeVries, private commun., Sept. 1958). If valid, this date implies that peperino is of more than one age and was formed as late as the Early Würm-Main Würm Interstadial.

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Pennsylvania III	Ralph, 1959
Pennsylvania V	Ralph and Stuckenrath, 1962
Pennsylvania VIII	Stuckenrath and Ralph, 1965
Pisa I	Ferrara, Reinhartz, and Tongiorgi, 1959
Pisa II	Ferrara, Fornaca-Rinaldi, and Tongiorgi, 1961
Rome II	Alessio, Bella, and Cortesi, 1964
Rome III	Alessio, Bella, Bachechi, and Cortesi, 1965
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SMITHSONIAN INSTITUTION RADIOCARBON
MEASUREMENTS III*

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INTRODUCTION

Most of these analyses were performed during 1965 with equipment and techniques previously employed at this laboratory. A cold (-40°C) charcoal trap stage was added to the CO_2 purification to remove radon, which eliminates the lag time between CH_4 preparation and counting (Long, 1965b).

Unless otherwise noted, all samples were submitted by Smithsonian staff members, each of whom supplied information pertaining to the samples and contributed generously to discussions of results.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Eastern United States

Elm Hill series, Virginia

Charcoal from site on left bank of Roanoke River ($36^{\circ} 36' 40''$ N Lat, $78^{\circ} 16' 20''$ W Long), in Mecklenburg County. Coll. 1964 by H. A. MacCord; subm. by Clifford Evans. Pottery analysis by Evans places site in Clarksville series.

SI-154.	280 ± 70
	A.D. 1670
Feat. 30 (refuse pit), Sec. 6D, Square 11, 40 in. depth below surface.	

SI-155.	2470 ± 70
	520 B.C.
Feat. 23 (refuse pit), Sec. 6B, Squares 80 and 90, 39 in. depth below surface. <i>Comment:</i> specimen apparently contaminated with older material.	

B. Central United States

Domebo site series, Oklahoma

Two fractions of bone of *Mammoth* from Domebo site ($34^{\circ} 57'$ N Lat, $98^{\circ} 16'$ W Long), Caddo County. Bone was treated and organic carbon fractionated by Vance Haynes, Geochronology Lab., Univ. of Arizona. Coll. 1962 by A. D. Anderson; subm. by F. C. Leonhardy, Mus. of the Great Plains, Lawton, Oklahoma. *Comment:* previous (unpub.) dates from this site are as follows: 4952 ± 300 (Texas Bio-nuclear) on

* Published with the approval of the Secretary of the Smithsonian Institution.

tusk; and $10,120 \pm 280$ (SM-610), $11,045 \pm 645$ (SM-645), both on wood. The present analyses indicate the tusk analysis includes more recent carbon contaminates.

SI-172. Fraction C

Organic matter soluble in 2 N HCl after initial 2% NaOH extraction.

11,220 \pm 500
9270 B.C.

SI-175. Fraction B

Organic matter soluble in 2% NaOH after initial 2% NaOH extraction and subsequent decalcification of bone.

11,200 \pm 600
9250 B.C.

Herl series, Kansas

Charred bone from 14GL401 ($38^{\circ} 42'$ N Lat, $101^{\circ} 37'$ W Long), in Greeley County. Coll. 1961 and subm. by P. W. Bowman, Kansas Anthropol. Assoc., Wallace, Kansas. Hilltop site with fireplaces and trash-filled pits containing bison and antelope bone; stemmed projectile points, no pottery. One burial pit contained Angostura-like point, probably intrusive. *Comment* (W. R. Wedel): date much younger than expected.

SI-132.

Feat. 2A, a shallow trash pit, 1.2 to 2.5 ft below surface.

1020 \pm 100
A.D. 930

SI-134.

Feat. 2, 0.4 to 1.4 ft below surface, shallow trash pit connected by short trench to Feat. 2A. Should be contemporaneous with Feat. 2A.

1180 \pm 120
A.D. 770

SI-133.

Feat. 7, trash pit, 1.7 ft below surface.

1000 \pm 110
A.D. 950

SI-143. Frank Wetmore site, Kansas

Charred bone from 14MD502 ($37^{\circ} 26'$ N Lat, $100^{\circ} 20'$ W Long), Meade County. From 8 to 24 in. depth in refuse pit at site totally devoid of potsherds, and containing much bone and a few projectile points and other stone work. Coll. 1964 and subm. by W. R. Wedel. *Comment* (W.R.W.): date is younger than expected.

940 \pm 90
A.D. 1010

Miller site series, Kansas

Charcoal from 14GE21 ($39^{\circ} 09' 26''$ N Lat, $96^{\circ} 54' 27''$ W Long), Geary County, Kansas. Coll. 1964 by J. E. Sperry, Univ. of Nebraska, Lincoln; subm. by Wedel. All samples associated with shell-tempered, shoulder-incised pottery. *Comment* (J.E.S.): SI-230 and SI-231 are in good agreement with dating of Budenbender site (see Michigan V, p.

41), 14PO4, which contained identical ceramics. SI-232, being only 0.2 ft below plow zone, is likely contaminated.

SI-230.	No. 992/4; F 116, x114	920 ± 90
	cache pit fill	A.D. 1030
SI-231.	No. 1006/5; F 289, x121	770 ± 80
	cache pit fill	A.D. 1180
SI-232.	No. 3119/6; F 313, x121 beam	410 ± 100
	fragments	A.D. 1540

Medicine Creek Reservoir sites series, Frontier County, Nebraska

SI-126.	Site 25FT18	1580 ± 100
		A.D. 370

Charcoal grab sample (No. XX) (40° 24' N Lat, 100° 14' W Long). Coll. 1964 by M. F. Kivett and G. S. Metcalf; subm. by Wedel. *Comment:* only a single culture component is recognized at this site, Keith Focus, Woodland pattern. Another sample from the same site, M-841, gave 1130 ± 200, A.D. 820 (Michigan V, p. 40). The present date is more in line with cultural associations.

SI-193.	Site 25FT36	800 ± 100
		A.D. 1150

Charcoal (sample no. 1375) (40° 08' N Lat, 100° 14' W Long). Feat. 3, 4 to 14 in. depth in midden. Coll. 1948 by Metcalf and Kivett; subm. by Wedel. *Comment:* Upper Republican aspect (Kivett, 1949).

SI-194.	Site 25FT16	930 ± 80
		A.D. 1020

Charred wood from Feat. 8 (40° 18' N Lat, 100° 13' 54" W Long). Coll. 1948 by Metcalf and Kivett; subm. by Wedel. *Comment:* Upper Republican aspect (Kivett, 1949). Another sample from this site dated A.D. 1235 ± 125 (I-583, Isotopes III, p. 73).

SI-195.	Site 25FT16	Modern
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Charcoal, Feat. 11, 15 to 50 in. depth. Coll. 1948 by Kivett and Metcalf. *Comment:* too recent, see SI-194, above.

SI-196.	Site 25FT39	670 ± 120
		A.D. 1280

Wood sample no. 1501 (40° 08' N Lat, 100° 14' W Long). House 2, posthole in NW corner, 20 in. depth. Coll. 1948 by Kivett and Metcalf; subm. by Wedel. *Comment:* Upper Republican aspect (Kivett, 1949). Other data from this site, A.D. 1200 ± 65 (SI-56, Smithsonian I, p. 184).

SI-197.	Site 25FT70	1260 ± 80
		A.D. 690

Charcoal sample no. 406 from Feat. 2 (house) (40° 08' N Lat, 100° 14' W Long). Coll. 1948 by Kivett and Metcalf; subm. by Wedel. *Com-*

ment: Upper Republican aspect (Kivett, 1949). Other dates from this site: SI-47, A.D. 1160 ± 65 ; SI-50, A.D. 880 ± 70 ; SI-53, 1105 ± 65 (Smithsonian I, p. 184). Possibly represents a component of the Keith Woodland Period which underlays a part of the site (M.F.K.).

720 \pm 80

SI-213. Fire Heart Creek site, North Dakota A.D. 1230

Charred wood from a Thomas Riggs focus house ($46^{\circ} 00'$ N Lat, $100^{\circ} 33'$ W Long). Coll. 1964 and subm. by D. Lehmer, Dana College, Blair, Nebraska. Dates the northern center of the Thomas Riggs distribution.

Huff site series, North Dakota

Samples from 32MO11 ($46^{\circ} 37' 05''$ N Lat, $100^{\circ} 38' 35''$ W Long), Morton County, ascribed to Huff focus by W. R. Wood, Univ. of Missouri, Columbia, Mo. 65202. Coll. 1960 by Wood and subm. by Wedel. *Comment* (W. R. Wood): two of these dates are rejected: SI-183 is much too late, for the site is prehistoric, and SI-182 is regarded as impossibly early. The remaining three dates are within an expectable range of variation. SI-179 is consistent with the range of A.D. 1485 to A.D. 1543 obtained by tree ring analysis of site timbers by G. F. Will (Will, 1946), and SI-178 is consistent with presence of La Roche focus trade pottery at Huff. SI-180 is regarded as probably too recent, but fact that it is late is consistent with superposition of House 8 over pre-existing pits filled with refuse from same occupation as that represented by the rest of the village. See Will and Hecker (1944).

310 \pm 190

SI-178. Charcoal, House 3, fireplace A.D. 1640

470 \pm 90

SI-179. Wood post, House 3, NE wall A.D. 1480

180 \pm 120

SI-180. Charcoal, House 8, floor A.D. 1770

SI-182. Charcoal, House 12, pit in floor 770 \pm 140
(Feat. 167) **A.D. 1180**

SI-183. Wood post, House 12, wall Modern

740 \pm 80

SI-212. Steinheimer site, Iowa A.D. 1210

Charcoal from site 13ML222 ($41^{\circ} 05' 07''$ N Lat, $95^{\circ} 47' 37''$ W Long) from a posthole of House 1, less than a foot below surface. Sample is associated with Beckman and McVey pottery wares with a few Woodland sherds. Coll. 1963 by L. A. Brown; subm. by R. W. Neuman. *Comment*: apparently this sample which is situated low in the valley is of no significant difference in age from those higher in the valley (e.g., Stonebrook, SI-210 and SI-211).

Stonebrook site series, Iowa

Charcoal from a plains site 13ML219 (41° 04' 28" N Lat, 95° 47' 25" W Long) in SW Iowa. Coll. 1963 by Brown and subm. by Neuman. Pottery from this site is of Nebraska aspect, Beckman and McVey types (Anderson, 1961).

SI-210.	No. 61, House 1, center post	670 ± 70
	2.2 ft below surface	A.D. 1280
SI-211.	No. 388, House 2, fill	1050 ± 90
	2.1 ft below surface	A.D. 900

*C. Central and South America***Marin series, Costa Rica**

Charcoal from Marin site (10° 10' N Lat, 83° 36' W Long), near Williamsburg. Coll. 1964 and subm. by M. W. Stirling, Natl. Geog. Soc. Detailed analysis of the cultural materials are in progress.

		900 ± 90
SI-144.	(W-4) Grave 7, 3.5 ft depth	A.D. 1050
		480 ± 90
SI-145.	(W-6) Grave 2, 3.0 ft depth	A.D. 1470
		1330 ± 120
SI-146.	(W-1) Grave 4, 3.0 ft depth	A.D. 620
		1360 ± 90
SI-147.	(W-2) Grave 11, 4.0 ft depth	A.D. 590

Puerto Hormiga series, Colombia

Charcoal (SI-151) and shell material (SI-152, SI-153) of genus *Pitar* from Puerto Hormiga shell mound (10° 08' N Lat, 75° 29' W Long), Dept. de Bolivar. Coll. 1963 by G. and A. Reichel-Dolmatoff; subm. by Evans. Associated pottery is crude and some of it fiber tempered. *Comment:* results agree well with unpub. shell date from this site (4875 ± 170 B.P., I-445).

		4820 ± 100
SI-151.	No. 1, Cut IV, 80 cm below surface	2870 B.C.
		4970 ± 70
SI-152.	No. 2, Cut IV, 75 cm below surface	3020 B.C.
		5040 ± 70
SI-153.	No. 3, Cut IV, 110 cm below surface	3090 B.C.
		220 ± 60
SI-171.	La Compañía site, Ecuador	A.D. 1730

Charcoal from inside burial urn from Mound B at site R-B-3 (1° 50' S Lat, 79° 33' W Long), Los Rio Province. Coll. 1961 by Evans, B. J.

Meggers, E. Estrada; subm. by Evans. Sample probably represents pre-contact period of Milagro culture, as it is not associated with trade goods.

160 ± 90

SI-149. Guadalupe mound, Venezuela

A.D. 1790

Charcoal from Mound 2, Cut 7, Level 4, 60 to 80 cm depth at Guadalupe mound complex (10° N Lat, 69° 40' W Long), Jimenez, State of Lara, associated with a primitive form of maize. Coll. 1963 by M. Sanoja; subm. by Evans. *Comment:* in view of previous dates from this complex (SI-120, A.D. 1570 ± 50; SI-121, A.D. 1570 ± 50, Smithsonian II, p. 252), both on shell, and this date, the charcoal apparently is dating a recent intrusion in the mound and not the maize.

Espinheiros I series, Brazil

Charcoal from sambaqui Espinheiros I (26° 18' 05" S Lat, 48° 50' 38" W Long), Municipio de Joinville, Santa Catarina. Coll. 1963 by W. F. Piazza, Faculdade de Filosofia, Ciências e Letras, Universidade de Santa Catarina, Florianópolis, Santa Caterina; subm. by Evans.

2220 ± 240

SI-224. No. 1, Level III, Sector 2, 93 cm depth

270 B.C.

2870 ± 100

SI-225. No. 2, Level V, Sector 2

920 B.C.

2920 ± 100

SI-226. No. 3, Level VI, Sector 2, 170 cm depth

970 B.C.

Ponta Das Almas series, Brazil

Marine shell (*Anomalocardia brasiliiana* Gmelin) and charcoal from sambaqui Ponta das Almas (27° 35' 32" S Lat, 48° 27' 33" W Long), Florianópolis, Santa Catarina. Coll. 1963 by Piazza; subm. by Evans.

2400 ± 250

SI-220. No. 1, shell, Trench F, Sector F'1

450 B.C.

**SI-221. No. 2, shell, Trench G, Sector G'1,
depth 60 cm**

2220 ± 250

270 B.C.

**SI-222. No. 4, shell, Sector B'2
Level 1, 15 to 30 cm depth**

4280 ± 400

2330 B.C.

**SI-223. No. 5, charcoal, Sector B'2,
Level II, 30 to 45 cm depth**

3690 ± 100

1740 B.C.

910 ± 200

SI-227. Casa de Pedra Cave, Brazil

A.D. 1040

Charcoal from 30 cm depth in test pit in central part of cave (28° 00' 40" S Lat, 49° 05' 22" W Long), Municipio de Urubici, Santa Catarina, which contained 70 cm of non-ceramic refuse and artifacts. Coll.

1963 by Piazza; subm. by Evans. Brazilian sites devoid of ceramics are not necessarily of great antiquity.

Rio Grande do Sul series, Brazil

Charred palm nuts (organic fraction run) from rock shelter OSO-1 (29° 37' 00" S Lat, 50° 17' 15" W Long), near Osório, Rio Grande do Sul. Samples are associated with non-ceramic cultural materials, including various types of stone projectile points. Coll. 1965 by E. T. Miller, Escola Técnica Industrial, Taquara, Rio Grande do Sul, Brazil; subm. by Evans.

SI-233.	No. 1, coordinates: 12-13, V-VI, 0.95 m depth	4280 ± 180 2330 B.C.
SI-234.	No. 2, coordinates: 12-13, V-VI 1.32 m depth	5950 ± 190 4000 B.C.
SI-235.	No. 3, coordinates: 12-13, V-VI-VII 1.75 m depth	5680 ± 240 3730 B.C.

D. Middle East

SI-156. Tepe Sabz, Iran

No. TS-14-300-310, carbonized wood, seeds, and goat dung from Tepe Sabz (32° 26' N Lat. 47° 16' E Long), SW Iran. From midden area, 300 to 310 cm depth in stratigraphic zone A₃, containing pottery of Bayat phase, roughly equivalent to Le Breton's "Susiana d," and related to late Ubaid. Coll. 1963 by J. A. Neely, Rice Univ. Expedition to Iran; subm. by K. V. Flannery. *Comment* (K.V.F.): would seem to check perfectly with other dates for same phase.

	5770 ± 120 3820 B.C.
SI-160. Tepe Ali Kosh, Iran	8920 ± 100 6970 B.C.
SI-160R. Replicate analysis of SI-160	8890 ± 200 6940 B.C.

Ash and carbonized seeds of *Prosopis* (No. AK-67-117) from midden area in stratigraphic zone A₂ at Tepe Ali Kosh, SW Iran (32° 20' N Lat, 47° 16' E Long). Midden dates to beginning of Mohammad Jaffar phase, containing oldest pottery known from SW Iran, and directly overlying preceramic village levels. Coll. 1963 by Frank Hole and Flannery; subm. by Flannery. *Comment* (K.V.F.): expected date would have been in the neighborhood of 6000 B.C.

Kunji Cave series, Iran

Charcoal from Mousterian levels in Kunji Cave, Khorramabad Valley, Luristan, W Iran (33° 30' N Lat, 48° 20' E Long). Samples were associated with flint chips and broken animal bones, including *Bos*, *Cervus* and *Equus*, dating to Middle Paleolithic. Coll. 1963 by Hole and

Flannery; subm. by Flannery. *Comment* (K.V.F.): this is expected dating for the Mousterian of the Zagros Mountains.

SI-247. No. K-7-135, Square 7, depth 135 cm, stratigraphic unit 12 **>40,000**

SI-248. No. K-7-145, Square 7, depth 145 cm, stratigraphic unit 12 **>40,000**

II. GEOLOGIC SAMPLES

Willcox Playa ostracode series, Arizona

Samples of ostracode fragments collected from lacustrine sediments at E edge of Willcox Playa (32° 10' N Lat, 109° 46' W Long), Cochise County, Arizona. Three samples collected from different auger holes by R. C. Robinson; subm. by J. F. Schreiber, Jr., Univ. of Arizona, Tucson.

SI-176. Sample WP-334-G **>30,000**
From 4139.5 to 4139.0 ft elev.

SI-177A. Sample WP-359-N **>30,000**
From 4132.7 to 4132.0 ft elev.

SI-177B. Sample WP-360-K **>30,000**
From 4132.7 to 4132.4 ft elev.

Willcox Playa carbonate series, Arizona

Carbonate samples from vicinity of Willcox Playa (32° 16' N Lat, 109° 54' W Long). Coll. 1965 and subm. by Long. List is supplementary to the one published in Arizona V. Stratigraphic units referred to, from youngest to oldest, are: UGC = upper green clay; IG = intermediate gravel; LGC = lower green clay; WWM = Willcox white marl. Willcox white marl is equivalent to part of the lower green clay.

SI-270. Caliche **6720 ± 80**
4770 B.C.

25 cm below surface and above UGC in gravel pit N of playa. Date is minimum age for host sediment (elev 4185 ft).

SI-271. Caliche **8140 ± 130**
6190 B.C.

30 cm below SI-270 and 70 cm above UGC (elev 4184 ft). Date is minimum age.

SI-272. Calcrete **12,470 ± 150**
10,520 B.C.

In bottom of ancient stream bed exposed in lime pit (elev 4165 ft).

SI-273. Top of WWM **12,860 ± 200**
10,910 B.C.

Exposed in drainage ditch (elev 4205 ft).

SI-274. WWM **22,670 ± 200**
20,720 B.C.

80 cm below SI-273 in WWM (elev 4203 ft).

SI-275. Caliche **5000 ± 100**
3050 B.C.

Above UGC at the Croton Springs locality, W of the playa (elev 4170 ft).

SI-276. Top of WWM **15,220 ± 250**
13,270 B.C.

In line pit E of the playa (elev 4170 ft).

Comment: results are discussed in detail by Long (1966). Results are reported here as ages based on 0.95 NBS oxalic acid although it is understood that care must be taken when comparing dates from fresh water carbonates and dates from wood or charcoal. Certain carbonates, e.g., caliche, were not formed in discrete events, and interpretation of the "date" depends entirely on stratigraphic context of sample.

San Augustin Plains series, New Mexico

Carbonate samples (tufa) at ground surface from San Augustin Plains (33° 45' N Lat, 108° 18' W Long). Coll. 1962 and subm. by Long. Tufa zones in this area are associated with terraces of Pleistocene Lake San Augustin (see Antevs, 1955; Powers, 1939); a core from center of basin has been analyzed by Clisby *et al.* (1956).

Comment: these dates are supplementary to those in Arizona V. Results are discussed in detail and interpreted by Long (1966). Ages are calculated based on 0.95 NBS oxalic acid, since actual A_0 is not known. Uncertainty associated with these ages is greater than with wood or charcoal samples, but lacustrine (i.e., not spring-deposited) tufa samples have been shown to be reasonably reliable in most cases (Broecker and Kaufman, 1965).

SI-277. Tufa, 6940 ft elev **10,360 ± 150**
8410 B.C.

SI-288. Tufa, 6980 ft elev **19,040 ± 300**
17,090 B.C.

SI-289. Tufa, 6965 ft elev **14,380 ± 300**
12,430 B.C.

Myrtle Beach series, South Carolina

Peat from Myrtle Beach (33° 40' N Lat, 78° 54' W Long). Coll. 1964 and subm. by Long. *Comment:* one or more of these samples are possibly equivalent to Frey's (1952) "Myrtle Beach Peat."

SI-249. Peat **Modern**
From zone just above high tide level.

SI-250. Peat**>35,000**

From zone just below low tide level.

Cornfield Harbor series, Maryland

Wood and clam shells in and above Pleistocene Pamlico formation at Cornfield Harbor (38° 02' N Lat, 76° 20' W Long). Coll. 1964 and subm. by Long from a low cliff formed by wave action. Upper six feet of the marine Pamlico formation is exposed, overlain by ca. four feet of brown silt and gravel, apparently alluvial.

SI-184. Recent shell**Modern**

From 4 ft above top of Pamlico, in shell layer.

SI-251. Pamlico shells**>38,000**

From near top of Pamlico.

SI-252. Pamlico wood**>41,000**

From near top of Pamlico.

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RHODESIAN RADIOCARBON MEASUREMENTS II

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The following is a list of dates which has been obtained since the compilation of List I in December 1963. Owing to an irreparable leak in our original counter, it became necessary to replace it with a new counter of similar design using the same shield as before. The new counter has been operated both at 500 mm Hg pressure, where it has a background of 1.7 counts/min and an NBS oxalic count of 11.4 counts/min, and at 1000 mm Hg pressure, where it has a background of 2.5 counts/min and an NBS oxalic count of 22 counts/min.

We have continued to use acetylene as our counting gas and the method we use for estimating our error is essentially the same as that outlined by Callow, Baker, and Hassall (1965), apart from the fact that we do not carry out any δC^{13} measurements.

Our pre-treatment for organic samples remains the same as previously described. In the case of shells we have followed the procedure of Dyck, Fyles, and Blake (1965) and given our samples between 30% and 40% pre-leach with hydrochloric acid.

We would like to record our thanks to Miss E. A. Heggarty who has carried out the work of preparing and counting the samples.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. East Africa

SR-16. Cherangani Hill, Kenya **1210 \pm 90**
A.D. 740

Peat sample found 175 to 185 cm below surface ($\pm 1^\circ$ N Lat, $35^\circ 28'$ E Long). Coll. and subm. by Prof. van Zinderen Bakker, Palynological Research, Univ. of the Orange Free State, Bloemfontein, South Africa (van Zinderen Bakker, 1962).

SR-64. Magosi Site 2, Uganda **6080 \pm 130**
4130 B.C.

Charcoal found 1 ft 10 in. deep in grey stony earth ($34^\circ 31'$ N Lat, $2^\circ 56'$ E Long). This date and several others still to be determined may provide date for Wilton culture in Uganda. Coll. and subm. by M. Posnansky, Assistant Director of British Inst. of History and Archaeol. in East Africa, P. O. Box 3913, Kampala, Uganda.

B. West Africa

- SR-52. Ntereso, Ghana** **3580 \pm 130**
1630 B.C.

Charred wood from third layer of Iron-age site at Ntereso ($9^{\circ} 07'$ N Lat, $1^{\circ} 13'$ W Long). Coll. and subm. by O. Davies, Dept. of Archaeol., Univ. of Ghana, Legon, Ghana.

- SR-61. Ntereso, Ghana** **3190 \pm 120**
1240 B.C.

Charcoal from top filling (Layer 1) of same site. Date probably marks introduction of iron in Ghana which may be taken as ca. 1000 B.C.

- SR-18. Fernando Poo** **1270 \pm 100**
A.D. 680

Charcoal ($3^{\circ} 25'$ N Lat, $8^{\circ} 45'$ E Long). Coll. and subm. by A. Martin, C.M.F., Inst. Claretiano de Africanistas, Apdo 10, Santa Isabel, Fernando Poo, West Africa. *Comment:* sample is thought to correspond to early Neolithic of Fernando Poo.

C. Southern Africa

- SR-22. Ingombe Ilede, Lusitu** **1120 \pm 200**
A.D. 830

Charcoal found at depth of 2 to 3 ft, to help date Zambian Iron Age ($16^{\circ} 10'$ S Lat, $28^{\circ} 47'$ E Long). Gold burials from site were dated ca. A.D. 850. Coll. and subm. by Dr. B. Fagan, Keeper of Prehistory, Rhodes-Livingstone Mus., P. O. Box 124, Livingstone, Zambia.

- SR-23. Ingombe Ilede, Lusitu** **1160 \pm 100**
A.D. 800

Charcoal from the 3 ft level. *Comment:* cross-checked with Q-720 dated at A.D. 985 ± 100 (Cambridge VI).

- SR-21. Ingombe Ilede, Lusitu** **1580 \pm 100**
A.D. 730

Charcoal from the 3 ft to 10 in. level.

- SR-31. Isamu Ipati mound, Kalomo** **910 \pm 90**
A.D. 1050

Charcoal from 18 in. depth. This Kalomo culture dates Zambian Iron age. Coll. and subm. by Dr. B. Fagan.

- SR-30. Isamu Ipati mound, Kalomo** **930 \pm 100**
A.D. 1020

Charcoal from 42 in. depth.

- SR-19. Isamu Ipati mound, Kalomo** **1300 \pm 90**
A.D. 650

Charcoal from bedrock.

- SR-20. Isamu Ipati mound, Kalomo** **1852 ± 100**
A.D. 100
Charcoal from 3 ft level.
- SR-74. Karundu mound, Kalomo** **870 ± 90**
A.D. 1080
Charcoal from Karundu mound, which is 2.9 mi SE of Kalomo. Karundu mound dates further confirm Zambian Iron age culture (17° 03' S Lat, 26° 30' E Long). Coll. and subm. by Dr. B. Fagan.
- SR-66. Karundu mound, Kalomo** **1050 ± 100**
A.D. 900
Charcoal.
- SR-41. Karundu mound, Kalomo** **1160 ± 90**
A.D. 790
Charcoal.
- SR-65. Karundu mound, Kalomo** **1650 ± 90**
A.D. 300
Charcoal.
- SR-57. Behrens site, Kalomo** **110 ± 90**
A.D. 1840
Charcoal from old Tonga settlement. It is hoped to use date to place arrival of Tonga people in Southern Province of Northern Rhodesia. Coll. and subm. by Dr. B. Fagan.
- SR-42. Kangila mound, Mazabuka** **510 ± 100**
A.D. 1440
Bone (15° 55' S Lat, 27° 50' E Long). Date was obtained on inorganic content of bone, and may therefore be somewhat younger than true age. Date is first type-site of Kangila ware of northern part of Southern Province plateau. Coll. and subm. by Dr. B. Fagan.
- SR-45. Kamusongolo Kopje Cave, Kasempa** **13,300 ± 250**
11,350 B.C.
North Western Province, Zambia
Charcoal (13° 27' S. Lat, 25° 51' E Long). The absolute dating and time span of the Later Stone age occupation of N of the Kafue and W of eastern Lungar has hitherto been untouched. Coll. and subm. by S. Daniels, Natl. Monuments Comm., P. O. Box 124, Livingstone, Zambia.
- SR-62. Dambwa, Livingstone** **1330 ± 110**
A.D. 620
Charcoal (17° 49' S Lat, 25° 51' E Long), found on a living site with evidence of iron smelting; dates Early Iron age occupation in Southern Province of Zambia. Coll. and subm. by S. Daniels.
- SR-47. Zimbabwe** **570 ± 90**
A.D. 1380
Charcoal from hut floor in middle of Great Enclosure (21° 3' S Lat, 31° 31' E Long). Coll. by Dr. E. Swart; subm. by R. Summers, Director,

Natl. Mus., P. O. Box 240, Bulawayo, Rhodesia. *Comment:* date confirms M-915 (Michigan VI).

SR-58. Aboyne Mine, Fort Rixon **650 ± 110**
A.D. 1300

Charcoal from a "firesetting" in a pre-European gold mine (20° 5' S Lat, 29° 21' E Long). Mine collapsed killing at least four miners whose bones were mixed with charcoal. Coll. and subm. by R. Summers.

SR-53. Aboyne Mine, Fort Rixon **780 ± 110**
A.D. 1170

Charcoal from same site as SR-58 and should be exactly contemporary with SR-58. Coll. and subm. by R. Summers.

SR-43. Mabveni **1770 ± 120**
A.D. 180

Charcoal from Gomanye Hill in Chibi Tribal Trust Area (20° 22' S Lat, 30° 28' E Long), found in ashy midden in association with Gokomere pottery. Coll. by K. Robinson; subm. by R. Summers.

SR-44. Woolandale Farm, Bulawayo **640 ± 90**
A.D. 1310

Charcoal from midden heap belonging to Leopard's Kopje industry, Phase 3. Coll. by K. Robinson; subm. by R. Summers.

SR-68. Taba-ka-Mambo **1080 ± 100**
A.D. 870

Charcoal from 36 to 42 in. level. Coll. and subm. by K. Robinson, Hist. Monuments Comm., Natl. Mus., P. O. Box 240, Bulawayo, Rhodesia.

SR-55. Leopard's Kopje, Khami Waterworks, Rhodesia **1250 ± 110**
A.D. 700

Charcoal from a domestic fire belonging to Leopard's Kopje industry, Phase 2. Coll. by K. Robinson; subm. by C. Cooke, Hist. Monuments Comm., P. O. Box 3248, Bulawayo, Rhodesia.

SR-69. Tshangula cave, Matopo Hills **112 ± 90**
A.D. 830

Charcoal from Layer 1 which also contained Wilton artifacts, Bambata ware, and Leopard's Kopje ware (21° 38' S Lat, 28° 36' E Long). Coll. and subm. by C. Cooke.

SR-75. Tshangula cave, Matopo Hills **2150 ± 100**
200 B.C.

Charcoal from bottom half of Wilton level. Coll. and subm. by C. Cooke. *Comment:* although samples 69 and 75 appeared to come from undisturbed strata, anomaly of the dates compelled further attention to the stratigraphical record. It is possible that these strata could have been disturbed by rain wash from the back of the cave and consequently the

two dates must be accepted with great reserve. Further sampling is in progress.

SR-73. Masuma River, Wankie National Park **1140 ± 90**
A.D. 90

Charcoal from a sealed position in eroded midden containing pottery similar to Gokomere type (18° 36' S Lat, 26° 20' E Long). Coll. by K. Robinson; subm. by C. Cooke.

SR-70. Harleigh Farm, Rusape **610 ± 90**
A.D. 1340

Charcoal from a Zimbabwe culture settlement (18° 32' S Lat, 32° 05' E Long). Coll. and subm. by P. Robins, Univ. Coll. of Rhodesia, P. Bag 167H, Salisbury, Rhodesia. *Comment:* see SR I for more dates from this site.

SR-71. Harleigh Farm, Rusape **440 ± 90**
A.D. 1510

Charcoal. Coll. and subm. by P. Robins.

SR-63. Striped Giraffe shelter, South West Africa **4590 ± 100**
2640 B.C.

Striped Giraffe shelter is in Karibib District of South West Africa. Charcoal found in an ash hearth 12 to 15 in. below surface. Date gives a basal date for local South West African variant of Later Stone age (Erongo culture), which shows acculturation with Wilton. Coll. and subm. by H. MacCalman, Archacol., State Mus., P. O. Box 1203, Windhoek, South West Africa.

SR-46. Numas Entrance Shelter, South West Africa **870 ± 100**
A.D. 1080

Numas Entrance shelter is in Numas Ravine of the Brandenburg mountains (14° 28' E Lat, 21° 10' S Long). Charcoal sample, associated with Wilton Later Stone age material in ash layer 2 to 6 in. below the surface, from an undisturbed deposit (Rudner, 1957). Coll. and subm. by H. MacCalman.

SR-51. Thakadu Copper Prospect **410 ± 100**
A.D. 1540

Charcoal from Thakadu Copper Prospect, 60 mi W of Francistown (21° 6' S Lat, 27° 32' E Long), Bechuanaland Protectorate. Sample came from a stope 18 ft below surface in an ancient copper working and gives indication of time when copper was first worked in this area. Coll. by G. Woodward, Rhodesian Selection Trust; subm. by Prof. G. Bond, Geology Dept., Univ. of Rhodesia, P. Bag, 167H, Salisbury, Rhodesia.

II. GEOLOGIC SAMPLES

SR-67. Shell mound of Revez Duarte **28,540 ± 490**
26,590 B.C.

Oyster shell found on bank of Umbeluzi River, Portuguese East Africa (26° 2' 3" S Lat, 32° 24' 15" E Long), some 6½ m above present

sealevel. Sample taken from 4th layer (numbering from bottom) of a profile containing 9 distinct layers. Mound is partially of human origin and sample layer itself contains paleoliths from Middle Stone age. Date marks occurrence of the Gamblian-Makalian inter-pluvial in Mozambique (Barrados, 1955). Coll. and subm. by L. Barradas, Inst. de Investigacao Cientifica de Mozambique, Caixa Postal 1780, Lourenco Marques, Mozambique.

33,720 \pm 700

SR-72. Kassimatis Quarry

31,770 B.C.

Oyster shell found on bank of Matola River, Portuguese East Africa ($25^{\circ} 58' 22''$ S Lat, $32^{\circ} 26' 10''$ E Long), some $2\frac{1}{2}$ m above present sealevel on a raised beach. Sample taken from 3rd layer of a profile containing 8 distinct layers. Date marks occurrence of the Gamblian-Makalian inter-pluvial transgression. Coll. and subm. by L. Barradas.

4730 \pm 200

SR-29. Forno da cal, Maputo River

2780 B.C.

Shell sample (*Balanus* sp.) from bank of Maputo River, Portuguese East Africa ($26^{\circ} 25' 25''$ E Lat, $32^{\circ} 39' 45''$ S Long), some $4\frac{1}{2}$ m above present sealevel. Sample taken from 3rd layer of a profile containing 6 layers. Date marks later stages of Gamblian-Makalian transgression in Mozambique. Coll. and subm. by L. Barradas.

4090 \pm 150

SR-27. Chidenguela

2140 B.C.

Fossil mollusca occurring in a sandstone wall running parallel to the littoral at the beginning of the Makalian regression (Borges, 1939). Coll. and subm. by L. Barradas.

1710 \pm 100

SR-40. Situmpa Forest Station, Machili, Zambia A.D. 240

Charcoal sample ($16^{\circ} 50'$ S Lat, $25^{\circ} 07'$ E Long), from a forest pit in the Kalahari sand; depth 42 in. Coll. and subm. by B. Fagan. *Comment:* sample has been dated in order to check C-662 (4078 ± 300 ; Libby, 1952), which was much older than expected.

Corrections to Southern Rhodesia I, Radiocarbon, vol. 6, p. 31-36.

SR-11. Pomongwe cave, Matopo Hill. '1st Intermediate Stone age' should read '2nd Intermediate Stone age.'

SR-24. Situmpa Forest Station. 'Depth 42 in.' should read 'depth 48 in.'

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TARTU RADIOCARBON DATES I

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Preparations for the development of a laboratory for the determination of absolute age by the radiocarbon method were started at the Geobiochemical Laboratory of the Institute of Zoology and Botany of the Academy of Sciences of the Estonian SSR in 1957. Dating of various carbon-containing specimens has been carried out since 1959.

The measurement of natural C^{14} activity is performed by a liquid scintillation method. Methanol and benzene have been used as the carriers of natural C^{14} activity, the former for samples from TA-I to TA-55, the latter for specimens beginning with TA-56.

Methanol has been synthesized by the method of Pringle (Pringle *et al.*, 1955) by the reduction of CO_2 with lithium aluminium hydride yielding lithium aluminium methylate from which methanol is isolated after alcoholysis. The average yield of the synthesis has been 50% as calculated on the basis of CO_2 (Liiva and Ilves, 1962).

The synthesis of benzene (Starik *et al.*, 1963) is carried out through lithium carbide or calcium carbide with their subsequent break-down with water and with the trimerization of acetylene obtained by means of the Ziegler catalyst ($iso-C_4H_{10}$)₃Al-TiCl₄—into benzene. The yield of benzene from acetylene has amounted to 55% (Punning *et al.*, 1966).

Counting of natural C^{14} is performed with the help of a one-channel scintillation device (Liiva and Ilves, 1963a). In the device the following specially selected photomultiplier tubes (FEU) have been used: FEU-13, FEU-42; FEU-43, EMI 9067 (Liiva *et al.*, 1966).

The cells for the liquid scintillator have been constructed by us and were made from aluminium with a potassium-free glass window (Liiva and Ilves, 1963b).

A layer of lead with a thickness of 12 cm and one of mercury, 2.5 cm thick, have been used for protection from cosmic radiation and from external radioactivity.

Automatic registration of counts is carried out by means of a numerical impulse-recorder device (Punning *et al.*, 1966).

Wood dating from A.D. 1850 ± 10 yr has been used as a reference standard of modern carbon. Old-carbon preparation has been synthesized from anthracite.

For methanol (70 ml of a scintillator solution containing 15% of CH_3OH by volume) the rate of the background has been 6.02 ± 0.06 counts/min, the pure count of modern carbon being 9.02 ± 0.12 counts/min. The maximum determinable age is equal to 28,200 yr (48 hours counting 4σ criterion). When benzene (25 ml of a scintillator solution containing 40% of C_6H_6 by volume) has been used, the corresponding

values have been 5.26 ± 0.085 counts/min, 54.73 ± 0.17 counts/min and 43,600 yr.

All radiocarbon data have been calculated proceeding from the period of the half-life of C^{14} equal to 5568 ± 30 yr. All dates are calculated from the year 1950.

Kääpa series

ARCHAEOLOGIC SAMPLES

Neolithic settlement Kääpa is located in Võru District of Estonian SSR on Võhandu River 8 km NE of town Võru. Cultural layer up to 50 cm thick lies in lower part of peat deposit at depth up to 210 cm from bottom surface and penetrates in places into sandy loam layer underlying peat (Liiva, 1963). Oldest part of cultural layer contains ceramic materials of Narva type archaeologically dated first half or middle of third millennium B.C. (Liiva *et al.*, 1955). In uppermost horizon of cultural layer were found pitted-comb ceramics. Pollen analyses (by A. Sarv) indicate the settlement existed at end of Atlantic period, i.e., Pollen Zone IV (V. Post-Nilsson system).

TA-4. Kääpa

4350 \pm 220
2400 B.C.

Charred wood from cultural layer of settlement Kääpa. Sample coll. 1959 by A. Liiva and subm. by L. Jaanits, Inst. of Hist., Acad. Sci. of Estonian SSR (later referred to as Inst. of Hist.).

TA-5. Kääpa

4865 \pm 235
2915 B.C.

Peat from lower part of cultural layer of settlement Kääpa. Coll. 1959 by A. Liiva; subm. by L. Jaanits.

TA-6. Kääpa

4480 \pm 255
2530 B.C.

Elk bone from cultural layer of settlement Kääpa. Coll. 1959 by L. Jaanits; subm. by K. Paaver, Inst. of Zool. & Bot., Acad. Sci. of Estonian SSR.

Narva series

Multi-layered settlement of Stone age on territory of town Narva. Probable age: Mesolithic layer I, 4th millennium B.C.; Mesolithic layers II and III, about the age of settlement Kunda (eighth to sixth millennium B.C.) (Liiva, *et al.*, 1965; Jaanits, 1959).

TA-7. Narva

5300 \pm 250
3550 B.C.

Charcoal from Mesolithic layer I of settlement Narva. Coll. 1960 by A. Liiva; subm. by L. Jaanits.

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- TA-33. Narva** **5820 ± 200**
3870 B.C.
Charcoal from a hearth of settlement Narva. Samples located at depth of 90 to 110 cm. Coll. 1960 and subm. by L. Jaanits.
- TA-17. Narva** **6020 ± 120**
4070 B.C.
Bones from Mesolithic layer II of settlement Narva. Coll. 1960 and subm. by L. Jaanits.
- TA-40. Narva** **6740 ± 250**
4790 B.C.
Charcoal from under a hearth of Mesolithic layer II. Coll. 1963 by A. Liiva and E. Ilves; subm. by L. Jaanits.
- TA-52. Narva** **7315 ± 190**
5365 B.C.
Charcoal from lower part of Mesolithic layer II at depth of 212 to 217 cm. Coll. 1964 by E. Ilves; subm. by L. Jaanits.
- TA-41. Narva** **7090 ± 230**
5140 B.C.
Charcoal from Mesolithic layer III at depth of 300 to 310 cm. Coll. 1963 by A. Liiva and E. Ilves; subm. by L. Jaanits.
- TA-25. Narva** **7580 ± 300**
5630 B.C.
Charcoal from Mesolithic layer III at depth of 223 to 212 cm. Coll. 1962 by E. Ilves; subm. by L. Jaanits.
- TA-53. Narva** **7640 ± 180**
5690 B.C.
Charcoal from Mesolithic layer III at depth of 313 to 318 cm. Coll. 1964 and subm. by L. Jaanits.

Kunda series

Samples from settlement Kunda-Lammasmägi, Rakvere District, Estonian SSR, 4 km S of town Kunda. Cultural layer lies on ground moraine at depth up to 62 cm and is covered with thin sterile interbed of clay (Liiva *et al.*, 1965). Pollen analyses showed that Mesolithic settlement existed in second half of Boreal climatic period. Coll. 1961 by A. Liiva; subm. by L. Jaanits.

- TA-14. Kunda** **8340 ± 280**
6390 B.C.
Charcoal from lower horizon of Mesolithic layer.
- TA-16. Kunda** **6015 ± 210**
4065 B.C.
Elk bones from upper horizon of cultural layer. The given layer was not in its original position because in it were discovered finds of

Mesolithic as well as non-Neolithic origin, including pitted-comb ceramics. Coll. 1961 and subm. by K. Paaver, Inst. of Zool. and Bot. *Comment:* sample may be attributed to late stage of Mesolithic settlement, or the bone may have been soiled by modern carbon.

TA-12. Kunda**9780 ± 260****7830 B.C.**

Mammoth tusk from settlement. Coll. 1936 by R. Indreko; subm. by K. Paaver. *Comment:* dating of sample and of lower cultural layer (TA-14) confirmed that the bone does not belong to the period of the existence of camp site but to an earlier date.

TA-8. Kreichi**4020 ± 300****2070 B.C.**

Wood from Neolithic settlement Kreichi, Ludze District, Latvian SSR. Pitted-comb ceramics and, in a small quantity, textile ceramics were discovered on territory of camp site (Zagorskij, 1960). Probable age of sample, beginning of 2nd millennium B.C. Coll. 1959 by F. Zagorskij; subm. by K. Paaver.

TA-10. Tamula, pile**3600 ± 180****1610 B.C.**

Wood (constr. pile) from Late Neolithic settlement Tamula, near town Võru, Estonian SSR. Cultural layer, 30 to 40 cm thick, is located in peat deposit at depth of 20 to 60 cm from ground surface. The pile was located in grass peat of underlying cultural layer so that its upper end reached the lower horizon of cultural layer, its tapering end penetrating into lake marl. Pitted-comb ceramic materials were found in cultural layer and cord ceramics in upper layers (Jaanits, 1954). Pollen analysis data (by A. Sarv) attribute the settlement to the Sub-Boreal period, Pollen Zone III (V. Post-Nilsson system). Probable age, first half of second millennium B.C. (Jaanits, 1959). Coll. 1956 and subm. by L. Jaanits.

TA-28. Tamula, elk**4050 ± 180****2100 B.C.**

Elk bones from cultural layer of Late Neolithic settlement Tamula. (See TA-10.) The sample evidently dates back to early period of the existence of settlement. Coll. 1961 and subm. by K. Paaver.

TA-11. Loona**Modern**

Bovine bone found on territory of Late Neolithic settlement at Loona, Kingissepa District, Estonian SSR, 3 km SW of contemporary settlement Kihelkonna. Cultural layer, 30 to 40 cm thick, lies immediately under turf cover. Archaeologic date of the existence of camp site is first half of second millennium B.C. Coll. by L. Jaanits; subm. by K. Paaver. *Comment:* analysis proved that the dated find got into Neolithic layer from later horizons.

3570 ± 240**1620 B.C.****TA-20. Villa**

Elk bones from lower part of cultural layer of Late Neolithic settlement Villa, Võru District, Estonian SSR, 3 km NE of town Võru. Cultural layer with thickness of 50 to 70 cm lies on clay in peat deposit (Jaani, 1959). Heterogeneous materials (pitted comb as well as cord ceramics along with ceramics of early Metal Age) were found in settlement. Coll. 1951 and subm. by K. Paaver. *Comment:* dating showed that samples goes back to period of existence of settlement.

1190 ± 230**A.D. 760****TA-21. Rõuge**

Charred coal from burnt-out layer I and II of E wall of settlement Rõuge, Võru District, Estonian SSR, 17 km SW of town Võru. Sample lay at depth of 68 to 70 cm from ground surface. Probable age, 6th to 11th century A.D. (Schmiedehelm, 1959). Coll. 1959 and subm. by M. Schmiedehelm, Inst. of Hist.

3970 ± 250**2020 B.C.****TA-23. Leimanishki, wood**

Charred wood from Late Neolithic settlement Leimanishki, Rezekne District, Latvian SSR. The finds were discovered in unconsolidated layer of peat and sand beneath black peat deposit. At depth of 180 to 200 cm there lies a layer of bluish clay. Sample was taken from depth of 100 to 105 cm where cord ceramic materials were discovered in thin layer, partly mixed with textile ceramics. Presumable archaeological age, first half or middle of 2nd millennium B.C. (Vankina, 1962). Coll. 1961 by L. Vankina; subm. by A. Dukkur, Mus. of Hist. of Latvian SSR.

3770 ± 200**1820 B.C.****TA-27. Leimanishki, bones**

Bones from Late Neolithic settlement Leimanishki (see TA-23).

4490 ± 250**2540 B.C.****TA-24. Sarnate, charcoal**

Charcoal from a hearth of Neolithic settlement Sarnate, Ventspils District, Latvian SSR (0.75 km E of settlement Sarnate).

In the cultural layer were found pitted-comb as well as textile ceramics along with ceramics characteristic of settlement Sarnate, having several characteristics common with ceramics of Narva type. Presumable age of settlement, 2nd half of third millennium to middle of 2nd millennium B.C. (Vankina, 1960). On the basis of pollen analyses (by A. Sarv) the settlement may be attributed to Sub-Boreal period. Coll. 1958 by L. Vankina; subm. by A. Dukkur.

4700 ± 250**2750 B.C.****TA-26. Sarnate, bones**

Bones from Neolithic settlement Sarnate (see TA-24).

TA-35. Sulgu**2060 ± 160
110 B.C.**

Charcoal from settlement Sulgu V "a", Pryazhensk District, Karelian ASSR, located on left bank of Sulgu River at 1.5 km from settlement Kudoma. Sample was taken from a hearth and lay at 30 to 80 cm from ground surface. Presumable archaeological age, end of third, beginning of second millennium B.C. (stone implements of Neolithic types, ceramics of "Sperrings" type and of pitted-comb Volga-Oka type). Coll. 1960 and subm. by G. A. Pankrushev, Inst. of Linguistics, Literature and History, the Karelian branch of Acad. Sci. of SSSR. *Comment:* dating of the same settlement (carried out at the Lab. of the Inst. of Archeol., Acad. Sci. SSSR) dated its age at 1960 ± 150 yr. *Note added in proof:* Recent studies (private commun., G. A. Pankrushev) have revealed that settlement Sulgu also contains ceramic materials attributed to early Iron Age; the latter corresponds with the radiocarbon measurements.

TA-38. Siimusaare**2370 ± 210
420 B.C.**

Charcoal from hearth in lower part of cultural layer of settlement Siimusaare, Viljandi District, Estonian SSR, 1 km N of settlement Melleski. Upper part of cultural layer starts immediately beneath ploughed-up turf (at 25 cm) and is attributed to early period of Iron Age (striated and textile ceramic materials). Lower part of cultural layer (not containing any ceramic materials) is attributed to the Mesolithic. Sample was picked at depth of 50 to 95 cm from ground surface and is dated at early period of the existence of settlement. Coll. and subm. 1965 by H. Moora, Viljandi Interdistrict Mus. of Regional Studies.

TA-47. Mt. Amiranis**3215 ± 170
1265 B.C.**

Fragments of human skeleton from burial place of settlement Mt. Amiranis (Akhalsikh District, Georgian SSR, 2.5 km NE of town Akhalsikh on left bank of Potskhovi River.) Probable date, 3rd millennium B.C. (Tchubinishvili, 1963). Coll. 1963 by Meskhety-Dzhavakhetv archaeological expedition; subm. by Inst. of Hist. of Georgian SSR.

TA-72. Lommi**Modern**

Charcoal from Neolithic settlement Lommi in NW part of Leningrad Region on Noiki River (small left tributary of Luga River) 3 to 4 km W of village Pulkovo. Cultural layer, up to 1 m thick, starts almost at ground surface and is covered only by thin alluvial sand layer. In places cultural layer proved to be ploughed up (Gurina, 1961; Jaanits, 1959). Sample coll. from a hearth, 47 to 72 cm from ground surface. Probable archaeological date of camp site, end of 3rd millennium or first half of 2nd millennium B.C. (characterized by typical pitted-comb ceramics). Coll. 1940 by R. Indreko; subm. by L. Jaanits.

- 630 \pm 100**
- TA-73. Padise** **A.D. 1320**
- Charred wood from part of E wall of settlement Padise in Harju District, Estonian SSR. Depth of sample, 225 cm. Presumable archaeological age 700 or 1500 yr. Coll. 1964 and subm. by O. Saadre, Inst. of History.

GEOLOGIC SAMPLES

- 3310 \pm 230**
1360 B.C.
- TA-3. Sõjamäe**
- Wood from boundary (recurrence) horizon of peat bog Sõjamäe, Harju District, Estonian SSR, 3 to 5 km E of Tallinn. Relative age, transition from Sub-Boreal to Sub-Atlantic period. Subm. by Prof. K. Orviku, Inst. of Geol., Acad. Sci. of Estonian SSR (later referred to as Inst. of Geol.).
- 2530 \pm 130**
580 B.C.
- TA-19. Kaali**
- Charcoal picked at depth of 120 to 130 cm from the fill of meteoritic crater No. 2 at Kaali, Is. Saaremaa, Kingissepa District, Estonian SSR. Putative geological age of the fall of meteorite, 3000 to 4000 yr ago. Coll. 1961 by A. Aloe; subm. by K. Orviku, Inst. of Geol.
- 2660 \pm 200**
710 B.C.
- TA-22. Kaali**
- Charcoal from meteoritic crater No. 2 at Kaali (see TA-19), collected at depth of 50 to 150 cm. Coll. 1962 by A. Aloe and E. Ilves; subm. by K. Orviku.
- 3280 \pm 180**
1330 B.C.
- TA-29. Pihlasoo**
- Sedge and reed peat from bog Pihlasso, Is. Hiiumaa, Estonian SSR. Sample taken at depth of 505 to 515 cm. Structure of section down to 300 cm, upper peat; 300 to 350 cm, transitional peat; 350 to 400 cm, lower peat with admixture of wood; 400 to 515 cm, lower arboreal peat, sand (marine bed). Pollen analyses attribute sample to upper part of Pollen Zone III (V. Post-Nilsson system). Coll. 1962 and pollen-analyzed by H. Kessel (Rebassoo, 1964); subm. by L. Laasimer, Inst. of Zool. and Bot.

Ulila series

Peat-bog Ulila is located in Võrtsjärve depression where in Early Holocene and extensive reservoir named Suur-Võrtsjärv was formed. Thickness of peat is 280 cm; beneath peat lies lacustrine marl (depth 280 to 480 cm). Valves of shells are met with in paleolacustrine sediments. Pollen analyses attribute shell sample to early part of Pollen Zone III (V. Post-Nilsson system). Pollen diagram was prepared by E. Liivrand and R. Pirrus. Coll. 1962 by M. Punning; subm. by K. Kajak,

State Production Geol. Comm., Estonian SSR (later referred to as Geol. Comm.).

TA-30. Ulila

6270 ± 240

4320 B.C.

Arboreal and reed peat collected at depth of 260 to 280 cm. Sample overlay lacustrine marl and is attributed to Pollen Zone VI.

TA-31. Ulila

7800 ± 260

5850 B.C.

Lacustrine marl taken at depth of 280 to 300 cm. Sample lay immediately beneath peat. It is referred to Pollen Zone VII.

TA-32. Ulila

9760 ± 320

7810 B.C.

Lacustrine marl picked at depth of 460 to 480 cm. Sample is attributed to the beginning of accumulation of lacustrine marl. Probable age 7700 to 9800 yr.

TA-36. Kaagvere, 400 cm

>30,000

Sandy loam with plant remains collected at depth of 400 cm near town Otepää in Valga District, Estonian SSR. Interstadial deposit of Valdai stage, 330 to 420 cm thick. Coll. 1963 and subm. by K. Kajak.

TA-50. Kaagvere, 346-362 cm

15,150 ± 575

13,200 B.C.

Sandy loam with plant remains collected at depth of 346 to 362 cm, overlying TA-36. From intermoraine deposits lying at depth of 320 to 370 cm. Pollen analyses showed spectra of pine and birch pollen. Pollen of herbaceous plants and spores shows cold-loving character. Coll. 1963 and subm. by K. Kajak.

TA-43. Kuliska, peat

8525 ± 250

6575 B.C.

Peat from bog Kuliska, located in depression of Lake Pskov in Pskov Region. Peat layer, 570 cm thick, consists of arboreal, sedge and reed peat. Depth of sample 550 to 570 cm. Sample is attributed to Pollen Zone VIII (V. Post-Nilsson system). Pollen diagram was produced by M. Grigorovitch. Coll. 1963 and subm. by V. Paulman, Geol. Comm.

TA-43A. Kuliska, humic substance

8530 ± 300

6580 B.C.

Same as TA-43, repeated with aim of studying contamination of sample. Dating was carried out by means of extracted humic substances.

TA-47. Kuliska, marl

10,400 ± 350

8450 B.C.

Silty lacustrine marl from bog Kuliska. (See TA-43.) Thickness of layer 20 cm. Depth of sample 550 to 570 cm. Sample is attributed to Pollen Zone IX (V. Post-Nilsson system). Coll. 1963 and subm. by V. Paulman.

TA-45. Rõngu, 600-670 cm **>30,000**

Peaty sapropelite with plant remains, near settlement Rõngu in Tartu District, Estonian SSR. Peat is overlain by brown sandy loam, mixed with gravel and pebbles (at 30 to 110 cm), sand (at 110 to 230 cm) and silty loam with plant remains (at 230 to 250 cm). Depth of sample 600 to 670 cm. Coll. 1964 and subm. by K. Kajak.

TA-46. Rõngu, 670-720 cm **>30,000**

Sapropelite, dark-grey, with plant remains, near settlement Rõngu. (See TA-45.) Sapropelite layer, 110 cm thick, is underlain by calcareous sapropelite with admixture of sand and plant remains (at 730 to 765 cm), and lower by sand. Depth of sample 670 to 720 cm. Coll. 1964 and subm. by K. Kajak.

TA-49. Yakutia

3005 ± 175
1055 B.C.

Wood from the valley of Mandychen River in Yakutian ASSR. Depth of sample 87 to 97 cm, in peat layer interbedded between layers of varved clay above perpetually frozen ground. Aim of dating was to establish the time of the melting of the glacier which gave rise to the valley of Mandychen River and to determine the time of the formation of lakes. Coll. 1963 and subm. by A. Tamme and M. Rubel, Inst. of Geol.

TA-54. Rannametsa

7860 ± 190
5910 B.C.

Wood buried in peat from Pärnu District, Estonian SSR. Depth of sample 497 to 503 cm. Peat is underlain by deposit of lake Ancylyus and overlain by pelitic lagoon sediments with remains of skeletons. Coll. 1959 and pollen-analyzed by H. Kessel (1963); subm. by K. Orviku, Inst. of Geol.

TA-55. Sindi

6710 ± 170
4760 B.C.

Wood, buried in peat, collected in Pärnu District, Estonian SSR. Sample lay at 195 to 202 cm, sedge and reed peat at 170 to 248 cm. Peat is underlain by fine-grained sediments of Lake Ancylyus, overlain by coastal sediments. Coll. 1959 and pollen-analyzed by H. Kessel (1963); subm. by K. Orviku.

TA-57. Kurenurme

12,650 ± 500
10,700 B.C.

Submorainic arboreal remains (willow) from Kurenurme in Võru District, Estonian SSR. From intermorainic sediments (Bölling interval). Depth of sample 580 cm. Coll. 1963 and subm. by K. Kajak.

TA-59. Kahala

8595 ± 75
6645 B.C.

Buried peat of Ancylyus age, from Harju District, Estonian SSR. Depth of sample 115 to 145 cm. Probable age 9000 to 8000 yr. Pollen

diagram was produced by H. Kessel. Sample belongs to Pollen Zone IX (V. Post-Nilsson system). Coll. 1965 and sum. by K. Elterman, Geol. Comm.

TA-60. Kivijärve **7590 ± 75**
5640 B.C.

Well-disintegrated peat from bog Kivijärve in Harju District, Estonian SSR. Depth of sample 640 to 670 cm. Coll. 1965 and subm. by K. Elterman.

TA-61. Hara **7080 ± 75**
5130 B.C.

Lacustrine sapropelite and peat from bog Hara in Harju District, Estonian SSR. Depth of sample 500 to 530 cm. Pollen diagram was produced by H. Kessel. Sample belongs to Pollen Zone V-VI (V. Post-Nilsson system). Coll. and subm. by K. Elterman.

TA-62. Aravete **7880 ± 70**
5930 B.C.

Peat from bog Aravete in Paide District, Estonian SSR. Depth of sample 350 to 400 cm. Pollen diagram was produced by E. Valt. Sample is attributed to Pollen Zone VIII (V. Post-Nilsson system). Coll. 1965 and subm. by K. Elterman.

TA-63. Peedu **20,673 ± 100**
18,723 B.C.

Submorainic peat from settlement Peedu in Tartu District, Estonian SSR. Sample was taken at depth of 668 to 677 cm. Coll. and subm. by K. Kajak.

Kuiksilla series

Peat bog Kuiksilla is located in S Estonia, Valga District, Estonian SSR. Low-lying deposit of peat with average thickness of 3 m rests on clay. Samples were taken from wall of cleared pit. Structure of the section: 0 to 25 cm, arboreal and sedge peat, degree of composition 70%; 25 to 120 cm, reed peat, degree of decomposition 35-40%; 120 to 170 cm, arboreal and reed peat, degree of decomposition 40%; 170 to 315 cm, reed peat, degree of decomposition 30-35%; 315 to 325 cm, reed and Bryales peat, degree of decomposition 40%; 325 to 330 cm, reed sapropelite; 330 cm, clay enriched in upper part by organic matter. Coll. 1964 by E. Ilves; pollen-analyzed (V. Post-Nilsson system) by R. Männil, H. Kessel, R. Pirrus, E. Valt, Inst. of Geol.

TA-64. Kuiksilla **4560 ± 80**
2610 B.C.

Reed peat, depth 102.5 to 107.5 cm. Boundary between Pollen Zones IV and III.

TA-65. Kuiksilla	4955 ± 65 3005 B.C.
Arboreal and reed peat, depth 127.5 to 132.5 cm. Maximum of oak. Pollen Zone IV.	
TA-66. Kuiksilla	5800 ± 70 3850 B.C.
Arboreal and reed peat, depth 157.5 to 162.5 cm. Maximum of elm. Pollen Zone V.	
TA-67. Kuiksilla	6645 ± 70 4695 B.C.
Reed peat, depth 177.5 to 182.5 cm. Boundary between Pollen Zones VII and VI.	
TA-68. Kuiksilla	7785 ± 70 5835 B.C.
Reed peat, depth 212.5 to 217.5 cm. Boundary between Pollen Zones VIII and VII.	
TA-69. Kuiksilla	8095 ± 75 6145 B.C.
Reed peat, depth 247.5 to 252.5 cm. Maximum of pine. Pollen Zone VIII.	
TA-70. Kuiksilla	9080 ± 100 7130 B.C.
Reed and Bryales peat, depth 315 to 319 cm. Boundary between Pollen Zones IX and VIII.	
TA-71. Kuiksilla	9350 ± 250 7400 B.C.
Peat sapropel, depth 329.5 to 334.5 cm. Pollen Zone IX.	

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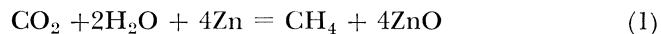
TATA INSTITUTE RADIOCARBON DATE LIST IV

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All measurements reported in the previous date lists (Kusumgar *et al.*, 1963a; Agrawal *et al.*, 1964 and 1965a) were based on acetylene counting. Since September 1964 we have changed over to methane counting and all dates presented here are based on this method. Methane counting offers certain advantages over acetylene, e.g., (1) rapid synthesis, (2) the non-explosive nature of gas, (3) the synthesized gas is radon-free. The disadvantage of having only one atom per molecule in methane (CH_4), as against two in acetylene (C_2H_2), is compensated by the fact that methane can be counted at higher pressures with relatively low operating voltages.

The method of methane synthesis developed by Anand and Lal (1964) for the purposes of counting tritium activity has been adapted by us for the measurement of activity of C^{14} . The pretreatment and combustion procedures (Kusumgar *et al.*, 1963b) remain unchanged except for the added steps of purification of CO_2 which is now passed through 0.1 N KMnO_4 solution and AgO at 350°C , before letting it through a charcoal-silica-gel trap at room temperature. Sample carbon, after being oxidized to CO_2 , is filled in a reaction vessel containing zinc dust, water, and catalyst. Methane is synthesized in the presence of the catalyst (0.5% Ru on Al_2O_3) maintained at $475\text{--}510^\circ\text{C}$. The following effective reaction takes place:



To make the reaction quantitative, 10% excess of water is taken and the yields of methane synthesized are better than 99.9%. Typical proportions of the reactants are: 6.3 L CO_2 (S.T.P.), 11 cc H_2O and 400 g zinc dust. Purification of the gas is then carried out. The procedures for a quantitative extraction and purification of methane have been described in detail elsewhere (Agrawal *et al.*, 1965b).

We have preferred to use the reaction (1) to the one developed by Fairhall *et al.* (1961), as the commercially available hydrogen was found to contain sufficient tritium activity. For reaction (1), we obtained "dead" water from a tubewell in Chanasma (Gujarat).

Two Oeschger-Houtermans gas-proportional counters of 2.7 L volume each are in use. One counter is filled at 115 and the other at 90 cm Hg corresponding to effective amounts of 0.91 and 0.75 gm carbon counted respectively. The background rate for both the counters is 1.5 cpm.

The dates presented here are based on the radiocarbon half-life value of 5568 yr. For conversion to A.D./B.C. scale, A.D. 1950 has been used as reference year.

All samples were pretreated with dil. HCl. NaOH treatment was given to the relatively harder samples, lest they disintegrate.

GENERAL COMMENTS ON DATES

With the availability of a large number of C^{14} dates the outlines of a consistent chronological framework are emerging (Agrawal and Lal, in press). (For this discussion C^{14} dates based on the half-life value of 5730 yr have been used.) Harappan time-spread seems to be confined to ca. 2300-1750 B.C. (Agrawal, 1964); the Chalcolithic cultures show a time-spread of ca. 1750-1000 B.C.; Painted Grey ware is covered by the maximum bracket of ca. 1000-400 B.C.; N.B.P. ware is bracketed within ca. 450-50 B.C. The southern Neolithic culture begins around ca. 2300 B.C. The Kashmir Neolithic culture shows a spread of ca. 2300-1500 B.C. This absolute chronology has now made it possible to synthesize the data available on the material traits of the protohistoric cultures. Circumstantial evidence, fortified by C^{14} dates, indicate (Agrawal, 1966) that the early Aryans are probably to be equated with the Banasians and the P.G. ware with the later wave Aryans.

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

Ahichchhatra series, Uttar Pradesh

Ahichchhatra ($28^{\circ} 22' N$ Lat, $79^{\circ} 7' E$ Long), Dist. Bareilly, is site of ancient capital of North Panchal. Excavations are being directed by N. R. Banerji. Samples subm. by A. Ghosh, Director General of Archaeol., New Delhi-11.

TF-301. Defences

**2255 ± 105
305 B.C.**

Charcoal from Locus CXIII-CXIV, Layer 1, depth 0.8 m, Field No. 2 (Defences). Visible rootlets were handpicked. NaOH pretreatment was also given. *Comment:* sample was found in debris just above mud-filling belonging to Phase II of defences.

TF-310. N.B.P. ware deposits

**2050 ± 90
100 B.C.**

Charcoal from highmound, Locus XI-XII, Pit No. 4 sealed by Layer 8A, depth 0.5 m, Field No. 177 (H.M.). *Comment:* red ware of N.B.P.-ware association was found in these deposits.

2360 \pm 105
410 B.C.

TF-311. N.B.P. ware deposits

Charcoal from highmound, Locus IX'-X', Pit No. 5 sealed by Layer 14, depth 3.8 m, Field No. 196 (H.M.). *Comment:* these deposits also yield P.G. ware.

2155 \pm 100
205 B.C.

TF-317. Late P.G. ware deposits (?)

Charcoal from highmound, Locus X-XI, Layer 15, depth 3.4 m, Field No. 214 (H.M.). *Comment:* sample belongs to disturbed strata.

Atranjikhhera series, Uttar Pradesh

Atranjikhhera ($27^{\circ} 42'$ N Lat, $78^{\circ} 44'$ E Long), Dist. Etah, is very important site for protohistory of Doab, as a distinct pre-P.G. ware black-and-red ware horizon has been established there. Site is being excavated by R. C. Gaur, Aligarh Univ., Aligarh, who subm. the samples.

2150 \pm 105
200 B.C.

TF-283. N.B.P. ware deposits

Charcoal from Trench ARJ-4, Locus A₁ (NE), Layer 27, depth 4.85 m, Field No. ARJ-4/64-1.

2180 \pm 95
230 B.C.

TF-284. N.B.P. ware deposits

Charcoal from Trench ARJ4, Locus A₁ (SW), Layer 29, depth 5.0 m, Field No. ARJ4/64-2. NaOH pretreatment was also given.

2410 \pm 85
460 B.C.

TF-194. Period III

Charcoal from Trench ARJ4, Locus A₁ (NW), Layer 16, depth 3.10 m, Field No. ARJ-4-A1 (NW).

1605 \pm 95
A.D. 345

TF-287. P.G. ware deposits (?)

Charcoal from Trench ARJ4, Locus E₂ (NW), Layer IV, depth 1.34 m, Field No. ARJ 4/64-5. Visible rootlets were handpicked. *Comment:* site is disturbed by later floods; sample seems to be a later intrusion.

2415 \pm 100
465 B.C.

TF-291. P.G. ware deposits

Charcoal from Trench ARJ4, Locus D1 (SE), Layer 6, depth 2.50 m, Field No. ARJ 4/64-9. *Comment:* sample belongs to late levels.

2550 \pm 105
600 B.C.

TF-289. Black-and-red ware deposits

Charcoal (coated with mud) from Trench ARJ4, Locus E1 (SW), Layer 4, depth 0.95 m, Field No. ARJ4/64-7. NaOH pretreatment was also given.

270 ± 120**TF-187. Baghai Khor, India, rock-shelters A.D. 1680**

Charcoal from Baghai Khor, Dist. Mirzapur, Trench BGK-Tr.3, Locus 2-3, Pit A sealed by Layer 1, depth 0.1 m, Field No. BGK (M) -63/3001. NaOH pretreatment was also given. Subm. by G. R. Sharma, Inst. of Archaeol., Allahabad Univ., Allahabad. *Comment* (G. R. Sharma): as these shelters have been used to light fires by shepherds till modern times, later intrusions cannot be ruled out. This charcoal is obviously much later.

Bainapalli series, Madras

Bainapalli (12° 33' N Lat, 78° 27' E Long), Dist. North Arcot, is megalithic-Neolithic site of S. It is being excavated by S. R. Rao. Samples subm. by A. Ghosh.

2265 ± 100**TF-350. Post-megalithic period 315 B.C.**

Charred grain from Trench BNPI, Locus C1, Pit 4, sealed by Layer 3, depth 1.30 m, Field No. BNP 1/C₁/64-2. Visible rootlets were hand-picked.

3340 ± 100**TF-349. Neolithic period 1390 B.C.**

Charcoal from Trench BNPI, Locus A1, Layer 6, depth 1.80 m, Field No. BNPI/A₁/64-1. NaOH pretreatment was also given.

2180 ± 105**TF-254. Besnagar, India, N.B.P. ware deposits 230 B.C.**

Charcoal from Besnagar (23° 32' 30" N Lat, 77° 48' E Long), Dist. Vidisha, Trench BSN-1, Locus G1-G2, Layer 8, depth 2.7 m, Field No. BSN-1/G1/C/64-2. Sample subm. by A. Ghosh.

Bahaja series, Maharashtra

Bhaja (18° 44' N Lat, 73° 29' E Long), Dist. Poona, is famous for its early Buddhist rock-excavations. Wooden rafters (though non-functional) have been used on the "roofs." *Comment*: both samples part of much later repairs.

75 ± 90**TF-245. Buddhist rock excavations A.D. 1875**

Wood from Bhaja rock-excavations, Field No. AR-11. Subm. by A. Ghosh.

350 ± 115**TF-170. Buddhist rock excavations A.D. 1600**

Wood from girders of the "roof." NaOH pretreatment was also given. Sample subm. by K. A. Chowdhury, Aligarh, Univ., Aligarh.

3670 \pm 90
1720 B.C.

TF-129. Burzahom, India, Neolithic culture

Charcoal from Burzahom ($34^{\circ} 10'$ N Lat, $74^{\circ} 54' 30''$ E Long), Dist. Srinagar, Trench No. BZH-1 (N. Ext.), Locus XIX_x-XXII_x, Layer 13, depth 2.9 m, Field No. BZH-1/62. Sample subm. by A. Ghosh.

Chirand series, Bihar

Chirand ($25^{\circ} 45'$ N Lat, $84^{\circ} 45'$ E Long), Dist. Saran, is well-known protohistoric site of Eastern India. Site is being excavated by B. S. Verma. B.P. Sinha, Dir. of Archaeol., Bihar, subm. the samples. *Comment:* "dates" show possibility of this black-and-red ware being derived from Banas culture via central India.

2640 \pm 95
690 B.C.

TF-336. Black-and-red ware deposits

Charcoal from Trench CRD-VIIB, Layer 14, depth 8.5 m. *Comment:* sample belongs to Period IB, characterized by the advent of iron.

2715 \pm 120
765 B.C.

TF-334. Black-and-red ware deposits

Charcoal from Trench CRD-VIIB, Layer 18, depth 12.5 m. Visible rootlets were handpicked. *Comment:* sample belongs to Period IA.

Dharnikota series, Andhra Pradesh

Dharnikota ($16^{\circ} 34' 45''$ N Lat, $80^{\circ} 24' 21''$ E Long), Dist. Guntur, is an early historic site near Amravati. Excavations were conducted by Venkatramayya and samples subm. by A. Ghosh. *Comment:* TF-248, TF-247 and TF-246 gave dates as expected. But TF-250, which derived from a disturbed pit, gave more activity than the modern standard.

2095 \pm 100
145 B.C.

TF-248. Fortifications

Charcoal from Trench DKT-1, Locus XXXVI-XXXIX, Layer 10, depth 6 m, Field No. DKT-1/63/No. III. *Comment:* sample will date the Satvahana fortifications.

2275 \pm 100
325 B.C.

TF-247. Early historic period

Charcoal from Trench DKT-2, Locus A₂-A₃, Layer 8, depth 3.7 m, Field No. DKT-2/63/No. I. NaOH pretreatment was also given.

2355 \pm 95
405 B.C.

TF-246. Early historic period

Charcoal from Trench DKT-1, Locus XXXVI-XLII, Layer 11, depth 6.5 m, Field No. DKT-1/63/No. II.

Kakoria series, Uttar Pradesh

Kakoria ($25^{\circ} 3'$ N Lat, $83^{\circ} 11'$ E Long), Dist. Varanasi, is the well-known pre-iron megalithic site of Doab. G. R. Sharma subm. the samples.

Comment: the megalithic habitation area is full of thick black "Palash" roots which when dry are quite often mistaken for charcoal. Samples are expected to belong to 1st millennium B.C., but modern ages of the sample counted show that recent black roots were mistaken for charcoal.

195 ± 90

TF-179. Megalithic habitation area **A.D. 1755**

Charcoal from megalithic habitation area. *Comment:* to cross-check this divergent age two more samples, TF-178 and TF-180, were counted; these gave more activity than the oxalic standard. This confirms that modern black roots were mistaken for charcoal.

Kalibangan series, Rajasthan

Kalibangan (29° 25' N Lat, 74° 05' E Long), Dist. Sri Ganganagar, was a provincial capital of Harappa culture. Site also yields remains of pre-Harappa culture. Excavations are being jointly conducted by B. B. Lal and B. K. Thapar. Samples subm. by A. Ghosh. *Comment:* Kalibangan provides an interesting site for study of role of soil cover in contamination. Whenever proper soil cover was not available, samples have given slightly younger ages.

3075 ± 100

TF-138. Harappa culture **1125 B.C.**

Charcoal from Trench KLB-2, Locus A7, Layer 3, depth 0.9 m, Field No. KLB-2, A7/C/1962-63-1. *Comment:* sample derives from uppermost levels of the mound. Whether younger age is due to contamination or some later occupation is not clear.

3250 ± 90

TF-244. Harappa culture **1300 B.C.**

Charcoal from Trench KLB-2, Locus E2, Layer 2, depth 0.35 m, Field No. KLB-2, E2, Qd.4/C/1963-64-4. *Comment:* sample derived from uppermost levels of the mound. Whether younger age is due to contamination or some later occupation is not clear.

3510 ± 110

TF-143. Harappa culture **1560 B.C.**

Wood from Trench KLB-2, Locus YA1, Layer 2, depth 0.25 m, Field No. KLB-2, YA1/C/1962-63-8.

3615 ± 85

TF-152. Harappa culture **1665 B.C.**

Charcoal from Trench KLB-2, Locus XB9, Layer 5, depth 0.90 m, Field No. KLB-2, XB9/C/1962-63-18. NaOH pretreatment was also given.

3635 ± 100

TF-142. Harappa culture **1685 B.C.**

Charcoal from Trench KLB-2, Locus XB8, Layer 4, depth 1.15 m, Field No. KLB-2, XB8/C/1962-63-7.

- 3675 \pm 140**
1725 B.C.
- TF-149. Harappa culture**
Charcoal from Trench KLB-2, Locus ZE1, Layer 3, depth 0.65 m, Field No. KLB-2, ZE1/C/1962-63-15. NaOH pretreatment was also given.
- 3705 \pm 110**
1755 B.C.
- TF-141. Harappa culture**
Charcoal from Trench KLB-2, Locus A7, Layer 7, depth 1.64 m, Field No. KLB-2, A7/C/1962-63-6.
- 3910 \pm 110**
1960 B.C.
- TF-153. Harappa culture**
Charcoal from Trench KLB-2, Locus XB7, Hearth sealed by Layer 1, depth 0.25 m, Field No. KLB-2, XB7/C/1962-63-20.
- 4195 \pm 115**
2245 B.C.
- TF-155. Pre-Harappa culture**
Charcoal from Trench KLB-1, Locus ZB2, Layer 9B, depth 3.40 m, Field No. KLB-1, ZB2/C/1962-63-3. *Comment* (B.K.T.): stratigraphy is, however, uncertain.
- 3610 \pm 110**
1660 B.C.
- TF-240. Pre-Harappa culture**
Charcoal from Trench KLB-1, Locus XD1, Pit 3 sealed by Layer 3, depth 2.50 m, Field No. KLB-1, XD1, Qd.1/C/1963-64-1. NaOH pretreatment was also given. *Comment*: date is younger than expected archaeologically.
- 3740 \pm 105**
1790 B.C.
- TF-156. Pre-Harappa culture**
Charcoal from Trench KLB-1, Locus XE1, Layer 2, depth 0.80 m, Field No. KLB-1, XE1/C/1962-63-5. NaOH pretreatment was also given. *Comment*: date is younger than expected archaeologically.
- 4090 \pm 90**
2140 B.C.
- TF-241. Pre-Harappa culture**
Charcoal from Trench KLB-1, Locus XD1, Pit 4 sealed by Layer 2, depth 2.75 m, Field No. KLB-1, XD1, Qd.1/C/1963-64-2. NaOH pretreatment was also given.

Karla series, Maharashtra

Karla (18° 45' N Lat, 73° 29' E Long), Dist. Poona, is site of famous Buddhist rock-excavations. Big trees have been used for rafters and ribs used in these "caves".

- 2075 \pm 100**
125 B.C.
- TF-171. Buddhist rock excavations**
Wood from an inside rib fitted to "wall of rock cave." Few antholes were visible. NaOH pretreatment was also given. Sample subm. by K. A. Chowdhury.

TF-185. Buddhist rock excavations**2180 ± 95
230 B.C.**

Wood-rib from Karla Chaitya Cave No. 8. NaOH pretreatment was also given. Sample subm. by A. Ghosh.

Kausambi series, Uttar Pradesh

Kausambi (25° 20' N Lat, 81° 23' E Long), now known as Kosam, Dist. Allahabad, is located on N bank of Yamuna. It is known as capital of later Pandavas. Site is being excavated by G. R. Sharma, who subm. these samples.

TF-226. Rampart II**2110 ± 95
160 B.C.**

Charcoal from Trench KSB-GR, Locus YZ3, 1-2, Layer 12, depth 1.8 m, Field No. KSB/63/GR-138. *Comment:* excavator's archaeological date bracket for sample is ca. 535-185 B.C.

TF-225. N.B.P. ware deposits**2285 ± 105
335 B.C.**

Charcoal from Trench KSB-GR, Locus YZ3, 1-2, Layer 11, depth 1.6 m, Field No. KSB/63/GR-136.

TF-219. N.B.P. ware deposits**2325 ± 100
375 B.C.**

Charcoal from Trench KSB1-III-RD, Locus 2-7, Road I, depth 3 m, Field No. KSB/63/AP-9.

TF-221. N.B.P. ware deposits**2385 ± 100
435 B.C.**

Charcoal from Trench KSB-I-III-RD, Locus 5-7, Pit B sealed by Layer 12, depth 4.3 m, Field No. KSB/63/AP-15. *Comment:* excavator's date on archaeological considerations is ca. 400 B.C.

**TF-252. Mahanadi Bridge, India, Mahanadi
river-bed****5815 ± 140
3865 B.C.**

Drift wood from Mahanadi Bridge site (20° 25' N Lat, 85° 45' E Long), Well No. 8, depth 39 m, excavated during railway bridge construction work. Sample subm. by K. Ramesh Rao, Forest Res. Inst., Dehradun. NaOH pretreatment was also given.

TF-188. Morahana Pahar, India, rock-shelter**1530 ± 95
A.D. 420**

Charcoal from Morahana Pahar, Dist. Mirzapur, Trench MRA, Locus 1-2, Pit A sealed by 1, depth 0.09 m, Field No. MRA (M)-63/3002. NaOH pretreatment was also given. Sample subm. by G. R. Sharma. *Comment* (G.R.S.): as these shelters have been used by shepherds till modern times to light fires, later intrusions cannot be ruled out.

2005 \pm 95**TF-169. Pataliputra, India, wooden palisades****55 B.C.**

Wood from Palisades of Kumrahar ($25^{\circ} 35' N$ Lat, $85^{\circ} 18' E$ Long), Dist. Patna, from depth of 5.4 m. Ant-holes were visible in wood. NaOH pretreatment was also given. Sample subm. by K. A. Chowdhury. *Comment*: sample was "dated" to help botanical studies on decay of cell-walls.

Rajghat series, Uttar Pradesh

Rajghat ($25^{\circ} 18' N$ Lat, $83^{\circ} 1' E$ Long), Dist. Varanasi, is well-known site on bank of River Ganga. Site was excavated by A. K. Narain, Banaras Hindu Univ., Varanasi, who subm. the samples.

2370 \pm 105**TF-293. N.B.P. ware deposits****420 B.C.**

Charcoal from Trench RGT-XIA, Locus XI-XII, Layer 11, depth 9.45 m, Field No. RGT-XIA/1963-64-S. No. 2. *Comment*: sample belongs to early phase of N.B.P. ware.

2350 \pm 95**TF-292. Black Slipped ware deposits****400 B.C.**

Charcoal from Trench RGT-Cutting B, Locus O'-II', Layer 6, depth 5.9 m, Field No. RGT-Cut. B/1963-64-S.No. 5. Visible rootlets were handpicked. *Comment*: in the layer there is evidence of flood.

2190 \pm 85**TF-294. Black and Red ware deposits****240 B.C.**

Charcoal from Trench RGT-XIA, Locus X-XI, Layer 14, depth 11 m, Field No. RGT-XIA-1963-64-S. No. 4. *Comment*: sample derives from disturbed strata.

Rupar series, Punjab.

Rupar ($30^{\circ} 58' N$ Lat, $76^{\circ} 32' E$ Long), Dist. Ambala, has given a sequence from the Harappan to late historical times. Site was excavated by Y. D. Sharma in 1953. Samples subm. by A. Ghosh.

2275 \pm 100**TF-213. N.B.P. ware deposits****325 B.C.**

Charred wood from Trench RPR-1, Locus O-VIII, Layer 26, depth not given, Field No. RPR-1-1710.

2365 \pm 100**TF-209. N.B.P. ware deposits****415 B.C.**

Charred wood from Trench RPR-2, Locus X'-XI', Layer 30, depth 11 m, Field No. RPR-2-3094.

1910 \pm 90**TF-369. Saradkel, India, "Asura" culture****A.D. 40**

Charcoal from Saradkel ($23^{\circ} 3' 30'' N$ Lat, $85^{\circ} 21' E$ Long), Dist. Ranchi, Trench SDK-2, Locus C3-C4, Layer 3, depth 0.01 m (?), Field

No. SDK-2/65-114. NaOH pretreatment was also given. Sample subm. by A. Ghosh. *Comment*: red ware sprinklers are associated with these deposits.

TF-371. Shomutepe, U.S.S.R., Eneolite period **2915 ± 95**
965 B.C.

Charcoal from Shomutepe (41° N Lat, 45° E Long), Dist. Kazakh (Azerbaijan), Lower stratum, depth 0.7 m. Sample subm. by I. Q. Narimanov. *Comment* (I.Q.N.): sample derives from transitional phase between Eneolithic and Bronze-age periods.

TF-376. Sonpur, India, Pre-N.B.P. ware deposits **2510 ± 105**
560 B.C.

Charred rice from Sonpur, Dist. Gaya, Pit sealed by Layer 9, depth 4.55 m, Field No. SPR-XII. Sample subm. by B. P. Sinha.

Tekkalakota series, Mysore

Tekkalakota (15° 32' N Lat, 76° 53' E Long), Dist. Bellary, is an extensive neolithic site. Site was excavated by H. D. Sankalia, Deccan College, Poona, who subm. the samples. *Comment*: C¹⁴ dates show that Tekkalakota represents the middle phase and Utnur the early phase of Neolithic culture of S.

TF-277. Ash-pit **2220 ± 105**
270 B.C.

Charred grains from Trench A, Locus TKT-GWD, Layer 2, depth 0.3 m. NaOH pretreatment was also given. *Comment* (H.S.D.): sample derives from historical levels.

TF-262. Neolithic culture **3460 ± 135**
1510 B.C.

Charcoal from TKT-I, Trench 9, Layer 1, depth 0.25 m. NaOH pretreatment was also given. Visible rootlets were handpicked.

TF-239. Neolithic culture **3395 ± 105**
1445 B.C.

Charcoal from TKT-I, Trench 1, Pit 4 sealed by Layer 4, depth 1.3 m. NaOH pretreatment was also given.

TF-237. Neolithic culture **3465 ± 105**
1515 B.C.

Charcoal from TKT-I, Trench 1, Layer 4, depth 1 m. NaOH pretreatment was also given.

TF-266. Neolithic culture **3625 ± 100**
1675 B.C.

Charcoal from TKT-II, Trench 2, Layer 2, depth 0.17 m. Field No. 265. NaOH pretreatment was also given.

6085 \pm 120
4135 B.C.

TF-372. Toyretepe, U.S.S.R., Eneolite period

Charcoal from Toyretepe (41° N Lat, 45° E Long), Dist. Kazakh, stratum medium, depth 4 m. Sample subm. by I. Q. Narimanov.

II. GEOLOGIC SAMPLES

Warkala series, Kerala

Warkala (8° 44' N Lat, 76° 42' 20" E Long) coast has been subject of many geologic investigations. Charred wood dated here was part of Warkala formations of Kerala coast. Samples subm. by G. Prabhakar Rao.

TF-201. Warkala formations **>45,000**

Charred wood from Warkala formations, embedded ca. 0.3 m in compact clay.

TF-202. Warkala formations **>40,000**

Charred wood from Warkala formations, embedded ca. 0.3 m in compact clay. NaOH pretreatment was also given.

Comment: dating of these formations has a bearing on the possibility or otherwise of oil-bearing strata in the region and on causes of the present day coastal erosion. Samples also will date emergence of the Kerala coast.

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UNIVERSITY OF TEXAS RADIOCARBON DATES IV

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This list reports routine measurements made at this laboratory since the preparation of the last list (Texas III). It also includes measurements made on bone samples earlier as part of a study of the suitability of bone for C^{14} dating (Tamers and Pearson, 1965). In the absence of the laboratory director, M. A. Tamers, who has been on leave at the Caracas (IVIC) laboratory since October, 1963, laboratory operation and the selection and description of geologic samples have been handled by Pearson, and laboratory administration and archaeological samples by Davis.

Ages are calculated using a C^{14} half-life of 5568 yr with 1950 the reference year. The modern standard used for all samples is 95% of NBS oxalic acid. The deviations reported are based on the counting statistics of the sample, background, and modern, and are $\pm 1\sigma$ except that when the sample count approaches either the modern or the background, 2σ limits are reported. Users of these dates should bear in mind that the C^{14} content of the atmosphere has varied by several percent during the last several millennia. This variation may be assumed to contribute an additional uncertainty equivalent to a standard deviation of 100 yr. Taking this uncertainty into account, an estimate of 1σ errors associated with dates in this and the earlier Texas lists may be found from the expression

$$\sqrt{(100)^2 + (\text{published error})^2}.$$

The laboratory continues to use liquid scintillation counting of benzene. The method of benzene synthesis was changed during the summer of 1965 from the method using SrC_2 and B_2H_6 -activated catalyst (Texas II, III) to one using Li_2C_2 and vanadium-activated catalyst (Noakes *et al.*, 1966). The sample-preparation time remains about the same with the new method as with the old, but the chemical yields, which formerly averaged about 50%, now average about 80% and are considerably more constant. As before, no radon has been observed, nor is the synthesized benzene quenched. Samples numbered through Tx-260 were prepared using the SrC_2 method; beginning with Tx-262 the Li_2C_2 method was used. Samples Tx-245, -249, -259, -261, and -269 were split and run by both methods.

The samples are counted in a liquid scintillation spectrometer equipped with two channels and a print-out device. The details of the counting procedure are similar to those described by Tamers (1966). The counter efficiency is determined daily using a "hot" reference sample

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calibrated against the NBS standard, and the absence of quenching is verified for each sample using the channels-ratio method (Noakes *et al.*, 1966; Tamers, 1966).

The benzene syntheses using the SrC_2 method were carried out by B. J. Bowen. Those using the Li_2C_2 method were performed by R. B. Wiggins, who also assisted in setting up the Li_2C_2 apparatus and stabilizing the technique. We continue to be grateful to Miss Jo Anne Nowick for her able assistance in laboratory administration and preliminary sample processing.

I. KNOWN-AGE BONE SAMPLES

The following are bone samples dated to determine the suitability of this material for C^{14} dating. All samples were found in close association with charcoal which has also been dated and provides control ages. Names of collectors and submitters, and details of the associations of these samples, are given in the reports of the charcoal equivalents referred to in the table of results. The complete study, including results of other bone samples run at the Caracas (IVIC) laboratory (Caracas II) has been presented elsewhere (Tamers and Pearson, 1965) but a summary of the conclusions is appropriate here.

All samples were thoroughly scrubbed, rinsed with dilute acid, and dried. The clean dry bone was dissolved in an excess of acid and the residue evaporated to dryness. The dry residue was burned in the usual way and is reported as fraction A. Some of the CO_2 evolved during the acid treatment was also dated and is reported as fraction B. Portions of some samples were not dissolved in acid but were burned directly and are reported as fraction C.

From the table, it is clear that fraction B, the carbonate portion of the bones, in all cases contained more C^{14} than the associated charcoal. This is probably due to exchange between the carbonate and CO_2 of the atmosphere. (See also comment on Tx-253, below). Bone carbonate is probably also present in fraction C, especially if burning was carried out at a high temperature. Thus fractions B and C are not likely to yield reliable dates.

In seven of the fourteen samples studied, the C^{14} content of the organic (A) fraction was statistically indistinguishable from that of the control. This result agrees with the conclusions of other workers (Berger *et al.*, 1964; Krueger, 1966) that organic fraction dates are reliable. However, the C^{14} ages of the seven remaining samples were younger than those of the controls by as much as several thousand years. We attribute this behavior, which has also been reported by others (*e.g.* UCLA-705, UCLA IV), to the fact that these samples were all buried bone and were sufficiently impregnated with soil and debris so that even with the most scrupulous cleaning it probably was not possible to remove completely the younger material. Therefore, unless we are certain the bone has been protected from contact with possible contaminants throughout its history (*e.g.* Tx-51, Texas II), we now treat bone measurements as giving

lower limiting ages only and report them as "greater than" the calculated age minus 2σ (see table and Tx-164, -250, -253).

TABLE I
Bone Results

Bone Sample Number	δC^{14} bone (‰)	Bone Age	Assoc. Charcoal Sample	Assoc. Charcoal Age & δC^{14}
<i>Fort St. Louis, Texas</i>				
Tx-162-A	-1 ± 14	modern	{ Tx-48 (Texas II)	195 ± 105 yr -24 ± 14 ‰
Tx-162-B	$+35 \pm 13$			
Tx-162-C	-16 ± 11			
<i>San Lorenzo, Texas</i>				
Tx-163-A	-59 ± 11	>290 yr	{ Tx-49 (Texas II)	380 ± 100 yr -46 ± 11 ‰
Tx-163-B	$+34 \pm 15$			
Tx-163-C	-65 ± 21			
<i>Bonfire Shelter, Texas</i>				
Bone Bed 3				
Tx-47-A	-295 ± 13	>2590 yr >1380 yr	{ Tx-106 (Texas II) Tx-131 (Texas III)	2780 ± 110 yr -293 ± 8 ‰ 2510 ± 110 yr -268 ± 9 ‰
Tx-229-A	-283 ± 57			
Tx-229-B	-176 ± 11			
Tx-229-C	-233 ± 110		Average	2645 ± 75 yr -280 ± 6 ‰
Bone Bed 2				
Tx-230-A	-606 ± 8	$>7,150$ yr	Tx-153 (Texas III)	$10,230 \pm 160$ yr -720 ± 6 ‰
Tx-230-B	-586 ± 8			
Tx-231-A	-679 ± 8			
Tx-231-B	-595 ± 8	$>8,020$ yr $>8,660$ yr		
Tx-231-C	-682 ± 8			
Tx-118-A	-648 ± 8			
Tx-232-A	-678 ± 8			
Tx-232-B	-594 ± 19			

II. GEOLOGIC AND PALEONTOLOGIC SAMPLES

A. Texas Vertebrate Faunas

The following are bone samples of unknown age from various Texas vertebrate faunas. All were treated as described above, and the ages reported are the lower limiting ages (2σ) based on the organic (A) fraction. The measured C^{14} contents of the fractions are given in the descriptions. All samples subm. by E. L. Lundelius, Jr., Dept. of Geology, Univ. of Texas, Austin. Comments by E. L. L.

Tx-164. Tedford Quarry

$>12,600$

Fragments of turtle carapace from Tedford Quarry near Ingleside, San Patricio County ($27^\circ 52'$ N Lat, $97^\circ 11'$ W Long). Coll. ca. 1940

from 6 to 15 ft below surface in fresh water pond deposit of Ingleside barrier chain (Price, 1958). $\delta C^{14}\text{-A} = -860 \pm 28\text{‰}$, $\delta C^{14}\text{-B} = -666 \pm 9\text{‰}$, $\delta C^{14}\text{-C} = -722 \pm 8\text{‰}$. *Comment:* Ingleside fauna is late Pleistocene and is very probably older than 12,000 yr as date suggests.

Tx-250. Cave Without a Name **>10,600**

Bone from Cave Without a Name, ca. 9 mi NE of Boerne, Kendall County (29° 53' N Lat, 98° 37' W Long). From undisturbed clay deposit at bottom of entrance shaft. Coll. 1960 by E. L. Lundelius, Jr. $\delta C^{14}\text{-A} = -745 \pm 6\text{‰}$, $\delta C^{14}\text{-B} = -700 \pm 8\text{‰}$. *Comment:* sample associated with Wisconsin vertebrate fauna with many extinct and extant species not now found in Kendall County. Date agrees with previous estimate of 10,000-20,000 yr B.P.

Tx-253. Felton Cave **>7,500**

Bone from accumulation of vertebrate remains in Felton Cave, ca. 10 mi S of Sonora, Sutton County (33° 28' N Lat, 100° 33' W Long). Sample from 12 to 21 in. below surface of cave fill on N side of entrance room. Coll. 1965 by R. M. Frank. $\delta C^{14}\text{-A} = -620 \pm 6\text{‰}$, $\delta C^{14}\text{-B} = -657 \pm 6\text{‰}$. *Comment* (F.J.P.): this is only bone sample we have run in which B-fraction contains less C^{14} than A-fraction. It is possible that C^{14} content of CO_2 in cave atmospheres may be lowered by exchange with or dilution by "dead" limestone. This anomaly might then be due to exchange between the bone carbonate and such CO_2 . (E.L.L.): this is an early Recent fauna with two species whose present ranges are restricted to the wetter area of E Texas. Date suggests that desiccation of this area which drove these species E began earlier than expected.

B. Western Gulf Coast

Bahia Salada Core III

Shell fragments from core in recent lagoonal-marine sediments under Bahia Salada, Tamaulipas, Mexico (24° 30' N Lat, 97° 45' W Long), dated to determine rate of sedimentation. Core from 200 m inside (W of) mouth of bay, adjoining Mexican Laguna Madre. Coll. Nov. 1964 by E. W. Behrens and R. F. Leo; subm. by P. L. Parker, Inst. of Marine Science, Univ. of Texas, Port Aransas, Texas.

900 \pm 75

Tx-247. Bahia Salada Core III-J; CD-4 **A.D. 1050**
75 cm below sediment-water interface. $\delta C^{14} = -107 \pm 8\text{‰}$.

1750 \pm 80

Tx-248. Bahia Salada Core III-K; CD-5 **A.D. 200**
150 cm below sediment-water interface. $\delta C^{14} = -195 \pm 8\text{‰}$. *Comment* (E.W.B.): these dates indicate an average rate of sedimentation of

0.8 mm/yr. Other samples from this core were analyzed for concentrations of fatty acids. These concentrations showed no correlation with depth. However, the ratios of saturated to unsaturated acids appear to increase with depth.

Tx-249. Laguna Madre CD-6

1940 \pm 60

A.D. 10

Fossil beach shells, including the genera *Aequipecten*, *Busycon*, *Dinocardium*, *Fasciolaria*, *Polinices*, and *Macrocallista*, from ca. 8 ft above sealevel in a bluff on NE shore of Bahia Salada near point where this bay enters Laguna Madre, near Carvajal, Tamaulipas, Mexico (24° 30' N Lat, 97° 45' W Long). Another sample from same location was dated at 2340 \pm 100 (Tx-154, Texas III). Coll. Nov. 1964 and subm. by E. W. Behrens, Inst. of Marine Science, Univ. of Texas, Port Aransas, Texas.

A portion of this sample was first dated using the SrC₂ method giving $\delta C^{14} = -213 \pm 7\text{‰}$, about 400 yr younger than the presumably equivalent Tx-154. To determine if the difference could be due to exchange with the atmosphere at the shells' surface, the CO₂ evolved from another portion of the sample was split into three parts corresponding roughly to the outer, middle, and inner thirds of the shells. The fractions were separately prepared by the Li₂C₂ method and the δC^{14} 's were: Outer 1/3: $-212 \pm 9\text{‰}$; Middle 1/3: $-221 \pm 8\text{‰}$; Inner 1/3: $-208 \pm 9\text{‰}$. No exchange could be demonstrated and the four measurements were averaged to give the date above. The discrepancy between this date and Tx-154 remains unexplained, although it is less than 3 σ and therefore may not be real. *Comment* (E.W.B.): this, with an earlier sample—Tx-154—is the first reported evidence from the Gulf of Mexico of a Recent stand of sealevel higher than the present position. Deposit may reflect local uplift, but date correlates with dates obtained from similarly elevated deposits from Brazil and Australia (vanAndel and Laborel, 1964; Fairbridge, 1961).

Tx-264. Aransas Pass Shells

>37,000

Fresh-water shells (*Physa* and *Planorbis*) from spoil island 1¾ mi NE of Intracoastal Waterway Bridge near Aransas Pass (27° 53' N Lat, 97° 06' W Long). From fresh-water pond deposits now ca. 15 ft below sealevel on seaward side of Ingleside barrier (Price, 1958). Coll. 1964 by H. D. Hoese; subm. by E. L. Lundelius, Jr., Dept. of Geology, Univ. of Texas, Austin. $\delta C^{14} = 0 \pm 5\text{‰}$. *Comment* (E.L.L.): these pond deposits were formed when sealevel was below level at which Tedford Quarry deposits were formed, and it was hoped this date, with Tx-164 (this list), would give the relative ages of the deposits. The hope was not fulfilled, but the present date does add to our knowledge of the history of the western Gulf Coast.

*C. Eastern Texas***Deweyville Terrace series**

Wood samples from Deweyville terraces, the first stream terraces above the recent terrace along most rivers of eastern Texas (Bernard and LeBlanc, 1965). Coll. 1965 and subm. by Saul Aronow, Dept. of Geology, Lamar State College of Technology, Beaumont, Texas, via P. T. Flawn, Bur. of Economic Geology, Univ. of Texas, Austin. Wood identification by Texas Forest Products Lab. Lufkin, and Forest Products Lab., Madison, Wisconsin.

Tx-266. Deweyville 1**25,700 \pm 800****23,750 B.C.**

Red oak wood from Deweyville Specialty Sand Co. pit ca 1/2 mi N of Deweyville, Newton County (30° 19' N Lat, 93° 45' W Long). Removed from pit by suction hose from reported depth of 15 to 20 ft from surface. $\delta C^{14} = -959 \pm 4 \text{‰}$.

Tx-267. Deweyville 2**19,900 \pm 500****17,950 B.C.**

Hickory wood, probably pecan, from Urbana Sand and Gravel Co. pit, ca. 0.8 mi SW of Urbana, San Jacinto County (30° 39' N Lat, 94° 57' W Long). Removed from pit by dragline from reported depth of 20 to 30 ft below surface. $\delta C^{14} = -916 \pm 5 \text{‰}$.

Tx-268. Deweyville 3**13,250 \pm 250****11,300 B.C.**

Sycamore wood from Cleveland Sand and Gravel Co. pit, ca. 1.3 mi NW of Cleveland, Liberty County (30° 21' N Lat, 95° 07' W Long). Removed from pit by dragline from reported depth of 15 to 30 ft below surface. $\delta C^{14} = -808 \pm 6 \text{‰}$.

General Comment (S.A.): Deweyville Terraces have been considered early Recent, but these dates are all older than Two Creeks, suggesting the terraces are late Pleistocene.

D. Western Texas

Samples from pluvial lakes in NW Texas dated to determine chronology of the sediments in these lakes. The problem is discussed in detail by Reeves (1966).

Mound Depression series

Organic mud samples from core in playa of Mound Lake, Lynn and Terry Counties, Texas (33° 13' N Lat, 102° 5' W Long). Core taken off the drilling pad on road leading to large central island. Coll. 1965 and subm. by C. C. Reeves, Jr., Dept. Geosciences, Texas Tech. College, Lubbock, Texas.

Tx-270. ML 2 **31,800** ⁺³⁷⁰⁰
-2500
Depth 2 ft; $\delta C^{14} = -981 \pm 7 \text{ ‰}$. **29,850 B.C.**

Tx-271. ML 7 **33,000** \pm **2500**
Depth 7 ft; $\delta C^{14} = -983 \pm 5 \text{ ‰}$. **31,050 B.C.**

Tx-272. ML 8 **37,000** ⁺⁴¹⁰⁰
-2700
Depth 8 ft; $\delta C^{14} = -990 \pm 4 \text{ ‰}$. **35,050 B.C.**

Tx-273. ML 15½ **>34,300**
Depth 15½ ft; $\delta C^{14} = -996 \pm 5 \text{ ‰}$.

Comment (C.C.R.): in this core, contact between kaolinitic and overlying montmorillonitic clays is at ca. 20 ft. This suggests lake fill is pre-Tahoka, not Tahoka or Recent.

T-Bar Depression series

Dolomite samples from N end of S lake in T-Bar Depression, Lynn County, Texas (33° 12' N Lat, 101° 55' W Long). Coll. 1964 and subm. by C. C. Reeves, Jr.

Tx-262. TBS 2 **20,300** \pm **300**
From upper dolomite. $\delta C^{14} = -920 \pm 6 \text{ ‰}$. **18,350 B.C.**

Tx-263. TBS 1 **19,800** \pm **500**
From lower dolomite. Sample split; $\delta C^{14} = -914 \pm 8 \text{ ‰}$, and $-916 \pm 5 \text{ ‰}$; date from average. **17,850 B.C.**

General Comment (C.C.R.): samples are from mid-part of Tahoka clay and correlate with dolomite found in mid-part of the Tahoka in other basins. Dates represent Vigo Park period of desiccation.

E. Oregon

Tx-245. Newberry Crater, Oregon **1270** \pm **60**
A.D. 680

Charcoal from beneath topmost pumice layer within caldera of Newberry volcano (43° 43' N Lat, 121° 15' W Long), Oregon. From exposure in roadcut between East and Paulina Lakes near point of collection of C-657 (2054 ± 230 , Libby, 1955), which should be equivalent. Coll. and subm. 1964 by U. S. Clanton, NASA Manned Spacecraft Center, Houston. Sample run twice by SrC_2 method giving $\delta C^{14} = -152 \pm 8 \text{ ‰}$ and $-153 \pm 10 \text{ ‰}$ and by Li_2C_2 method giving $\delta C^{14} = -132 \pm 9 \text{ ‰}$. Date is average of three runs. *Comment* (U.S.C.): pumice bed is capped by an obsidian flow which appears to be last volcanic activity within caldera; sample thus establishes maximum age for last event.

*F. Miscellany***Tx-261. Modern Oak leaves** $\delta C^{14} = 555 \pm 6 \text{‰}$

Leaves from live oak trees growing on grounds of Balcones Research Center, Austin, Texas (30° 23' N Lat, 97° 44' W Long). Coll. Sept. 1963 by G. M. Dotson; subm. by M. A. Tamers, this lab. A large quantity of these leaves was burned and converted to $SrCO_3$ at time of collection. A portion was measured in May 1964 and had $\delta C^{14} = +534 \pm 14 \text{‰}$. Three lots of CO_2 from the same $SrCO_3$ were processed in Aug. 1965, to test the Li_2C_2 method. The δC^{14} 's were $+576 \pm 11 \text{‰}$, $+557 \pm 11 \text{‰}$, and $+553 \pm 11 \text{‰}$. The value given above is the average of the four measurements.

10,750 \pm 210**Tx-269. Appleton, Wisconsin****8800 B.C.**

Sample from log dated and reported previously (Tx-44, 10,700 \pm 210, Texas II). Rerun using Li_2C_2 method. $\delta C^{14} = -738 \pm 7 \text{‰}$. *Comment:* in excellent agreement with earlier determination.

III. ARCHAEOLOGIC SAMPLES

A. Lower Pecos River Region, Texas

For a summary of the chronological situation in this region see Texas II, p. 151, and Texas III, p. 301.

625 \pm 185**Tx-227. Cammack Sotol pit****A.D. 1325**

Charcoal from occupation area just NE of main midden, Cammack Sotol pit (41 VV 260), W bank of tributary of Cow Creek, approx. 2 mi SE of Comstock, Val Verde County, Texas (28° 38' N Lat, 101° 10' W Long). From Trench III, 1.5 to 2.0 ft below surface, in Units #10 and 11. Associated with arrow points with contracting and rectangular stems like those in Toyah, Austin, and Livermore foci and in Bravo Valley aspect. These associations suggest date of A.D. 1200-1300. Coll. 1964 by J. W. Greer; subm. by C. D. Tunnell, Texas Archeol. Salvage Project, Univ. of Texas, Austin. $\delta C^{14} = -75 \pm 21 \text{‰}$. *Comment* (J.W.G.): date agrees well with preliminary estimate.

B. Central Texas

For a summary of Central Texas archaeological chronology see Texas II, p. 144-145.

Britton site series

Charcoal samples from Britton site (41 ML 37; Story and Shafer, 1965, p. 76-135), a buried alluvial terrace site on E side of N Bosque R, ca. 7 mi NW of Waco, Texas (31° 37' N Lat, 97° 22' W Long). Materials in approx. the upper 6 ft of deposit represented an unmixed component of Transitional period of Archaic Edwards Plateau aspect. Cultural assignment of the few materials found more deeply buried in the

terrace fill is uncertain. Previous dates from site are Tx-200, 2080 ± 80 , and Tx-201, 2330 ± 80 (Texas III), both from hearth 8 ft below surface. The only other Transitional Edwards Plateau aspect date from this region is Tx-28, 1165 ± 120 (Texas II) from Smith shelter; like the other Smith shelter dates (Tx-21 through Tx-28, Texas II) it is 300-400 yr more recent than archaeological evidence warrants. Coll. 1964 and subm. by Dee Ann Story, Texas Archeol. Salvage Project, Univ. of Texas, Austin.

Tx-233. Britton 184 **1865 \pm 95**
A.D. 85

From Feature 35, a hearth and associated mussel and snail shells and a few burned rocks, 4.0 to 4.2 ft below surface. $\delta C^{14} = -208 \pm 10 \text{‰}$.

Tx-234. Britton 209 **1940 \pm 110**
A.D. 10

From Feature 48, a hearth exposed in N end and parts of W wall of Trench 19, 8.5 to 9.0 ft below surface. $\delta C^{14} = -216 \pm 9 \text{‰}$. *Comment* (D.A.S.): the four Britton site dates now at hand are consistent with cultural and geologic findings, indicating a time around beginning of Christian era for Transitional period of Edwards Plateau aspect, and a relatively rapid accumulation of alluvium at the site.

C. Caddoan Area, Texas-Louisiana

The following samples pertain to the chronology of the Caddoan archaeological area in adjacent parts of Texas and Louisiana. For a summary of Caddoan chronology see Texas II, p. 154.

Harroun site series, Texas

Charcoal samples from Harroun site (41 UR 10; Jelks and Tunnell, 1959), NE of Ore City, Upshur County, Texas ($32^{\circ} 50' \text{ N Lat}$, $94^{\circ} 42' \text{ W Long}$), associated with artifacts of Whelan complex (early Titus focus). Previous dates for this same complex are: Dalton mound, Tx-83, 480 ± 110 (Texas II); Harroun site, Tx-84, 490 ± 100 (Texas II); Sam Roberts, Tx-199, 320 ± 60 and Tx-202, 240 ± 90 (Texas III). Coll. 1958 by E. B. Jelks and C. D. Tunnell, Texas Archeol. Salvage Project, Univ. of Texas, Austin; subm. by Jelks.

Tx-238. Harroun site No. 2 **265 \pm 65**
A.D. 1685

From Mound B, Sq. N105-W90, elev 98.92 ft. $\delta C^{14} = -33 \pm 8 \text{‰}$.

Tx-239. Harroun site No. 3 **330 \pm 110**
A.D. 1620

From Mound C, Sq. N114-W105, elev 99.8 ft. SW edge of Houses 1 and 2. $\delta C^{14} = -40 \pm 13 \text{‰}$.

Tx-240. Harroun site No. 1 **555 \pm 70**
A.D. 1395

From Mound C, Sq. N115-W100, elev 100.2 ft. $\delta C^{14} = -67 \pm 8 \text{‰}$.

345 ± 75**Tx-241. Harroun site No. 4****A.D. 1605**

From beam above floor of House 4, Mound D. Elev 97.66 ft. $\delta C^{14} = -42 \pm 9\%$.

General Comment (C.D.T. and E.M.D.): the 8 dates now at hand for the Whelan complex, taken as a group, indicate a time between A.D. 1400 and 1700. On archaeological evidence Whelan complex is the penultimate prehistoric complex in this area, preceding the prehistoric Titus focus cemeteries. Therefore, the earlier part of the indicated C^{14} time range is the most likely dating.

Knight's Bluff series, Texas

Charcoal samples from Knight's Bluff site (41 CS 14; Jelks, 1961, p. 11-41), ca. 6 mi NE of Douglassville, Cass County, Texas, on S bank Sulphur R, in Texarkana Reservoir basin (30° 15' N Lat, 94° 15' W Long). Samples are believed to be associated with Texarkana focus-like occupation. Coll. 1952 and subm. by E. B. Jelks.

550 ± 90**Tx-242. Knight's Bluff 2****A.D. 1400**

From grave fill, Burial #5, adjacent to skull. Association with burial could have been fortuitous, but may date Texarkana focus-like occupation. $\delta C^{14} = -66 \pm 10\%$.

680 ± 70**Tx-243. Knight's Bluff 5****A.D. 1270**

From Sq. E120-N5, 18 in. below surface. Association with Texarkana focus-like occupation not certain, but probable. Date average of two measurements: $\delta C^{14} = -81 \pm 9\%$ and $-81 \pm 12\%$.

General Comment (E.B.J.): dates are in agreement within 1σ and are within estimated time range of Texarkana focus.

Coral Snake mound series, Louisiana

Charcoal samples from Coral Snake mound (16 SA 48), 2 mi E of Pendleton Crossing of Sabine River, 20 mi SW of Many, Sabine Parish, Louisiana (31° 28' N Lat, 93° 42' W Long). Mound contained cremations, copper artifacts, rocker stamped sherds, and other items, indicating that it is pre-Caddoan and may represent western fringe of Marksville culture. Coll. 1965 and subm. by Burney B. McClurkan, Texas Archeol. Salvage Project, Univ. of Texas, Austin. Comments by E.M.D.

210 ± 90**Tx-244. Coral Snake 2****A.D. 1740**

From NW quadrant of mound, coordinates N511.00/E487.45, elev 100.50. No direct associations. $\delta C^{14} = -26 \pm 11\%$. *Comment*: evidently intrusive.

Ex-265. Coral Snake 207**1650 ± 90****A.D. 300**

From base of hemispherical fire pit in central portion of mound; coordinates N505/E496, elev 100.57. No artifacts in direct association. $\delta C^{14} = -186 \pm 9 \text{‰}$. *Comment:* in harmony with current chronological evidence of later part of Marksville time range in lower Mississippi valley (e.g., Ford, 1963, p. 46-7).

*D. Panhandle Area***Panhandle aspect series**

Charcoal samples from sites of Panhandle aspect in Canadian R valley and Palo Duro Canyon in Texas Panhandle. Most of these sites are pueblo-like villages of Plains Indians whose artifact inventory is related to complexes to the E and NE. Trade sherds from Pueblo area indicate occupation in A.D. 1300-1450. Coll. and subm. by Jack T. Hughes (except as noted), Panhandle-Plains Hist. Mus., Canyon, Texas; site nos. in parentheses are those in Museum files. In most cases samples were split and part sent to Univ. of Wisconsin Center for Climatic Research for cross-check as part of their study of historic climatology in Southern Plains.

Tx-255. Sanford ruin**700 ± 90****A.D. 1250**

From shallow midden on N side of house, in Sanford ruin (A61), now under S end of Sanford Dam on Canadian R, Hutchinson County (35° 42' N Lat, 101° 33' W Long). This was an isolated house with large round living room and smaller adjoining storage rooms. Coll. 1953. $\delta C^{14} = -83 \pm 10 \text{‰}$.

Tx-256. Spring Canyon ruin**550 ± 90****A.D. 1400**

From midden NE of large rectangular structure at Spring Canyon ruin (A41; Duffield, 1964, p. 48-71), on N side of Canadian R NW of Sanford, Hutchinson County (35° 43' N Lat, 101° 33' W Long). Coll. 1961. $\delta C^{14} = -66 \pm 11 \text{‰}$.

Tx-257. Currie ruin**830 ± 100****A.D. 1120**

From house fill in Currie ruin (A254), S side of Lake Stockton in Palo Duro Canyon, Randall County (35° 03' N Lat, 101° 46' W Long). This is an isolated house with a single rectangular room. Coll. 1956. (Same field sample as WIS-100, 670 ± 75, Wisconsin II.) $\delta C^{14} = -101 \pm 11 \text{‰}$.

Tx-258. Coetas ruin**430 ± 80****A.D. 1520**

From room floor, Coetas ruin (A611) S side Coetas Creek 2 mi E of Canadian R, Potter County (35° 30' N Lat, 101° 44' W Long). Site con-

sists of several adjoining rectangular houses (Studer, 1934). Coll. 1965. (Same field sample as WIS-95, 800 ± 75 , Wisconsin II.) $\delta C^{14} = -52 \pm 10 \text{ ‰}$.

480 \pm 80

Tx-259. Alibates ruin **A.D. 1470**

From Room 24, Alibates ruin (A45), E side Alibates Creek $1\frac{1}{2}$ mi S of Canadian R, Potter County ($35^{\circ} 34' \text{ N Lat}$, $101^{\circ} 40' \text{ W Long}$). This is large village with a variety of structures. Coll. 1939 by Ele M. Baker. (Same field sample as WIS-101, 600 ± 70 , Wisconsin II.) Date average of two measurements: $\delta C^{14} = -55 \pm 13 \text{ ‰}$, SrC_2 method and $\delta C^{14} = -61 \pm 12 \text{ ‰}$, Li_2C_2 method.

465 \pm 85

Tx-260. Palisades shelter **A.D. 1485**

From Sq. 5, 30 to 36 in. below surface, in camp debris on talus slope below Palisades shelter (A530), N side Palo Duro Canyon in Palisades Club, Randall County ($35^{\circ} 04' \text{ N Lat}$, $101^{\circ} 48' \text{ W Long}$). Coll. 1964. (Same field sample as WIS-108, 630 ± 75 and 600 ± 75 , Wisconsin II.) $\delta C^{14} = -56 \pm 10 \text{ ‰}$.

Comment on Panhandle aspect series (J.T.H.): the radiocarbon dates span the time range indicated by Puebloan sherds in these sites. Archaeological evidence suggests tentatively that larger ruins with more abundant Pueblo traits (e.g., Coetas, Alibates) are later than others, and these C^{14} determinations lend some support to this suggestion.

E. Northeastern Mexico

Cueva de la Zona de Derrumbes series, Nuevo Leon

Charcoal samples from Cueva de la Zona de Derrumbes (site NL-92, listed in Texas III as Cueva de la Zona), ca. 31 km W of Linares, Nuevo Leon, NW Mexico, on the Ejido Santa Rosa ($24^{\circ} 45' \text{ N Lat}$, $99^{\circ} 49' \text{ W Long}$). Samples are from a deposit below a gravel layer 5 ft thick, which in turn underlay a cultural deposit from which came dates previously published (Tx-144 through Tx-150, Tx-204 through Tx-209, Texas III). The earliest date, from just above the gravel, was 4840 ± 220 (Tx-150). The present samples, all from Sq. N0/W25 and S5/W25, are from a deposit 2 ft thick under the gravel, containing 3 charcoal zones, Occupation Layers 1, 2, and 3 (from top to bottom). Projectile points from this deposit are of small triangular and lanceolate forms similar to those found immediately above the gravels. Coll. 1964 and subm. by J. F. Epstein, Dept. of Anthropology, Univ. of Texas, Austin. Samples are listed in order of increasing depth.

4880 \pm 120

Tx-254. Zona de Derrumbes C20-GR-TS **2930 B.C.**

From contact of gravel with underlying deposit. $\delta C^{14} = -456 \pm 7 \text{ ‰}$.

Tx-236. Zona de Derrumbes C-21-TS-L1 **4700 ± 120**
2750 B.C.

From Occupation Layer 1. $\delta C^{14} = -443 \pm 8 \text{‰}$.

Tx-237. Zona de Derrumbes C22-TS-L2 **4755 ± 110**
2805 B.C.

From lower part of Occupation Layer 2 and fill immediately below.
 $\delta C^{14} = -448 \pm 8 \text{‰}$.

Tx-235. Zona de Derrumbes C23-TS-L3 **4950 ± 160**
3000 B.C.

From Occupation Layer 3. $\delta C^{14} = -459 \pm 11 \text{‰}$

General Comment (J.F.E.): the present series is consistent with the series reported in Texas III, and confirms archaeological evidence that no significant time interval is represented by the gravel deposit.

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UCLA RADIOCARBON DATES V*

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The measurements reported have been carried out during 1965 in the Isotope Laboratory of the Institute of Geophysics and Planetary Physics as a continuation of the UCLA date lists I through IV. Samples were analyzed as CO₂-gas at one atm in a 7.5 L proportional counter with three energy channels. Dates have been calculated on the basis of a 5568 yr half-life as was recommended by the Sixth International C¹⁴ and H³ Dating Conference, June 1965, in Pullman, Washington. The standard for the contemporary biosphere remains as 95% of the count rate of NBS oxalic acid for radiocarbon laboratories. Background determinations have been made with CO₂ obtained from marble. The error listed is always at least a one-sigma statistical counting error.

All measurements have been classified in the following way:

I. Archaeologic-Historic Dates

- A. United States
- B. Mexico
- C. South America
- D. Pacific and Far East
- E. Europe
- F. Egypt
- G. Africa

II. Geophysical, Geological-Climatological and Biological Measurements

- A. C¹⁴ in Atmospheric Carbon Dioxide
- B. Bomb C¹⁴ in Foodstuffs
- C. Bomb C¹⁴ in Human Tissues
- D. Bomb C¹⁴ in Plants
- E. Oceanic Measurements
- F. Vegetation and Climate
- G. Geological Processes

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC-HISTORIC DATES

A. United States

Panamint Valley series, California

This study is concerned with establishment of radiocarbon chronology of environmental changes in this valley since the Pleistocene and its occupancy by prehistoric man. Panamint Valley is located close to California/Nevada state line at approx. $36^{\circ} 20' N$ Lat, $117^{\circ} 20' W$ Long. Coll. and subm. by E. L. Davis, UCLA.

UCLA-989. Panamint

10,020 \pm 120
8070 B.C.

Organic material at 4 to 6 ft depth below present fan surface following curve of former lake bed. *Comment* (E.L.D.): material underlies more recent soils containing charcoal lenses and cultural waste (stone flakes) probably associated with Lake Mohave culture (Campbell, 1937).

UCLA-990. Panamint

10,520 \pm 140
8570 B.C.

Burnt reeds at approx. 14 in. below surface in Trench #2 at N end of Lake Hill. *Comment* (E.L.D.): no cultural material found in soil directly overlying sample. However it is contained in an organic rich layer probably associated stratigraphically with UCLA-989.

Santa Rosa Island, Fire Area series, California

In ca. 1 mi of sea cliffs on Santa Rosa Island, there are approx. 100 fire areas exposed in Tecolote member of Santa Rosa Island formation (Orr, 1960), which are uniform in structure of 2 types.

1. A "U"-shaped pit, ca. 2 ft in diam and depth
2. A saucer-shaped area 6 to 8 ft in diam

Both of these indicate very hot fires for a long time in a confined space which burned the clay a brick red. Many of the fire areas contain charred dwarf mammoth or bird bones. It has been suggested that these fire areas may be the work of Pleistocene man (Orr, 1956a).

Dates for similar areas are L-290-R at $29,700 \pm 3000$ and L-290-T at $12,500 \pm 500$ (Lamont IV); M-599 at $16,700 \pm 1500$ (Michigan III); UCLA-106 at $11,800 \pm 800$ (UCLA I).

The following dates are part of an extensive investigation into the possible presence of Pleistocene man on Santa Rosa which will be discussed in greater detail elsewhere. Coll. and subm. by P. C. Orr, Santa Barbara Mus. of Nat. History, California, and R. Berger, UCLA.

UCLA-748. Santa Rosa Island

11,300 \pm 160
9350 B.C.

Black muck and charcoal chunks from center of fire area, 22 in. thick at center and overlaid by bright brick red burned earth from Arlington Springs site #131.173 (Santa Barbara Mus. of Nat. History),

Santa Rosa Island ($34^{\circ} 00' \text{ N Lat}$, $120^{\circ} 10' \text{ W Long}$). At depth of 10 ft in mammoth-bearing Tecolote member of Santa Rosa Island formation, slightly deeper, stratigraphically, than human bone (L-650 at $10,000 \pm 200$, Lamont VII; Orr, 1962a, 1962b) and ca. 10 ft below M-1133 (7350 ± 350 , Michigan VII).

UCLA-746. Santa Rosa Island

$27,000 \pm 800$

25,050 B.C.

Charcoal from typical "U"-shaped fire area, ca. 2 ft in diam and 9 ft below surface in upper Tecolote member of Santa Rosa Island formation at Otter Point, Santa Rosa Island ($34^{\circ} 20' 00'' \text{ N Lat}$, $120^{\circ} 12' 08'' \text{ W Long}$). Fire lies ca. 100 yd W of similar fire area dated at $16,700 \pm 1500$ B.P. (M-599, Michigan III) at depth of 6 ft and both dates indicate slow rate of deposition on head of Garanon alluvial fan at a time when sea-level was -45 to -50 fathoms (Fairbridge, 1960; Curry, 1960) and the shoreline between 4.7 and 5.2 nautical mi from present.

UCLA-749. Santa Rosa Island

$>37,000$

Rich charcoal from elipitical fire area ca. 3 ft in diam at depth of 80 ft in Tecolote member of Santa Rosa Island formation E of Arlington Canyon, Santa Rosa Island ($34^{\circ} 25' 00'' \text{ N Lat}$, $120^{\circ} 10' 30'' \text{ W Long}$).

UCLA-732. Santa Cruz Island, California

220 ± 80

A.D. 1730

Charcoal from depth of 4 ft in Canalino Indian midden in Cueva Escondito, Santa Cruz Island (34° N Lat , $119^{\circ} \text{ W Long}$). Coll. and subm. by P. C. Orr. Associated with shell, bird bones, sticks and well-preserved feathers of cormorant *Phalacrocorax penicillatus* (id. by Mrs. Roxie C. Laybourne, U. S. Div. of Wildlife Research). Preservation of these feathers is remarkable for a semi-sea cave; quantity of feathers suggests cave was used as "poultry market" rather than habitation site.

UCLA-745. Santa Rosa Island, California

750 ± 80

A.D. 1200

Black organic muck from humus layer, 30 in. below surface exposed in 24 ft cut bank of Canada Verde, Santa Rosa Island ($34^{\circ} 00' 15'' \text{ N Lat}$, $120^{\circ} 06' 25'' \text{ W Long}$). Date represents period of moist humus producing conditions near terminus of deposition period which began as valley fill ca. 10,000 B.P. (see L-290-C at 9050 ± 600 , Lamont IV; UCLA-662 at 7600 ± 400 , UCLA IV; Orr, 1966).

Southern California archaeological sites

This suit of dates will permit coordination of a number of site remains for which there are at present only guess dates, particularly for those locations within past 2000 yr which are at present more poorly dated than older sites and hence more difficult to fit into general culture history of southern California. Subm. by C. W. Mcighan, UCLA.

All shell samples have been measured based on shell carbonate. For conditions of southern California coast, correction of $-2 \pm 1\%$ equivalent to 160 yr has been applied, to bring apparent age of shell carbonate dates into line with other biospheric dates (see section on Oceanic Measurements, this list). A more detailed evaluation of the following dates will appear elsewhere in the future.

Malibu, Los Angeles County, series

Malibu site is one of the deepest containing cultural material in southern California, surpassed only by Malaga Cove site. Unlike Malaga Cove site, Malibu ($34^\circ 2' \text{ N Lat}$, $118^\circ 40' 30'' \text{ W Long}$) was excavated under controlled conditions. Coll. by C. King, UCLA.

UCLA-918A. Malibu **970 \pm 80**
A.D. 980

Mytilus californianus shells from 42 in. depth of Area II.

UCLA-918. Malibu **2120 \pm 80**
170 B.C.

Mytilus californianus shells from 65 in. depth of Area II.

UCLA-918C. Malibu **2510 \pm 80**
560 B.C.

Mytilus californianus shells from 120 in. dept of Area II.

UCLA-918E. Malibu **2715 \pm 80**
765 B.C.

Mytilus californianus shells from 180 in. depth of Area II.

UCLA-918F. Malibu **6310 \pm 100**
4360 B.C.

Mytilus californianus shells from 0 to 6 in. depth of Area III, Pit II.

UCLA-918G. Malibu **6870 \pm 100**
4920 B.C.

Hinnites giganterum shells from 18 in. depth of Area III, Pit 6.

General Comment: UCLA-918A through E fall into estimated age range according to analysis of artifacts. UCLA-918F and G are from approx. 1300-2000 yr earlier than anticipated.

UCLA-919A. Deer Canyon, Ventura County, **1770 \pm 80**
California **A.D. 180**

Mytilus californianus shells from coastal shell midden Ven-7 ($34^\circ 04' \text{ N Lat}$, $118^\circ 59' \text{ W Long}$), Pit F-28, 48 to 54 in., N wall, 5 in. from E wall. Associated with Canalino or Late Horizon sites in Ventura County. Coll. by E. Gerow and P. Best, UCLA.

UCLA-920. Paradise Cove, Los Angeles **4300 \pm 80**
County, California **2350 B.C.**

Haliotis cracherodii shell from Site LAn-222 at a sea terrace 100 ft above sealevel containing several burial areas on W side of Ramera

Canyon (34° 01' 15" N Lat, 118° 47' W Long), Pits 1 and 2, Trenches A and Z, 27 in. below surface. Coll. by J. Smith, UCLA.

UCLA-922A. Little Sycamore Canyon, Ventura County, California **2610 ± 80**
660 B.C.

Tivela stultorum shell from Site Ven-1 at mouth of canyon (34° 3' 30" N Lat, 118° 57' 30" W Long). From Pit B-3, 6 to 12 in. of shell midden deposit. Coll. by W. Wallace, Univ. of Hawaii.

UCLA-922B. Little Sycamore Canyon, Ventura County, California **6960 ± 100**
5010 B.C.

Halotis cracherodii from same site as 922A. *Comment:* greatly different ages of UCLA-922A and B suggest occupation of site at different times.

UCLA-926. Big Tujunga, Los Angeles County, California **1515 ± 80**
A.D. 435

Charcoal from confluence of Big and Little Tujunga Washes in San Fernando Valley (34° 17' N Lat, 118° 22' W Long). From lowest cultural stratum, 36 to 38 in. below surface of LAn-167. Coll. by J. Ruby and G. Kritzman, Univ. of California, Santa Barbara.

Bone Collagen Dating series

In order to illuminate the problem of contamination of bones with soil organics of different radiocarbon age, several Indian bones were obtained from highly disturbed site at Malaga Cove, Palos Verdes, California (33° 49' N Lat, 118° 23' W Long) through courtesy of M. Reiter, Los Angeles Harbor College.

Collagen was isolated by method of Berger, Horney, and Libby (1964). Half of this collagen was analyzed without subsequent treatment as UCLA-1008A. The other portion was treated overnight with 0.1 N NaOH at room temperature to remove alkali-soluble contaminants like humic acids. After filtration on Büchner funnel and repeated washing with distilled water, sample was measured as UCLA-1008B. Resulting age discrepancy again stresses need for pretreatments as discussed by Olson and Broecker, 1958, and used routinely in this lab.

UCLA-1008A. Untreated collagen **215 ± 80**
A.D. 1735

UCLA-1008B. NaOH-treated collagen **1790 ± 160**
A.D. 160

UCLA-1010. Cave Painting, California **< 100 yr**

Charcoal associated with Indian cave painting from painted cave in Ventura County discovered in 1964 by Stanford Univ. geology crew. Apparently cave had not been visited by whites before since an excellent steatite bowl was still *in situ* on cave floor. Coll. and subm. by C. Grant,

Santa Barbara Mus. of Nat. History, Santa Barbara, California. *Comment* (C.G.): on basis of my studies of Chumash Indians (Grant, 1965), painting is very likely of late prehistoric or early historic date (early 1800's).

Falcon Hill Basketry series, Nevada

The following series of dates is continuation of project (see UCLA IV) to date materials from seven caves at Falcon Hill, located at N end of Winnemucca Dry Lake in Washoe County, Nevada (40° 19' 20" N Lat, 119° 20' 40" W Long). More detailed analysis of significance of following dates will be published in a monograph by Nevada State Mus. Samples subm. by R. Shutler, Univ. of Hawaii and Charles Rozaire, Los Angeles County Mus. of Nat. History. Comments by Charles Rozaire.

UCLA-904. Falcon Hill

2175 ± 80

225 B.C.

Basketry (coiled) No. 1966 from Site Wa-198, Washoe County, Nevada, 30 to 36 in. level. *Comment*: constitutes earliest date from site.

UCLA-905. Falcon Hill

3660 ± 80

1710 B.C.

Twined basketry No. 1096-1 from Site Wa-196, Washoe County, Nevada, Burial 3, Trench A, 0 to 12 in. Coll. by D. Tuohy, Nev. State Mus., Carson City. *Comment*: dates the technique of plain, 2 element Z-twining with false embroidery and one-strand half-twist overlay decorative technique.

UCLA-906. Falcon Hill

1240 ± 80

A.D. 710

Basketry (Lovelock Wicker) from Site Wa-200, Washoe County, Nevada, No. 406, 333, 405, 397, 400, 401 and 398. Area 2, 42 to 48 in. deep. Coll. by R. Shutler. *Comment*: though found relatively deep in deposit, it constitutes latest date at site and is 160 yr later than earliest occurrence of this type of basketry in caves at Falcon Hill.

UCLA-931. Falcon Hill

3325 ± 90

1375 B.C.

Basketry fragment (close, plain 2-element S-twined basket) No. 368A from Site Wa-202, Washoe County, Nevada. From Burial No. 1, 40 in. from surface, 32.5 in. from datum plane, 43 in. SE of rear wall to datum plane. Coll. by R. Shutler. *Comment*: may be remnant of a cap. Earliest date from Site Wa-202.

UCLA-932. Falcon Hill

3745 ± 90

1795 B.C.

Matting (warp face, plain 2-element Z-twined) No. 2136 from Site Wa-196, Washoe County, Nevada. From Grotto No. 3, Sec. G, 36 in. below wire. Coll. by R. Shutler.

- 1725 \pm 120**
A.D. 225
- UCLA-933. Falcon Hill**
Basketry (close, plain 2-element Z-twined with stiff rod warp) No. 556 from Site Wa-198, Washoe County, Nevada. 11 to 13 in. along W wall, 18 to 24 in. deep. Coll. by R. Shutler.
- 3620 \pm 80**
1670 B.C.
- UCLA-976. Falcon Hill**
Basketry No. 2134, part of a cache from Site Wa-196, Washoe County, Nevada. Grotto No. 3, Sec. H, 48 in. of datum line between G & H, 63 in. to datum line along W wall. Coll. by D. Tuohy. *Comment:* finely woven Z-twined basketry fragment with decoration. Constitutes latest date for Site Wa-196.
- 4030 \pm 85**
2080 B.C.
- UCLA-978. Falcon Hill**
Fisherman's kit, 2-ply cord around a tule bag, No. 498, from Site Wa-200, Washoe County, Nevada, 12 to 18 in. deep. *Comment:* earliest date for Site Wa-200.
- 3660 \pm 100**
1710 B.C.
- UCLA-979. Falcon Hill**
Basketry fragment, No. 1096, from Site Wa-196, Washoe County, Nevada. From Trench A, Burial 3, 10.5 to 15.5 in. deep. Coll. by R. Shutler.
- 3760 \pm 80**
1810 B.C.
- UCLA-980. Falcon Hill**
Basketry fragment, No. 1069-D, from Site Wa-196, Washoe County, Nevada. From Trench A, Burial 4, 0 to 12 in. deep. Coll. by D. Tuohy. *Comment:* bottom portion of an S-twined basket.
- 6730 \pm 90**
4780 B.C.
- UCLA-981. Falcon Hill**
Grass fragments, No. 237, from Site Wa-205, Washoe County, Nevada. Cache 1, Level 2. Coll. by D. Tuohy.
- 390 \pm 80**
A.D. 1560
- UCLA-982. Falcon Hill**
Grass, No. 282A, from Site Wa-205, Washoe County, Nevada, Burial 1. Coll. by D. Tuohy. *Comment:* the latest date for caves at Falcon Hill.
- 3850 \pm 100**
1900 B.C.
- UCLA-983. Falcon Hill**
Matting fragment, No. 1513, from Site Wa-196, Washoe County, Nevada, 81 in. below datum, Burial 2. Coll. by D. Tuohy. *Comment:* earliest occurrence of twined matting at Site Wa-196.
- 3700 \pm 80**
1750 B.C.
- UCLA-984. Falcon Hill**
Basketry fragment, No. 1961, from same site as UCLA-983. Sec. F and G, 41 to 53 in. below datum No. 1. Coll. by D. Tuohy.

UCLA-985. Falcon Hill**400 ± 80****A.D. 1550**

Cache bag (outer), No. 210, from Site Wa-205, Washoe County, Nevada, 13 in. below surface. Coll. by D. Tuohy. *Comment:* the latest date for a twined bag in caves at Falcon Hill.

UCLA-986. Falcon Hill**595 ± 80****A.D. 1395**

Tule matting fragment, No. 54, from Site Wa-198, Washoe County, Nevada. From rope cache, 20 in. deep. Coll. by B. Shutler. *Comment:* the latest date for twined Tule matting in caves at Falcon Hill. It is latest date for Site Wa-198.

*B. Mexico***La Venta series II, Tabasco**

The four charcoal samples described below were recovered by R. J. Squier during June-July, 1964, test excavations conducted at site of La Venta, Tabasco. All samples were taken from a single test pit (Pit C-1964) which was excavated in a large habitation area S of main La Venta pyramid (Complex C). Levels assignable by their ceramic materials to Early Preclassic, Middle Preclassic (La Venta), and Late Preclassic phases occurred in stratigraphic association in area in which pit was excavated. Stratigraphic sequence as revealed in test pit does not appear, however, to be uninterrupted, i.e., later subphase (s?) of Early Preclassic and earlier subphase (s?) of Middle Preclassic (La Venta) phase apparently are missing in this Pit C-1964 sequence. The missing subphase (s?) of Early Preclassic was present in another 1964 test pit (Pit B-1964) in another location at La Venta, but no evidence of beginning developments of Middle Preclassic phase has been found at La Venta to date. These statements respecting La Venta sequence are derived from preliminary laboratory analysis of materials from the 1964 season and are subject to later revision.

None of the samples described below is entirely satisfactory as to exact original provenience of charcoal being dated. No actual fire hearths or other such definitive charcoal-bearing features were found in Pit C-1964. Charcoal in each sample was picked from small scattered pieces in soil matrices. Possibility of redeposition of older charcoal-bearing soil is therefore present in each case, although this is perhaps minimal for sample 788B. No evidence of such redeposition has been detected in cultural materials recovered from any level in this test pit. Subm. by R. J. Squier, Univ. of Kansas and R. F. Heizer, Univ. of California, Berkeley.

UCLA-788B. La Venta**2650 ± 240****700 B.C.**

Wood charcoal from small burned soil zone at top of sandy clay layer in Pit C-1964, depth 210 to 214 cm below surface. Charcoal occurred as scattered small pieces embedded in burned soil. No cultural materials

occurred in burned soil lens. *Comment* (R.J.S.): stratigraphic position of sample agrees with assignment to either latest Early Preclassic or earliest Middle Preclassic activity in area sampled by Pit C-1964. Date would agree with assignment to earlier part of Middle Preclassic (La Venta) phase.

UCLA-788C. La Venta

3760 ± 80

1810 B.C.

Wood charcoal from habitation level in Pit C-1964, depth 270 to 285 cm below surface. Charcoal and sherds very abundant in this level. *Comment* (B.J.S.): brief comparison of ceramic materials from this level with materials from Tehuacan Valley, through courtesy of R. S. MacNeish, suggests this level coeval with early part of Late Ajalpan Phase of Tehuacan Valley, with expected dating of approx. 1100-1300 B.C.

UCLA-788D. La Venta

9750 ± 160

7800 B.C.

Wood charcoal from habitation level at base of Pit C-1964 deposit, depth 360 to 365 cm below surface. Sherds and charcoal very abundant in this level. *Comment* (R.J.S.): preliminary study of ceramic materials from this level show some differences from materials in level of sample 788C. Date expected, approx. 1300-1500 B.C. Charcoal probably from *in situ* or redeposited soil into which Early Preclassic cultural materials intruded, perhaps by trampling.

UCLA-1012. Tequilita, Nayarit, West Mexico

1850 ± 100

A.D. 100

Conch shell trumpet, *Xancus angulatus* Solander, of Gulf of Mexico-Caribbean origin found in shaft tomb at Tequilita, Nayarit (21° 15' N Lat, 104° 35' W Long). Inner carbonate fraction was dated and no corrections were applied. Coll. and subm. by P. T. Fürst, UCLA. *Comment* (P.T.F.): date is highly significant as it pinpoints for the first time the most widespread tomb figurine style of Western Mexico popularly called "Chinesca Period." Tomb from which shell was collected in 1965 was looted 3 yr ago, but salvage excavation yielded 129 conch shell trumpets, over 100 whole or partial ceramic vessels and several figurines or fragments. Date is well within expected age range when compared with earlier radiocarbon dates (UCLA-593A-C, UCLA IV) and fits in with most recent dates from Teotihuacan. Several conches are decorated in a style closely resembling similar shells of the Teotihuacan II period, A.D. 100-250 (Teotihuacan series, UCLA IV).

UCLA-966. San Sebastian, Jalisco, West Mexico

1730 ± 80

A.D. 220

Bone collagen from left tibia of a human skeleton from last occupation period of shaft tomb No. 1, Hacienda de San Sebastian, Municipio de Etzatlan, Jalisco, Mexico (20° 40' N Lat, 104° 00' W Long). Coll. 1963 by S. Long; subm. by S. Long and R. E. Taylor, UCLA. *Comment* (S.L.): expected date of sample was between 1400-1700 yr ago according

to another C¹⁴ date (derived from shell, UCLA-593C, 1710 ± 100 , UCLA IV) believed to be coeval with this sample. Both UCLA-593-C and UCLA-966 appear to date last period of San Sebastian tomb occupation and last part of tomb complex found in Magdalena Lake basin.

840 \pm 80

UCLA-1017. Las Cuevas, Jalisco, West Mexico A.D. 1110

Charcoal from Pit #9, 60 to 80 cm from Las Cuevas, Municipio de Etzatlán, Palisco, Mexico ($20^{\circ} 40' N$ Lat, $104^{\circ} 00' W$ Long). Coll. 1963 by M. Glassow, UCLA; subm. by S. Long and R. E. Taylor. *Comment* (S.L.): expected age of sample was between 750-1050 yr. Sample dates upper portion of next to last pre-conquest cultural period in Magdalena Lake Basin.

C. South America

Peruvian Archaeological series

All samples in series were collected at dry sites in Peruvian coastal desert to provide determinations for critical points in absolute chronology of area. Subm. by J. H. Rowe, Univ. of California, Berkeley.

4720 \pm 80

UCLA-967. Ancón, Encanto camp site

2770 B.C.

Tillandsia charcoal from Site PV45-25, camp site on Loma Encanto, on E side of Pampa del Canario, N of Ancón, central coast of Peru ($11^{\circ} 44' S$ Lat, $77^{\circ} 7' W$ Long). From a deposit consisting of ash-stained sand containing abundant charcoal and sea shells, some broken and burnt stones, and a few stone chips. Depth of deposit ca. 25 cm. Sample taken from a 2 x 2 m test pit at depth of 5 to 25 cm. Coll. Nov. 1961 by Edward P. Lanning. *Comment* (J.H.R.): sample should date Encanto complex, briefly preceding establishment of cotton using preceramic villages near shore. Date could be an acceptable age for an Encanto associated complex.

4200 \pm 80

UCLA-968. Ancón, Tank site

2250 B.C.

Wood charcoal from Tank site, PV45-2, on slope S of Ancón, central coast of Peru ($11^{\circ} 47' S$ Lat, $77^{\circ} 11' W$ Long). Taken from deepest level of a trench on W side of site and associated with occupation refuse of final preceramic culture at Ancón, characterized by twined cotton textiles, straight-shanked shell fish hooks, and large percussion flaked projectile points. Coll. May 1962 by Jorge C. Muelle. *Comment* (J.H.R.): sample should briefly antedate introduction of ceramics on central coast of Peru. Date is 200-400 yr earlier than expected.

3050 \pm 80

UCLA-969. Ica, Erizo site

1100 B.C.

Wood charcoal from Erizo site, PV62-191, Hacienda Collango, Ica Valley, S coast of Peru ($14^{\circ} 26' 45'' S$ Lat, $75^{\circ} 39' 40'' W$ Long). Site consists of occupation refuse on a desert terrace on W bank of Ica River; it

has been severely eroded by wind. Sample is from pocket of undisturbed refuse representing earliest occupation of site and was associated with distinctive pottery, cotton textiles, a stone adze, and abundant vegetable remains but no maize. Taken from area less than 2 m across and from depth of 5 to 30 cm. Coll. Aug 1963 by J. H. Rowe and J. J. Lyon. *Comment* (J.H.R.): sample should date near beginning of Initial Period (i.e., shortly after introduction of pottery at Ica). Geochron Labs., Inc., has made two measurements on samples from same association: GX-0185, 3890 ± 90 ; GX-0186, 3820 ± 85 , (Geochron I). These measurements are consistent with other recent radiocarbon results from Peruvian coast but substantially earlier than UCLA-153, 2960 ± 90 , (UCLA II), which, on archaeological grounds, should be nearly contemporary with Erizo occupation.

1590 \pm 80

UCLA-970. Ica, Peña de Ocucaje cemetery **A.D. 360**

Slender branch of wood from small cemetery site near Site PV62-38 on Peña de Ocucaje, Ica Valley, S coast of Peru ($14^{\circ} 20' S$ Lat, $75^{\circ} 41' 30'' W$ Long). Sample was part of roofing material of buried tomb (Rubini Collection, Burial 27) which contained pottery of Ocucaje Phase 10. Surface of sample may be contaminated by newspaper storage. Coll. April 1956 by Aldo Rubini. *Comment* (J.H.R.): sample should date to last epoch of Early Horizon and should be about a century older than the following sample. Expected age, about 2300 yr.

1790 \pm 80

UCLA-971. Ica, Peña de Ocucaje **A.D. 160**
habitation site

Animal or human dung from Site PV62-38, Peña de Ocucaje, Ica Valley, S coast of Peru ($14^{\circ} 22' S$ Lat, $75^{\circ} 41' 30'' W$ Long). Taken from Cut 1, Level 2, which consisted of sandy refuse with abundant vegetable matter and pottery exclusively of Nasca Phase I. Coll. Feb 1960 by L. E. Dawson. *Comment* (J.H.R.): sample should date to about middle of first epoch of Early Intermediate Period and should be about a century more recent than preceding sample. Expected age, about 2300 yr.

880 \pm 80

UCLA-972. Ica, Pampa de las Animas **A.D. 1070**
Alta site

Animal or human dung from Site PV62-153, Pampa de las Animas Alta, Hacienda Callango, Ica Valley, S coast of Peru ($14^{\circ} 30' S$ Lat, $75^{\circ} 37' 30'' W$ Long). From depth of 5 to 20 cm in shallow deposit of refuse on low sandy rise in alluvial plains of Callango Basin. Refuse deposit contains pottery exclusively of Nasca Phase 9. Coll. 1959 by L. E. Dawson. *Comment* (J.H.R.): sample should date to first epoch of Middle Horizon. Univ. of Pennsylvania lab. has made a measurement on a sample dating to this epoch: P-511, 1345 ± 118 . This measurement is consistent with other recent radiocarbon results from Peruvian coast and present sample should be of about same age.

General Comment (R. Berger): a recent discussion of Peruvian chronologies by Mason (1964) includes the following sequences by J. H. Rowe to which are here compared the present UCLA measurements. Radio-carbon measurements by different laboratories and this chronology, with the addition of the most recent Colonial Period, have also been discussed by Rowe (1965).

Period	Duration	UCLA	Date
Late Horizon	A.D. 1476-1534		
Late Intermediate Period	A.D. 1100-1476		
Middle Horizon	A.D. 800-1100	972	A.D. 1070
Early Intermediate Period	A.D. 150-800	971	A.D. 160
Early Horizon	700 B.C.-A.D. 150	970	A.D. 360
Initial Period	1400 - 700 B.C.	969	1100 B.C.
		968	2250 B.C.
		967	2770 B.C.

1650 ± 120

UCLA-754. Brazilia

A.D. 300

Charcoal from a 1 to 2 m deep trench under a well-developed "cer-rado" (clump of stunted trees on cattle grazing land) at a location in Brazilia (16° S Lat, 48° W Long). Part of an investigation into the possibility of man-made brush fires set by ancient Indians. Coll. by C. T. Rizzini, Botanical Garden, Rio de Janeiro; subm. by J. Reynolds, Univ. of California, Berkeley.

D. Pacific and Far East

Palawan/Sarawak series

This suit of dates is designed to elucidate the temporal relationships of different cultures of man in the Pacific. A recent discussion is that by Shutler (1965) and a forthcoming paper by R. B. Fox. Previous measurements are found in UCLA III. Samples coll. by R. B. Fox, Nat. Mus., Manila, Philippines; subm. by R. B. Fox and Richard Shutler, Jr.

4070 ± 100

UCLA-698. Guri cave, Palawan

2120 B.C.

Nevita shells from Guri Cave, Lipuun Point, Quezon, Palawan, Philippines (9° 20' N Lat, 117° 45' E Long). Square 13-B, depth 60 to 70 cm below stratum. Nat. Mus. catalog 1962-P-791. Uncorrected carbonate date. *Comment* (R.S.): brings the Tabonian flake-tool tradition into coexistence with polished stone tools and as persisting later than a small-flake-and-blade industry. Sample dated later in time than expected. Only non-charcoal sample from Tabon caves so far.

23,200 ± 1000

UCLA-699. Tabon cave, Palawan

21,250 B.C.

Charcoal from Tabon cave, Palawan, Philippines (9° 20' N Lat, 117° 45' E Long). Square 26-d, depth 139 to 149 cm. Nat. Mus. catalog 1962-I-9745. *Comment* (R.S.): flake-tool industry III. Flake tools, ham-

mer stones, a few basalt choppers; soft bones of bats, birds and small mammals; charcoal and fossil human bones in a thick uneven occupation zone.

UCLA-957. Niah cave, Sarawak

37,500 \pm 1600

35,550 B.C.

Oysters (*Oyster gigas*) from the great Niah Cave, Sarawak, Gan Kiva (3° 58' N Lat, 113° 45' E Long), Y 1 x 5, 6 to 12 in. *Comment* (R.S.): dates highest ocean level at Niah in late Pleistocene, and confirms the >40,000 yr age of *Homo sapiens* skull, as shell layer stops just above skull. Oyster shell is used extensively in the cave for tools.

UCLA-958. Tabon cave, Palawan

30,500 \pm 1100

28,550 B.C.

Charcoal from Tabon cave, Palawan, Philippines (9° 20' N Lat, 117° 45' E Long). Square 21-N, L, R-28 cm, In-Out 27 cm, depth from surface 121 cm. *Comment* (R.S.): flake-tool industry IV, the earliest evidence of man so far discovered in Palawan and the oldest radiocarbon date so far in the Philippines.

UCLA-992A. Manunggul cave, Palawan

2840 \pm 80

890 B.C.

Charcoal from Manunggul cave, Quezon, Palawan, Philippines (9° 20' N Lat, 117° 45' E Long), from Chamber A, subsurface. Nat. Mus. catalogue 1964-M-86. Associated with Early Iron-age with Sa-Huy'nh funerary pottery.

UCLA-922B. Manunggul cave, Palawan

2660 \pm 80

710 B.C.

Charcoal from same location as UCLA-992A. Nat. Mus. catalog 1964-M-48, 49, 57. Should be similar age as above.

UCLA-992C. Manunggul cave, Palawan

2140 \pm 100

190 B.C.

Charcoal from same cave, but Chamber B, surface and sub-surface. Nat. Mus. catalog 1964-M-136, 137. Associated with jar burial assemblage with iron.

UCLA-994. Duyong cave, Palawan

5680 \pm 80

3730 B.C.

Charcoal from Duyong cave, Iwaig, Palawan, Philippines (9° 20' N Lat, 118° 5' E Long). Square II, depth 30 cm. Associated with jar burial assemblage with pottery of Sa-Huy'nh tradition.

UCLA-965 Chinese statue

110 \pm 80

A.D. 1840

Sandalwood statue of a Chinese deity whose origin was believed to be much older. Coll. and subm. by S. Chang, 207 E. 7th St., Los Angeles, California.

E. Europe

UCLA-930. Banolas mandible **17,600 ± 1000**
15,650 B.C.

Travertine surrounding Banolas mandible, suspected to be from Neanderthal man found 1887 near Gerona, Spain. Carbonate-based date. Subtracted 2400 yr for correction (UCLA III). Obtained through M. Fusté, Univ. of Barcelona, Spain, and K. P. Oakley, British Mus., London; subm. by K. P. Oakley and J. D. Clark, Univ. of California, Berkeley. *Comment:* for a Neanderthal, present date is too recent. The possibility of more modern travertine contaminating older travertine to yield a more recent composite date, or the relocation of an ancient mandible into travertine is open.

UCLA-959. Painting **Modern**

Wood and canvas from painting believed to be by Antonio Correggio, 1489-1534. Coll. and subm. by R. DeGrasse, Glendale College, Los Angeles, California.

European Medieval Architecture series

Dates listed below are a continuation of investigation into Aisled Medieval Timber Hall (UCLA III and IV). Oakwood samples coll. and subm. by Walter Horn, Univ. of California, Berkeley and R. Berger. The Frocester and Middle Littleton barns are discussed in detail in Horn, Charles and Berger (1966); Beaulieu St. Leonard by Horn and Born (1965). Frocester barn is located 5 mi W of city of Stroud (51° 44' N Lat, 2° 19' W Long); Middle Littleton, NW of Evesham, Worcestershire (52° 10' N Lat, 1° 50' W Long); Leicester Hall, Leicester, Leicestershire (52° 34' N Lat, 1° 7' W Long). Beaulieu St. Leonard, SW of Portsmouth (50° 40' N Lat, 1° 28' W Long).

UCLA-950. Frocester **485 ± 80**
A.D. 1465
Truss 2, collar beam, waney edge.

UCLA-951. Frocester **660 ± 80**
A.D. 1290
Cruck blade, Truss 5.

UCLA-952. Frocester **Modern**
Waney edge from beam, Truss 5.

UCLA-1001. Frocester **450 ± 60**
A.D. 1500
Bark from Truss 12, N blade.

UCLA-1002. Frocester **320 ± 80**
A.D. 1630
Sapwood/hardwood from S blade, Truss 5.

UCLA-1003. Frocester	270 ± 80 A.D. 1680
Sapwood near heartwood from principal collar beam, Truss 5.	
UCLA-953. Middle Littleton	730 ± 80 A.D. 1220
N post of Truss 2, waney edge.	
UCLA-954. Middle Littleton	785 ± 80 A.D. 1165
Wedge of first W cruck truss, N blade, waney edge.	
UCLA-1004. Middle Littleton	600 ± 80 A.D. 1350
Sapwood from N post, Truss 11. Probably contaminated.	
UCLA-1005. Middle Littleton	935 ± 60 A.D. 1015
Heartwood from N post, Truss 11.	
UCLA-1006. Middle Littleton	Modern
Sapwood from N blade, Truss 3, above wedge.	
UCLA-941. Leicester	1245 ± 80 A.D. 705
Norman capital on landing close to center of tree.	
UCLA-942. Leicester	1185 ± 80 A.D. 765
Post f', Truss F, aisle face, S edge.	
UCLA-943. Leicester	640 ± 80 A.D. 1310
Longitudinal brace from post e' to roof plate, between post e' and d'.	
UCLA-944. Leicester	505 ± 80 A.D. 1445
Truss E, trans. brace from post e' to tie beam upper fare of brace connecting post e'.	
UCLA-945. Leicester	595 ± 80 A.D. 1355
Roofplate between Truss D and E S of post e', nave side.	
UCLA-946. Leicester	285 ± 80 A.D. 1665
Roofplate between posts f and g, W range.	
UCLA-947. Leicester	410 ± 80 A.D. 1540
Tiebeam, Truss B, waney edge.	

530 \pm 80

UCLA-948. Leicester **A.D. 1420**
 Elbow brace from tiebeam of Truss E to E principal rafter over Truss E.

605 \pm 80

UCLA-949. Leicester **A.D. 1345**
 Lower purlin, W side, between post C and c.

100 \pm 60

UCLA-1014. Beaulieu St. Leonard **A.D. 1850**
 Lintle over wagon doors, sapwood.

155 \pm 60

UCLA-1015. Beaulieu St. Leonard **A.D. 1795**
 Lintle over wagon doors, bark, same beam as UCLA-1014. *Comment* (R.B.): bark of oak trees has growth increments analogous to, but not like, tree rings. This particular bark has ca. 40 and more growth increments which become indistinguishable near outside of bark.

220 \pm 80

UCLA-1016. Beaulieu St. Leonard **A.D. 1730**
 Lintle over wagon doors, heartwood, same beam as UCLA-1014.
General Comment (W.H.): results of UCLA-1014, 1015, and 1016 are expected. Beam has appearance of belonging to wall plate system of original 13th century barn of Beaulieu St. Leonard. It is archaeologically difficult to understand how a beam of these large dimensions and scantlings suitable for a very large building should have been made so recently and be incorporated into a much smaller late medieval restoration of a portion of the original barn.

F. Egypt

4120 \pm 80

UCLA-928. V Dynasty Linen **2170 B.C.**
 Check sample to test accuracy of radiocarbon dates. V Dynasty linen from W cemetery at Giza, excavated in 1932 in Pit B of G 2220. Burial was intact and linen is part of padding of well-preserved woman's body, wrapped to simulate her dress and form. It lay in a large wooden coffin, also well-preserved and unopened since burial. Tomb is published in G. A. Reisner (1942). Obtained through courtesy of W. S. Smith, Mus. of Fine Arts, Boston, Mass. Subm. by R. Berger. *Comment* (R.B.): linen is dated by Reisner's experience of the development of building methods and structural types as well as the topography of the cemetery (Smith, 1965, pers. commun.) and not by actual inscriptions. Therefore its historical age has some margin. If the new half-life of 5730 yr is used, linen dates from 4250 ± 80 yr or 2300 B.C. According to Hayes chronology (1962), the V Dynasty lasted from 2350-2500 B.C.

G. Africa

The following three series on man in prehistoric Africa are a continuation of measurements reported in earlier date lists such as Groningen V, Lamont V, UCLA III and IV. Later Pleistocene cultures of Africa have been discussed recently by Clark (1965). Samples subm. by J. D. Clark.

Travertine series

Samples come from South Africa, Northern Rhodesia, and Angola. All are Upper Pleistocene age and confirm wide extent of cooler and wetter climatic conditions in S. Africa equating with later part of Würm/Wisconsin Glaciation. "Middle Stone Age" cultural material is directly associated with first two samples. Travertine samples have been age-corrected, as stated in UCLA IV.

UCLA-706. Witkranz cave, Taungs, Cape Province, South Africa **33,150 ± 2500**
31,200 B.C.

Travertine associated with lower breccia. Cave was partly excavated by the late Dr. F. E. Peabody in 1951 and contains a late Upper Pleistocene fauna and a Petersburg-type occurrence, a flake of which is still embedded in the specimen (Specimen No. 38/I. 5.119). Estimated age 35-20,000 yr. Coll. by F. E. Peabody.

UCLA-707. Twin Rivers cave, Lusaka, Northern Rhodesia **>33,200**

Travertine from middle of main breccia section. A good "Middle Stone age industry" is associated with the previously dated sample (UCLA-229, UCLA III) but only a sparse, indeterminate industry occurs in the cave or sink-hole. Coll. by C. K. Brain.

UCLA-708A. Huila Plateau limestones, Sa Da Bandeira district, SW Angola **>34,000**

Leba 2 cave; travertine from approx. 5 ft below top of red breccia and interbedded with it. Breccia is sealed by travertine sheet represented by sample UCLA-708B below. Associated with Upper Pleistocene fauna but no industry. Coll. by J. D. Clark.

UCLA-708B. Huila Plateau limestones, Sa Da Bandeira district, SW Angola **30,800 ± 1700**
28,850 B.C.

Leba 2 cave; travertine sheet sealing red breccia believed to be of Upper Pleistocene age. Coll. by J. D. Clark.

UCLA-708C. Huila Plateau limestones, Sa Da Bandeira district, SW Angola **29,800 ± 1650**
27,850 B.C.

Leba 3 Fissure; travertine and grey/cream breccia incorporating fossil bone. Grey/cream breccia was believed to be of lower Pleistocene age

on identification of fossil fauna, but evidently is also Upper Pleistocene. It is important to confirm this for this site. Coll. by J. D. Clark.

**UCLA-708D. Huila Plateau limestones, Sa Da
Bandeira district, SW Angola >34,000**

Cangalonge 3 breccia filled fissures; travertine interbedded with red-brown breccia containing much fauna of Upper Pleistocene age. Sample from upper levels at S end of exposure. Coll. by J. D. Clark.

Northern Rhodesia series

Fossil bone associated with Stone age occupation sites in Middle Zambezi (Gwembe) Valley. Carbonate-dates were unavoidable due to lack of collagen.

**UCLA-720. Siachingola Village area 2520 ± 80
570 B.C.**

Bone from top levels of buff alluvium associated with late Magosian industry. Coll. 1957 by J. D. Clark. *Comment* (J.D.C.): date is later than expected if artifacts are Magosian.

**UCLA-722. Siasuntwe Village area 2010 ± 80
60 B.C.**

Bone from eroded midden of Later Stone age Wilton date. Coll. 1957 by J. D. Clark. *Comment* (J.D.C.): date is compatible with late Wilton age.

**UCLA-723. Kalundo mound, Kalomo 960 ± 80
A.D. 990**

Charcoal from occupation site of early Iron age Kalomo culture. From Pit I at depth of 9 ft, cut into bedrock. Estimated age of 1000 B.P. confirmed. These come from end of oldest levels of Kalomo culture yet known. Coll. by B. M. Fagan.

South West Africa series

Associated with foundations of windbreaks and bedding places and with perishable cultural material of Late Erongo culture, preserved by dry climatic conditions. Culture is believed to be identifiable with BergDama negroids.

**UCLA-724A. Great Elephant Shelter, Erongo 2550 ± 80
Mountains 600 B.C.**

Charcoal from depth of 3 to 6 in. Estimated age 2 to 300 yr but might be older. Coll. by R. MacCalman.

**UCLA-724B. Great Elephant Shelter, Erongo 1400 ± 80
Mountains A.D. 550**

Charcoal from depth of 6 to 9 in. Estimated age as above. Coll. by R. MacCalman. *Comment* (J.D.C.): both dates older than expected.

West African series

A number of first radiocarbon dates of post-medieval and medieval towns for West Africa. Subm. by R. A. Mauny, Sorbonne, Paris.

455 ± 80

UCLA-695A. Tondi Koiré **A.D. 1495**

Charcoal from post-medieval ruins of site occupied by Songai rulers before fall of their empire to Moroccans in 1591. Tondi Koiré, République du Niger (13° N Lat, 1° 10' E Long). Coll. by M. Toucet, IFAN, Niamey, Nigeria.

395 ± 80

UCLA-695B. Tondi Koiré **A.D. 1555**

Charcoal from same site as UCLA-695B.

1150 ± 80

UCLA-696. Tegdaoust **A.D. 800**

Charcoal from medieval ruins of Tegdaoust, République Islamique de Mauritanie (17° 25' N Lat, 10° 20' W Long). *Comment* (R.A.M.): Tegdaoust first mentioned A.D. 905. It was very prosperous Saharan oasis during all of 10th century. Town was destroyed in 1054 by Almoravids. Date is somewhat earlier than expected for Tegdaoust's most flourishing period.

II. GEOPHYSICAL, GEOLOGICAL-CLIMATOLOGICAL AND BIOLOGICAL MEASUREMENTS

A. C¹⁴ in Atmospheric Carbon Dioxide

Atmospheric Radiocarbon Activity series, California

This series is a continuation of data published in UCLA IV. The C¹⁴ content in ground level atmospheric CO₂ is monitored monthly at China Lake, California (35° 37' N Lat, 117° 41' W Long). Samples are collected with the cooperation of Gilbert Plain, Acting Head, Research Dept. Naval Ordnance Test Station, China Lake, California.

The following list contains exposure times of the NaOH solutions to air and the percent increase of C¹⁴ above the reference level of 1890 or 0.95 NBS oxalic acid. Data are graphed in Fig. 1.

UCLA-494.	28 Nov. - 5 Dec. 1964	+78.8
UCLA-495.	26 Dec. - 2 Jan. 1965	+80.2
UCLA-496.	30 Jan. - 6 Feb. 1965	+73.7
UCLA-497.	27 Feb. - 6 Mar. 1965	+90.6
UCLA-499.	26 Mar. - 3 April 1965	+75.2
UCLA-1101.	29 April - 6 May 1965	+77.4
UCLA-1103.	29 May - 5 June 1965	+77.8
UCLA-1106.	26 June - 3 July 1965	+80.1
UCLA-1114.	31 July - 7 Aug. 1965	+75.2

UCLA-1119.	2 Sept. - 9 Sept. 1965	+75.9
UCLA-1122.	1 Oct. - 8 Oct. 1965	+76.1
UCLA-1126.	30 Oct. - 6 Nov. 1965	+72.7
UCLA-1127.	27 Nov. - 4 Dec. 1965	+69.2

The unusually high value of UCLA-497 for the collection period 27 Feb.-6 March 1965 may be coupled to a period of strong northerly winds originating in the general area of Alaska (65° N) as can be seen from meteorological charts for the 500 and 700 mb pressure level. Proof of this relation must await additional analyses.

B. Bomb C^{14} in Foodstuffs

Wheat Bread series

Regular white bread was obtained and analyzed for its radiocarbon content, which is expressed as the percent increase over the reference level of 1890 or 0.95 NBS oxalic acid.

UCLA-498.	Los Angeles, Calif	April 1965	+96.7
UCLA-1102.	Los Angeles, Calif.	May 1965	+86.4
UCLA-1108.	Los Angeles, Calif.	July 1965	+94.1
UCLA-1109.	Melbourne, Australia	July 1965	+59.4
UCLA-1115.	Bogota, Colombia	Aug. 1965	+60.7

Beef

UCLA-500.	Los Angeles, Calif.	April 1965	+70.5
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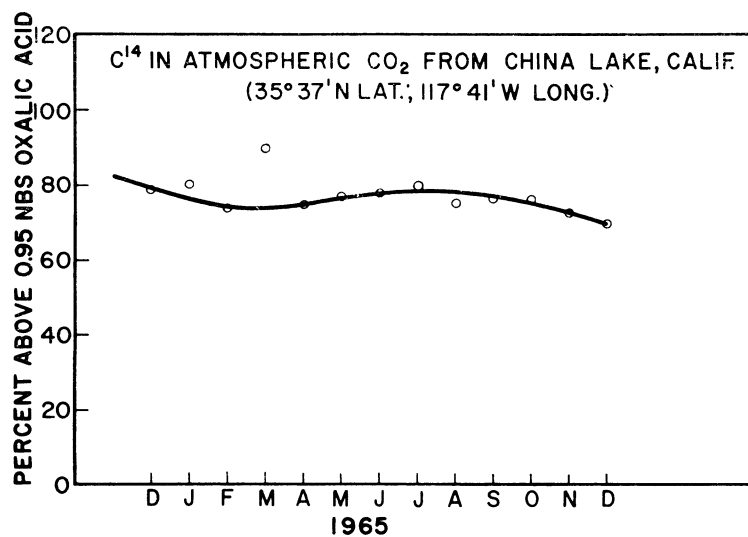


Fig. 1. C^{14} enrichment over NBS standard of atmospheric CO_2 during 1965 at China Lake, California.

C. Bomb C¹⁴ in Human Tissues

This is a continuation of measurements reported in UCLA IV. The radiocarbon activity is expressed as percent increase over the 1890 level or 0.95 NBS oxalic acid, Samples subm. with the cooperation of J. F. Mead and G. V. Alexander, UCLA; D. Chamnirokasant and G. Ciliv, IAEC-fellows.

UCLA-828. Blood plasma protein +55.6

From healthy young Australian, 30 days in N hemisphere. Coll. Dec. 1964.

UCLA-829. Erythrocyte protein +34.6

Same blood as UCLA-828.

UCLA-830. Blood plasma protein +45.6

From healthy young S. African, 14 days in N hemisphere. Coll. Dec. 1964.

UCLA-831. Erythrocyte protein +33.7

Same blood as UCLA-830.

UCLA-832. Cranial hair +45.2

From 24 yr old healthy Thai, Bangkok-Los Angeles, May 1965. Coll. by D. Chamnirokasant.

UCLA-833. Cranial hair +41.0

From 78 yr old Australian (Melbourne) with myocardial failure, April 1965. Coll. by S. E. Freeman, Univ. of Melbourne.

UCLA-834. Cranial hair +32.8

From 71 yr old Australian (Melbourne) with coronary occlusion, April 1965. Coll. by S. E. Freeman.

UCLA-835. Cranial hair +30.6

From healthy 29 yr old Australian (Heathcote, N.S.W.), May 1965. Coll. by M. Dingeldei.

UCLA-836. Cranial hair +47.2

From barbershop, Santiago, Chile, June 1965. Coll. by C. Maggiolo, Univ. Catolica de Chile, Santiago.

UCLA-837. Cranial hair +42.0

From healthy 26 yr old Thai, Bangkok, April 1965. Coll. by V. Jiravathana.

UCLA-838. Erythrocyte protein +83.5

Los Angeles resident, July 1965.

UCLA-839. Blood plasma protein +62.0

Same blood as UCLA-838.

UCLA-840. Myelin +37.9

From 74 yr old female, Los Angeles, Caucasian. Died 19 Aug. 1962. Coll. by J. F. Mead and D. Long, UCLA.

UCLA-841. Myelin +31.0

From 54 yr old female, Los Angeles, Negro. Died 21 Aug. 1962. Coll. by J. F. Mead and D. Long.

UCLA-842. Brain +51.7

Total brain protein from 69 yr old Melbourne, Australia female. Partial gastrectomy, carcinoma of stomach. Died 26 Sept. 1965. Coll. by W. P. Freeman, Univ. of Melbourne.

UCLA-843. Liver +56.4

Total liver protein. Same person as UCLA-842.

UCLA-844. Heart +62.9

Total heart protein. Same person as UCLA-842.

UCLA-845. Brain +63.9

Total brain protein from 62 yr old Melbourne, Australia female. Ostler's disease, cardiac failure. Died 25 Sept. 1965. Coll. by W. P. Freeman.

UCLA-846. Liver +48.5

Total liver protein. Same person as UCLA-845.

UCLA-847. Heart +51.3

Total heart protein. Same person as UCLA-845.

UCLA-825. Human DNA +34.8 ± 10.6

From healthy liver obtained fresh from autopsy, July 1964, through J. F. Ross, UCLA. Prepared by R. Staudenmayer and R. Berger according to method of Zamenhof, 1958. Yield 2.74 g per 1.2 kg of liver.

*D. Bomb C¹⁴ in Plants***UCLA-1124. Lichen +77.6**

Rock-growing lichen from Pike's Peak, Colorado area. Coll. Nov. 1965 and subm. by W. F. Libby.

*E. Oceanic Measurements***Seawater series**

A continuation of seawater C¹⁴ measurements from southern California coast (see UCLA IV). Radiocarbon activity expressed as previously.

UCLA-1111. Seawater +12.9

From Zuma Beach, Los Angeles County, California, 27 July 1965.
Coll. by R. Staudenmayer and S. Libby, UCLA.

UCLA-1112. Seawater +10.0

From Santa Monica, Los Angeles County, California, 4 Aug. 1965.
Coll. by R. Staudenmayer and S. Libby.

UCLA-1113. Seawater +8.1

From Pacific Palisades, Los Angeles County, California, 11 Aug. 1965. Coll. by R. Staudenmayer and R. Sherman, UCLA.

UCLA-1116. Seawater +8.7

From Oxnard, Ventura County, California, 17 Aug. 1965. Coll. by R. Staudenmayer and J. Libby.

UCLA-1117. Seawater +12.9

From San Clemente, San Diego County, California, 2 Sept. 1965.
Coll. by R. and H. Staudenmayer.

Mexican and Californian Marine Shells series

Application of these measurements of modern but pre-bomb marine shells to shell-based archaeological dates will be discussed elsewhere. The radiocarbon measurements are corrected for C^{13} and are numerically equal to Δ but are expressed as percent deviation from the count rate of 0.95 NBS oxalic acid, rather than as per mil. The δC^{13} (‰) measurements with reference to the Chicago PDB standard were carried out by Isotopes, Inc., Westwood, New Jersey. Shells obtained and subm. by R. E. Taylor and R. Berger, UCLA.

UCLA-913. Shell -3.08

Anadara grandis (B&S) shell from Mazatlan, Sinaloa. Coll. 1939 by Allen; subm. by G. D. Webster, Dept. of Geology, UCLA. Uncorrected δC^{14} measurement, $-3.41 \pm .56$; δC^{13} measurement, -1.7 .

UCLA-914. Shell -6.98

Tivela byronensis (Gray) shall from Kino Bay, Sonora. Coll. 1935 by H. N. Love; subm. by E. P. Chase, Nat. Hist. Mus., San Diego, California. Uncorrected δC^{14} measurement, $-7.05 \pm .59$; δC^{13} measurement, -0.4 .

UCLA-915. Shell -3.21

Ostrea fischeri (Dall) shell from Manzanillo, Colima. Coll. 1930 by H. N. Lowe; subm. by E. P. Chase. Uncorrected δC^{14} measurement, $-3.0 \pm .58$. δC^{13} measurement $+1.10$.

UCLA-917. Shell -7.06

Strombus granulatus (Swainson) shell from Carmen Island, Gulf of Calif. Coll. 1911 by P. Bartsch; subm. by J. Rosewater, Smithsonian Institution, Washington, D. C. Uncorrected δ^{14} measurement, $-6.97 \pm .60$. δ^{13} measurement, $+0.5$.

UCLA-916. Shell -4.54

Strombus granulatus (Swainson) shell from Cape San Lucas, Baja, Calif. Coll. 1932 by T. Crocker; subm. by L. G. Hertlein, Calif. Acad. of Sciences, San Francisco. Uncorrected δ^{14} measurement, $-4.65 \pm .52$. δ^{13} measurement, -0.6 .

UCLA-936. Shell -3.38

Hexaplex regius (Wood) shell from Isabel Island, Nayarit. Coll. 1938 by G. Willett; subm. by J. McLean, L.A. County Mus. Uncorrected δ^{14} measurement, $-3.46 \pm .58$. δ^{13} measurement, -0.4 .

UCLA-940. Shell -2.39

Strombus gracilior (Sowerby) shell from Banderas Bay, Jalisco. Coll. 1938 by G. Willett; subm. by J. McLean. Uncorrected δ^{14} measurement, $-2.55 \pm .58$. δ^{13} measurement, -0.8 .

UCLA-939. Shell -3.34

Anadara (Anadara) tuberculosa (Sowerby) shell from Magdalena Bay, Baja, Calif. Coll. 1938 by G. Willett; subm. by J. McLean. Uncorrected δ^{14} measurement, $-3.65 \pm .62$. δ^{13} measurement, -1.6 .

UCLA-963. Shell -2.49

Pecten (Lyropecten) subnodosus (Sowerby) shell from Cedros Island, Baja, Calif. Coll. 1939 by H. B. Allen; subm. by L. R. Saul, Dept. of Geology, UCLA. Uncorrected δ^{14} measurement, $-2.53 \pm .60$. δ^{13} measurement, -0.2 .

UCLA-938. Shell -2.56

Turritella leucostoma (Valenciennes) shell from Guatulco Bay, Oaxaca. Coll. 1938 by G. Willett; subm. by J. McLean. Uncorrected δ^{14} measurement, $-2.4 \pm .50$. δ^{13} measurement, $+0.8$.

UCLA-149. Shell -2.0 \pm .65

Mytilus californianus (Conrad) shell from Santa Cruz County, Calif. Coll. 1878 by L. G. Yates; subm. by P. C. Orr, Santa Barbara Mus. of Nat. History, California. No δ^{13} available.

UCLA-1033. Shell -1.74

Lunatia lewisii (Gould) shell from Seal Beach, Calif. Coll. 1921 by C. E. White; subm. by L. R. Saul. Uncorrected δ^{14} measurement, -1.84 . δ^{13} measurement, -0.5 .

F. Vegetation and Climate

California Pleistocene Floras series

The following dates represent additional ages for previously described late Pleistocene floras of California (Lamont IV, UCLA II and III). They confirm previous estimates of their ages as based on geologic and paleobotanic evidence. Samples are from paleobotanical collections, Univ. of California, Berkeley, and where subm. and commented on by D. I. Axelrod, UCLA.

UCLA-735. San Bruno flora, San Mateo County, California **10,170 \pm 120**
8220 B.C.

Wood of *Pseudotsuga menziesii* from San Bruno flora, described by Potbury (1932) from alluvial gravels near San Bruno, California (37° 37' N Lat, 122° 27' W Long). *Comment:* flora suggests higher rainfall and cooler climate than that at San Bruno today, and the young date is consistent with assignment to waning part of last glacial stage.

UCLA-736. Tomales flora, Marin County, California **29,050 \pm 1100**
27,100 B.C.

Pinus radiata cones from Millerton Head (38° 7' N Lat, 122° 52' W Long) in Millerton formation. Date supports reference of flora to late Pleistocene, as shown by geologic occurrence and composition of associated flora (Mason, 1934). *Comment:* date for flora implying relatively cool climate and corresponding to a time prior to last glacial advance is significant because warm-water marine invertebrates occur in same beds (see Mason, 1934, p. 103-106). Whether local or due to worldwide warming, warmer sea offshore may account for increased precipitation, with greater cloudiness and slightly lower temperature indicated by flora.

UCLA-737A. Rancho La Brea Tar Pits **23,300 \pm 510**
21,350 B.C.

Date is based on cypress wood in collection at Univ. California, Berkeley, from tar pits (34° 03' 45" N Lat, 118° 21' 25" W Long). *Comment:* other dates of cypress wood are much younger—14,500 B.P. (Howard, 1961). Taken together with date of 32,350 \pm 1400 yr for live oak leaves (see below) from tar pits, it is apparent that flora is not a floristic unit, but was assembled in the pits over a long period of time. This evidence makes interpretation of flora simpler, for it contains such ecologically disparate plants as juniper and Monterey pine (see Axelrod, 1966). The drier flora (juniper, walnut, etc.) and the more humid ones (Monterey pine, Bishop pine, cypress) probably are to be referred to interglacial and glacial ages respectively.

UCLA-737B. Rancho La Brea Tar Pits **32,350 \pm 1400**
30,400 B.C.

Date based on *Quercus agrifolia* leaves, from collections at Univ. California, Berkeley. Both samples UCLA-737A and B were continuously extracted with ether similar to the following La Brea series.

UCLA-728. McKittrick flora, Kern County, California **38,000 ± 2500**
36,050 B.C.

Date based on stems in collection at Univ. California, Berkeley, from S edge of McKittrick, California (35° 17' N Lat, 119° 38' W Long). *Comment*: age of flora has not previously been placed closely, though it was referred to late Pleistocene (Mason, 1944). Flora represents a pinyon-juniper woodland like that now in San Rafael Mts., a few tens of miles to SW, and indicates 10 to 15 in. more precipitation than at McKittrick today (5 in.).

UCLA-966. Point Sal Ridge **26,700 ± 800**
24,750 B.C.

Unaltered wood of *Pinus muricata* provided basis for date. Wood and pine cones are in Orcutt Sand in canyon directly W of head of Corralillos Canyon, several mi SW of Guadalupe, California (34° 55' N Lat, 129° 39' W Long). *Comment*: Orcutt Sand represents oldest terrace deposit in Santa Maria region, and has a wide distribution. Since the Orcutt is deformed (dips of 11° to -20°) on flanks of anticlines in the region, the date of 26,700 yr provides measure of rate of deformation. Cones of *Pinus muricata* are abundant in the Orcutt Sand, and cones of *P. radiata* and *P. remorata* are also present. They suggest a moister climate than that in the area today.

La Brea Tar Pit series

Wood from La Brea tar pits, Los Angeles, California (34° 03' 45" N Lat, 118° 21' 25" W Long). Coll. during 1913-1915 excavations by Los Angeles County Mus. Part of an extensive modern analysis of materials found in the pits. See also LH-55, LJ-89, LJ-21 (LaJolla I) and Y-354 and Y-355 (Yale IV) for other La Brea dates and literature sources. More recent publications are Marcus (1960), Howard (1962) and Stock (1963).

Samples were extracted continuously with ether in a Soxhlet extractor for specified length of time until free from tar. Subm. by Th. Downs, Los Angeles County Mus.

UCLA-773A. La Brea **33,700 ± 1600**
31,750 B.C.
Pit 4, 5 ft depth. 5 months extraction.

UCLA-773B. La Brea **>40,000**
Pit 9, 10½ ft depth. 5 months extraction.

UCLA-773C. La Brea **37,000 ± 2660**
35,050 B.C.
Pitt 77, no record of depth. 5 months extraction.

UCLA-773D. La Brea **13,300 ± 160**
11,350 B.C.
Pit 9, 8½ ft depth. 5 months extraction.

UCLA-773E. La Brea **>40,000**

Pit 16, 12 ft depth. 8½ months extraction.

UCLA-773F. La Brea **>40,000**

Pit 9, 16 ft depth. 9½ months extraction.

UCLA-773G. La Brea **>40,000**

Pit 16, 6½ ft depth. 9½ months extraction.

General Comment (T.D.): data greatly amplify the known history of La Brea. Difference in ages of pits is apparently confirmed.

Douglas Fir, Humboldt County, California Series

Study is concerned with past conditions of Douglas fir-redwood area in Humboldt County, California.

Douglas fir heartwood samples were obtained from trunks buried in alluvium at various depths from Bull Creek Drainage in Humboldt County (40° 29' N Lat, 124° W Long). Coll., subm. and commented on by E. C. Stone and R. B. Vasey, Univ. of California, Berkeley.

UCLA-997. Douglas fir from 29 ft depth **9540 ± 120**
7590 B.C.

UCLA-998. Douglas fir from 53 ft depth **9500 ± 120**
7550 B.C.

UCLA-999. Douglas fir from 102 ft depth **9450 ± 120**
7500 B.C.

Comment: data indicate that mass of alluvium (>100 ft deep) was deposited over a period not longer than 330 yr. Such deep deposition over such a relatively short period suggests major flooding and deposition some 9500 yr ago. Together with deposition measurements of more recent times (Stone *et al.*, 1962), major flooding and heavy deposition appear to be a natural part of area's environment.

UCLA-1018. Mt. San Gorgonio, California **<100**

Wood from central section of large dwarf limber pine at 10,300 ft elevation on lateral moraine of San Gorgonio (11,485 ft) (32° 2' N Lat, 116° 48' W Long). Date was run to determine if trees were very old or of average age, in hearing of U.S. House of Representatives on the need for preservation of this wilderness area. Apparently the measurement corroborates reports of lack of vegetation at this location during conquest of the summit in 1872. Perpetual snow was reported on Gorgonio during the last century. Coll. and subm. by R. W. Tosh, Redlands, California.

Neotoma Midden series, SW States

Series is part of a dating program begun with UCLA III and IV to use the plants of packrat middens to infer environmental conditions at

time of deposition. Coll. and subm. by P. V. Wells, Univ. of Kansas, Lawrence.

UCLA-934. Burro Mesa, Texas **>36,600**

Site #2, ca. 4000 ft elev. *Comment* (P.V.W.): a woodland assemblage of *Pinus cembroides* and *Juniperus pinchotii* associated with a tortoise shell (*Gopherus*).

UCLA-935. Spotted Range, Nevada **9450 ± 90**
7500 B.C.

Site #2, ca. 5100 ft elev. *Comment* (P.V.W.): woodland assemblage of *Pinus monophylla*, *Juniperus ostiosperma* and *Acer glabrum*.

G. Geological Processes

UCLA-908. Mammoth Mountain **920 ± 80**
A.D. 1030

Charcoal and wood from under 18 to 20 in. of pumice at Mammoth Mountain Inn, California (37° 38' N Lat, 119° 2' W Long), 300 yd ESE of ski headquarters and ca. 150 yd S of road and 100 ft above road in altitude. Coll. by R. Bumbaugh, Ch. Bailes and E. Pemberton; subm. by E. Pemberton and D. I. Axelrod.

UCLA-1007. Beeri sulfur quarries, Israel $\Delta = -980 \pm 175$
 $\delta C^{14} = 98.2\%$

Fossil mats, apparently algal, found as layers in sulfur-rich sandstone ridges parallel to the E Mediterranean coast from vicinity of Beeri sulfur quarries, Israel, 9 km S of Gaza (31° 28' N Lat, 34° 29' E Long). Original growth environment is thought to be lagunal. *Comment* (I.R.K.): apparent age is $32,350 \pm 1400$ yr, δC^{13} (PDB scale in per mil) -83 (T. A. Rafter, Wellington, New Zealand), and -85 and -89 (S. R. Silverman Chevron Research Co., La Habra, California). This appears to be lowest C^{13}/C^{12} ratio of any solid organic material yet measured, implying fractionation of an organic carbon source by microorganisms. But this mechanism cannot account for the C^{14} depletion alone, which must be the result of age.

California Tufa Series

A series of measurements of organic and inorganic fractions of tufas, to be discussed elsewhere after C^{13} analyses are available. Inorganic dates have been corrected by subtracting 2500 yr and increasing the error to 500 or 1000 yr, depending on apparent age (Broecker and Walton, 1959).

For isolation of the organic carbon, raw tufa was treated in 1 N HCl to remove all inorganic carbon. Then, after washing and drying, the treated tufa was heated in a stream of oxygen. Resulting CO_2 was absorbed in 4 N NaOH. Rn was removed by flushing the NaOH-solution. Finally CO_2 was liberated for standard purification. Coll. by E. L. Davis and R. Staudenmayer; subm. by R. Staudenmayer and R. Berger.

UCLA-1110-I. Tufa	16,600 ± 1000 14,650 B.C.
Inorganic portion. From Panamint Valley (36° 9' 12" N Lat, 117° 16' 20" W Long), 1150 ft elev.	
UCLA-1110-0. Tufa	13,400 ± 200 11,450 B.C.
Organic portion.	
UCLA-1118-I. Tufa	24,500 ± 1000 22,550 B.C.
Inorganic portion. From Panamint Valley (36° 26' N Lat, 117° 24' W Long), 1900 ft elev.	
UCLA-1118-0. Tufa	12,500 ± 800 10,550 B.C.
Organic portion.	
UCLA-1121-I. Tufa	8000 ± 500 6050 B.C.
Inorganic portion. From Ridgecrest-Trona highway, California (35° 39' N Lat, 117° 30' W Long).	
UCLA-1121-0. Tufa	3150 ± 150 1200 B.C.
Organic portion.	
UCLA-1123-I. Tufa	13,450 ± 100 11,500 B.C.
Inorganic portion. From Panamint Valley (36° 26' N Lat, 117° 24' W Long), 1800 ft elev.	
UCLA-1123-0. Tufa	12,000 ± 260 10,050 B.C.
Organic portion.	
UCLA-1125-I. Tufa	10,150 ± 1000 8200 B.C.
Inorganic portion. From Ridgecrest-Trona highway, California (35° 39' N Lat, 117° 21' W Long).	

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Lamont VII	Olson and Broecker, 1961
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Michigan VII	Crane and Griffin, 1962
Pennsylvania VI	Stuckenrath, 1963
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UCLA II	Fergusson and Libby, 1963

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RADIOCARBON DATING AT THE UNIVERSITY OF WASHINGTON III

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This date list consists of those measurements made since 1962. The counter is one described previously (Fairhall and Schell, 1963). The results are computed using NBS oxalic acid as the standard and 5568 for the half-life of C^{14} . Standard deviations are computed for each measurement, including the statistical error in the sample count and uncertainties in background and standard. In general, each sample is counted at least twice. The quoted error on the date is the standard deviation. A 2σ criterion is used to establish a lower limit to the age of very old samples with no detectable trace of C^{14} . No correction for isotope fractionation has been made in any of the measurements.

During the time that samples UW-28 through UW-44 were measured, tritium from the 1961-1962 bomb tests began to appear in the hydrogen used to prepare the methane for counting (Fairhall *et al.*, 1961) whereas our background gas was tritium-free. Before we became aware of this problem the results had been reported to the persons submitting the samples. Unfortunately some of these erroneous dates may have found their way into the literature. The extent of this problem was carefully investigated and the results reported here have been corrected for this tritium contamination. The problem has since been eliminated entirely by using hydrogen derived from petroleum, available from Air Products and Chemicals, Inc., Allentown, Pennsylvania.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

UW-28. Saanich Inlet, British Columbia **610 ± 110**
A.D. 1340

Chip of wood 233 cm from top of core of varved mud from the bottom of Saanich Inlet, Vancouver Island, Canada ($48^{\circ} 35' N$ Lat, $123^{\circ} 30' W$ Long). Sample had to be diluted three-fold to provide sufficient counting gas. *Comment* (M.G.G.): established that the sediments show annual bands of diatom debris and provided an estimate of the rate of sediment deposition (Gross *et al.*, 1963). Coll. and subm. by M. G. Gross, Univ. of Washington, Seattle.

UW-31. Des Moines, Washington **$36,800 \pm 1800$**
34,850 B.C.

Wood from pre-Vashon deposit near Des Moines, Washington ($47^{\circ} 27' N$ Lat, $122^{\circ} 17' W$ Long). From deposit of peat, silt, and clay encountered in water well beneath ca. 300 ft of sand and gravel formed by advancing Vashon Glacier. Coll. 1962 and subm. by F. B. Roberts, Seattle Water Dept., Seattle.

UW-32. Penn Cove, Whidbey Island, Washington **13,100 ± 170**
11,150 B.C.

Shells from glaciomarine drift along N shore of Penn Cove on Whidbey Island (48° 14.6' N Lat, 122° 42.5' W Long). Date establishes presence of late Pleistocene glaciomarine drift on Whidbey Island probably equivalent to similar drift in the Bellingham and Fraser delta areas. Coll. 1962 and subm. by D. J. Easterbrook, Western Washington State Coll., Bellingham.

UW-35. Garcia, Washington **13,570 ± 130**
11,620 B.C.

Wood from laminated silt and clay in section exposed on bank of S fork of Snoqualmie River ca. 1/3 mi N of Garcia railroad station (47° 26' N Lat, 121° 38' W Long). Sediments were deposited in lake dammed by an end moraine of Puget glacier during Vashon Glaciation. Wood provides date for period of sedimentation. Coll. 1962 by R. C. Ellis; subm. by S. C. Porter, Univ. of Washington, Seattle.

UW-48. Union, Washington **>47,000**

Peat from ca. 5 ft above road near mouth of Skokamish River ca. 2½ mi SW of Union, Washington (47° 19.7' N Lat, 123° 07.1' W Long). Altitude of sampled peat layer ca. 25 ft. Overlain by a sequence up to 300 ft thick of sand and gravel predominantly of Olympic Mountain provenance. Sequence contains glacial and nonglacial deposits overlain by Vashon Drift. Believed to be pre-Salmon Springs age. Coll. 1963 and subm. by J. B. Noble, Dept. of Conservation, Olympia.

UW-49. Hammersley Inlet, Washington **>45,000**

Wood from beach bluff, ca. 8 ft above high tide on S shore of Hammersley Inlet ca. 7 mi E of Shelton (47° 12' N Lat, 122° 57' W Long). Coll. 1963 and subm. by J. B. Noble. *Comment* (J.B.N.): samples ca. 10 ft above a till believed to be within Salmon Springs Drift. However, wood in non-glacial materials thought to be within the younger Kitsap Formation (Garling and Molenaar, 1965) would certainly date >45,000, and the significance of the date is not yet clear.

UW-50. Goldsborough Creek Valley, Washington **>40,000**

Wood from within a sequence of gravels of Olympic Mountain Provenance, mostly non-glacial, overlain by Vashon Drift, ca. 12 ft above creek level. Located ca. 1 mi W of Shilton, 100 ft downstream from toe of Rayonier-Simpson dam (47° 13' N Lat, 123° 08' W Long). Coll. 1963 and subm. by J. B. Noble. *Comment* (J.B.N.): sequence probably the same as the one that contained UW-48.

UW-53. Port Angeles, Washington **>42,000**

Wood from one of approx. 12 stumps, all of which are upright on a beach area on Straits of Juan de Fuca at a point ca. 2 mi W of mouth

of McDonald Creek and 9 mi E of Port Angeles (48° 07' N Lat, 123° 15' W Long). Wave action is rapidly eroding a bank of interbedded outwash gravels, sands and silts overlying a 10-ft clay layer, the bank rising a total of ca. 100 ft above high tide. Forest floor on which the trees would have been growing would be 0 to 5 ft below high tide and has not been seen, but the large number of standing stumps 1 to 3 ft in diam, most of them coniferous species, suggests strongly that they are rooted in place. Stumps are in an excellent state of preservation, as are shredded wood fragments and occasional small logs in or immediately below a 24-in. layer of peat-like material situated directly below clay and a few ft above stump horizon. Coll. 1963 and subm. by K. B. Bengtson, Richland, Washington.

21,200 ± 300**UW-55. Seattle, Washington****19,250 B.C.**

Wood in association with bones of a woolly mammoth found ca. 50 ft below surface during excavation of a new office building (48° 41' N Lat, 122° 18' W Long). Coll. 1963 by V. S. Mallory; subm. by W. A. Fairservis, Washington State Mus., Seattle.

Platinum, Alaska series

Basal peat from four bogs exposed in seacliffs 1 to 2 mi N of mouth of Salmon River near Platinum, Alaska (58° 52.8' N Lat, 161° 46.8' W Long). Peat directly overlies drift of late Wisconsin age and dates provide minimum ages for deglaciation. Coll. 1963 and subm. by S. C. Porter.

8910 ± 110**UW-56. Platinum, Alaska No. 63627-2****6960 B.C.**

Peat from base of bog 1.9 mi N of Salmon River.

UW-57. Platinum, Alaska No. 63627-1**>45,000**

Peat from base of bog 1.6 mi N of Salmon River. *Comment* (S.C.P.): sample age contrasts sharply with ages of basal peat from adjacent bogs. Reason is not known.

12,840 ± 170**UW-70. Platinum, Alaska No. 63622-1****10,890 B.C.**

Peat from base of bog 1.2 mi N of Salmon River.

12,110 ± 130**UW-71. Platinum, Alaska No. 62622-2****10,160 B.C.**

Peat from bog 1.3 mi N of Salmon River.

5050 ± 90**UW-62. Duwamish Valley, Washington****3100 B.C.**

Wood fragments from a well located in postglacial alluvium ca. 2 mi SW of Kent (47° 22' N Lat, 122° 15' W Long). Sample found in a layer 305 to 320 ft below surface, overlain by 305 ft of black silty sand. Beneath lay andesitic gravel and boulders in clay, 320 to 342 ft, and gray silty

sand, 342 to 430 ft. Coll. 1963 and subm. by J. E. Luzier, U. S. Geol. Survey, Tacoma. *Comment* (J.E.L.): date indicates that woody debris and underlying gravel and boulders in clay represent a lobe of Osceola Mudflow, ca. 65 mi from its source on Mt. Rainier. Wood from outcrops of mudflow has been previously dated as 4800 ± 450 (L-223A), 4950 ± 450 (L-223B) and 4700 ± 250 (W-564; Crandell, 1963). Mudflow entered Puget Sound lowland while Duwamish Valley was still a long, deep marine embayment receiving sediment from the Green and Cedar rivers. A third river, the White, entered embayment after its diversion by the mudflow (Crandell, 1963). Following this event, deposits of White River aggraded embayment above sealevel (Mullineaux, 1961).

UW-63. Cherry Point, Washington **>49,000**

Wood in till beneath late or post-Vashon glaciomarine deposits near base of seacliff N of Cherry Pt. on Georgia Strait at Aldergrove Rd. ($48^{\circ} 52.5' \text{ N Lat}$, $122^{\circ} 46.2' \text{ W Long}$). Coll. 1961 and subm. by D. J. Easterbrook, Bellingham, Washington. *Comment*: sample was previously measured (Dorn *et al.*, 1962) as UW-17, with age reported as $24,200 \pm 2100$. Reason for discrepancy not known. See also comment under UW-67, below.

UW-66. Ronald, Washington **>37,500**

Flakes of charcoal from sandy silt of probably eolian origin that lies on top of thick gravel outwash body and underlies stoney till of maximum late-Wisconsin advance of Cle Elum valley glacier in cutback on E bank of Cle Elum River 1.7 mi S of Ronald, Washington ($47^{\circ} 12.6' \text{ N Lat}$, $121^{\circ} 01.2' \text{ W Long}$). Coll. and subm. 1964 by S. C. Porter. *Comment* (S.C.P.): sample apparently contaminated with flakes of Eocene coal which crops out upvalley.

UW-67. Cormorant Passage **>44,000**

Remeasurement of sample of peat originally dated (UW-19) at $33,000 \pm 1000$. This discrepancy along with those reported under UW-63 and UW-74 suggests that a systematic error may be present in all samples in our first date list (Dorn *et al.*, 1962) which are older than ca. 20,000 yr. Although origin of this difficulty cannot be traced, it may have been due to inception of tritium problem mentioned in introduction. If this is the case only the very old samples would be significantly affected.

UW-73. Snoqualmie Pass, Washington **7200 \pm 210**
5250 B.C.

Charcoal fragments from stream cut through bog at Snoqualmie Pass summit on U. S. Route 10 ($47^{\circ} 29.5' \text{ N Lat}$, $121^{\circ} 24.9' \text{ W Long}$). Bog lies in kettle basin between 2 youngest recessional moraines of latest stage of last glaciation. Stratigraphic section exposes 1 ft stony till at base, 2 to 3 ft laminated lacustrine silt and clay, 1 in. organic matter from which sample was collected, 4 to 6 in. pale grayish-orange ash (Mazama ash),

and 3 ft organic silt and peat containing 2 thin ash layers of Mt. St. Helens origin. Coll. 1964 and subm. by S. C. Porter.

UW-74. Johnson Point, Washington **>50,000**

Peat from a 3 to 4 in. peat layer at top of Kitsap formation, conformably overlain by 3 to 4 in. of coarse sand with gravel up to 1½ in. diam, grading upward to 8 to 10 ft thick sequence of brown sand and gravel; underlain by fine sand and silt and several lower peat layers in a 10 to 15 ft thick section. Location ca. 5,000 ft S of and on E side of Johnson Point (47° 10.6' N Lat, 122° 49.1' W Long). Coll. 1964 and subm. by D. Moleenaar, Olympia. *Comment*: sample collected from same site, but possibly from different peat layer, as UW-7, which was dated at $27,900 \pm 800$ (see comment under UW-67).

II. ARCHAEOLOGIC SAMPLES

A. Egypt

UW-30. Nubia, Egypt **4660 ± 100**
3710 B.C.

Charcoal from Afyeh, Nubia, on W bank of Nile (22° 30' N Lat, 31° 50' E Long). From site AFH-1; Sq. A4; Locus B5-2.40 x A5-3.20—0.45 to 0.55 meters; Layer 3. Coll. 1962 by Shri B. Lal, New Delhi, India; subm. by W. A. Fairservis.

B. Pakistan

Quetta Valley, W Pakistan series

Charcoal samples from two sites in Quetta Valley, W Pakistan (30° 10' N Lat, 67° 00' E Long). Coll. 1963 and subm. by Walter A. Fairservis.

UW-59. Quetta Valley, No. Q8 **4330 ± 70**
2380 B.C.

Site Damb Sadaat, Test Pit AT, Level 160, Damb Sadaat I. *Comment* (W.A.F.): sample is of particular interest since it represents Kechi Beg phase in Quetta Valley, which has typological ties to Pre-Harappan Kot Diji and Amri in Sind, suggesting that the beginning of the Harappan civilization there is probably ca. 2300 B.C.

UW-60. Quetta Valley, No. MG **4030 ± 160**
2980 B.C.

Site Damb Sadaat, from Rubble Wall, Phase 1E, Damb Sadaat III. *Comment* (W.A.F.): from the level in Quetta Valley in which Harappan materials have been found.

UW-61. Quetta Valley, No. Q-24 **5260 ± 80**
3310 B.C.

Site Kile Gul Mohammad, Level 235T, upper levels of Kile Gul Mohammad I. *Comment* (W.A.F.): sample represents last phases of the pre-, or aceramic, levels at the site.

Chahsadda, W Pakistan series

Charcoal samples from excavations at Shaikhhan Dheri (Chahsadda), a large city mound located near entrance to Khyber Pass (34° 00' N Lat, 71° 31' E Long). Site is important in that it represents early contact with the Mediterranean world and is associated with the reign of King Kanishka I. Coll. 1964 by A. H. Dani, Univ. of Peshawar; subm. by W. A. Fairservis.

UW-77. Chahsadda, No. A4**2155 ± 60****205 B.C.**

From Site SHK, Location A4, Stratum 2, Pit 1.

UW-78. Chahsadda, No. B4**1940 ± 70****A.D. 10**

From Site SHK, Location B11, Stratum 3.

*C. British Columbia and Washington***Beach Grove, British Columbia series**

Charcoal samples from a site near Beach Grove (49° 02' N Lat, 123° 04' W Long), which, from cultural remains, is indicated as being of Marpole phase, one of the richest periods in cultural sequence of Fraser River delta area. Previous age determinations on samples from Marpole phase have ranged from 4th century B.C. to 2nd century A.D. Subm. by C. E. Borden, Univ. of British Columbia, Vancouver.

UW-43. Beach Grove, No. UBC-1370**1540 ± 130****A.D. 410**

Charcoal from a stratum 18 ft N and 64 ft W of datum, 190 cm below surface, containing dark, charcoal-stained soil, with pea gravel and clam shell fragments. Coll. 1962 by P. D. Harrison. *Comment* (C.E.B.): date indicates that Marpole phase lasted considerably longer than had been realized previously.

UW-44. Beach Grove, No. UBC-2371**1600 ± 120****A.D. 350**

Charcoal from a stratum 18 ft N and 6 to 7 ft W of datum, 107 cm below surface, containing clay, clam, cockle and wood fragments. Coll. 1962 by J. H. Sendy. *Comment* (C.E.B.): this date lends additional support to indications that Marpole lasted longer than had been known. Wooden wedges, cordage, and basketry remains found with this sample, are the oldest dated perishables of this kind known from the Northwest Coast.

Columbia River, Washington series

The following samples were collected between 1957 and 1962 in the archaeological salvage excavations in the reservoirs of Priest Rapids and Wanapum dams in Grant, Yakima and Kittitas Counties. Dates cover a

span of time when the middle Columbia Valley was occupied by wandering hunters and gatherers whose essential patterns of living continued with relatively little change to the time of Euro-American settlement. One of the most significant innovations to occur during this period was the introduction of semi-subterranean dwellings for winter habitation between 1500 and 2000 yr ago according to samples UW-40, UW-41, UW-41A, and UW-51, which bracket this event. The series also enables a more detailed ordering of artifact forms indicative of other aspects of culture change in the region. Subm. by R. E. Greengo, Univ. of Washington, Seattle.

UW-37. Sourdough Creek

**4200 ± 125
2250 B.C.**

Fragmented animal bone from Indian midden site on alluvial fan at mouth of Sourdough Creek on W bank of Columbia River, 3.5 mi upstream from Priest Rapids dam (46° 41' N Lat, 119° 57' W Long). Samples in association with side-notched projectile points and bipoints, in what appeared to be a secondary deposit stratified under ca. 2 m of culturally sterile sands and silts. Coll. 1958 by R. E. Greengo. *Comment* (R.E.G.): the large side-notched points appear to be an important horizon marker in the Northwest, and dating is toward the more recent temporal placing of this form elsewhere in the Columbia-Snake drainage.

UW-39. French Rapids

**<80
>A.D. 1870**

Charcoal from fireplace 40 to 52 cm below surface in Indian house-pit on W bank of Columbia River, 2.3 mi upstream from old Vantage bridge (47° 00' N Lat, 120° 00' W Long). Coll. 1961 by R. S. Kidd. *Comment* (R.E.G.): associated with small basal and corner-notched projectile points. Stratified below historic materials. Most recent date obtained thus far on late prehistoric Columbia River materials.

UW-40. Crescent Bar

**1250 ± 70
A.D. 700**

Charcoal from lowest level of occupation at 130 cm depth below surface at Indian house-pit site on S end of Crescent Bar, E bank of Columbia River, 14.5 mi below Rock Island Dam (47° 11' N Lat, 120° 00' W Long). Coll. 1961 by S. O. Solland. *Comment* (R.E.G.): associated with small basally notched projectile points and pentagonal points. Date is consistent with that of UW-38.

UW-38. Vantage, E bank

**1070 ± 120
A.D. 880**

Charcoal from Indian house-pit site on E bank of Columbia River, ca. 13.5 mi upstream from old Vantage bridge (47° 08' N Lat, 120° 00' W Long). Coll. 1961 by R. E. Greengo. *Comment* (R.E.G.): an acceptable date for Late Columbia Valley basally-notched point complex.

UW-51. Vantage, W bank **1170 ± 200**
A.D. 780

Charcoal from fireplace in lowest occupation stratum of House-pit 30 at 178 cm below surface. Located 14 mi upstream from old Vantage bridge on W bank of Columbia River (47° 09' N Lat, 120° 00' W Long). Coll. 1960 by M. L. Susia. (Sample had to be diluted to provide enough gas for counting.) *Comment* (R.E.G.): dates late Columbia River basally and corner-notched points.

Schaake Village subseries

Samples from Indian house-pit site near mouth of Whiskey Dick Creek on W bank of Columbia River, 4.5 mi upstream from old Vantage Bridge (47° 01' N Lat, 122° 00' W Long).

UW-36. Schaake Village, Nos. 4116, 4273 **3210 ± 150**
1260 B.C.

Charcoal composite from a stratum 550 cm below datum and immediately above river gravels, associated with projectile points of small to medium size with rectangular to contracting stems generally regarded as markers of a middle prehistoric period on the Columbia. Coll. 1963 by B. G. Holmes.

UW-41. Schaake Village, No. 2888 **2040 ± 120**
90 B.C.

Charred antler from below house-pit floors, but well above river gravel, 180 cm below datum (170 cm below surface). Coll. 1962 by B. G. Holmes. (Sample had to be diluted in order to provide enough gas for counting. Furthermore, antler is poor material for radiocarbon dating.) *Comment* (R.E.G.): associated in a feature with a relatively large rectangular stemmed projectile point, a bone point, mountain sheep horn cores, and river mussel shells. Date not inconsistent with pre-house-pit context, but may be too recent.

UW-41A. Schaake Village, No. 2071 **2780 ± 190**
830 B.C.

Charcoal from a stratum which represents a continuation of that represented in UW-41 at 230 cm below datum (175 cm below surface). Coll. 1962 by B. G. Holmes. *Comment* (R.E.G.): associated with a medium-sized contracting stem projectile point and mussel shell. Date is more consistent with this context than is UW-41, late in the middle period.

UW-64. Schaake Village, No. 2860 **1520 ± 110**
A.D. 430

Charcoal from house-pit fill 125 cm below datum. Coll. 1962 by B. G. Holmes. *Comment* (R.E.G.): this midden contains projectile points considered late in the Plateau, including corner-notched expanding-stemmed forms, some with long barbs, unnotched triangular points small

to medium in size, and a "Plateau Pentagonal" point. Date appears to be consistent with others with this complex of material.

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VICTORIA
NATURAL RADIOCARBON MEASUREMENTS I

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This list contains a selection of results of measurements made since September, 1963. Until the end of 1962, the stability of equipment performance was unsatisfactory and, when the author assumed responsibility for the operation of the laboratory in 1963, several dates that had been published (Focken, 1960, 1962, and private commun.) were withdrawn. The performance and operation of the equipment were re-assessed and improved during 1963 and routine dating was begun towards the end of the year.

All determinations have been made with a proportional counter, ca. $3\frac{1}{2}$ L, which is shielded by 1 in. mercury, a double coincidence ring and an 8 in. steel shield. Carbon dioxide is used as the filling gas, final purification being made by absorption on lime.

The electronic system is duplicated after the preamplification stage; a single channel analyzer is paralleled by a four channel analyzer which can be used to correct for radon impurity. A system of overall gain stabilization devised by R. D. Carman (1961) uses variations in the coincidence pulse amplitude distribution in the four channel analyzer to supply an automatic correction voltage to the counter. All recorded count rates are monitored at 50 or 100 min intervals and subsequently analyzed. Neutron monitoring equipment runs in conjunction with the dating equipment.

Changes in anticoincidence count rates with barometric pressure have not been detected; analysis of background and standard count rates gives variations close to statistical expectation over long periods.

Age calculations are based on a modern reference activity of 95% NBS oxalic-acid standard and the value 5568 yr for the half-life of C^{14} . Results are expressed in years before A.D. 1950. The statistical error quoted (1σ) is derived solely from the counting statistics and the uncertainty in the half-life figure is not included. Minimum ages for samples indistinguishable from background are calculated on an activity of 3σ above background.

Pretreatment of samples with hydrochloric acid and sodium hydroxide is routine, but this procedure has been modified where sample size precluded an alkali leaching.

Sample descriptions are based on information supplied with the samples, or have been provided by the persons submitting the samples.

ACKNOWLEDGMENTS

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ment of Victoria; additional support from the Australian Institute of Nuclear Science and Engineering is gratefully acknowledged.

Measurements of C^{13}/C^{12} ratios of standards were made by the Institute of Nuclear Sciences, Department of Scientific and Industrial Research, New Zealand, through the kind co-operation of the Director, Mr. T. A. Rafter, and the staff. Special thanks are due to the laboratories which supplied check samples, and grateful acknowledgment is made to submitters of samples who assisted with descriptions.

The author is particularly indebted to Mr. David Turner, who joined the laboratory in June 1964, for his excellent assistance.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. New South Wales

Riverine plain series, New South Wales

Transported wood samples in alluvium; coll. by Trevor Langford-Smith in continuation of a long-term study of geomorphic history of New South Wales sector of Australia's inland riverine plains (Langford-Smith, 1960, 1962) for which eight dates (Murrumbidgee Plain series) were reported in Yale VIII. Coll. Sept 1960 and subm. by T. Langford-Smith, Univ. of Sydney.

V-46. Learmonth Well

460 \pm 105

A.D. 1490

From relic of former stream 6 to 24 in. below present surface of stream bed, 17 mi W of Griffith, New South Wales (34° 15' S Lat, 145° 45' E Long).

V-47. Moppin

2265 \pm 120

315 B.C.

From 12 in. below surface of bed of former stream, 20 mi N of Moree, New South Wales (29° 20' S Lat, 149° 40' E Long). *Comment* (T.L.-S.): V-46 is part of former Murrumbidgee system which, so far, has given a clustering of dates into an old group, 11,000 yr or older, and a younger group, 4700 yr or younger. Previous date for this system of 300 \pm 70 (Y-869, Yale VIII) was rejected as possibly part of a modern root, but this date of 460 \pm 105 suggests possibility of some stream discharge at about this time. V-47 is from series of former streams some 400 mi NW of V-46, but still part of same riverine plain series. Age is close to 2480 \pm 80 (Y-862, Yale VIII) obtained for wood from a stream near V-46. Further field work and dating necessary before firm conclusions can be reached as to episodes of stream flow in these alluvial traces.

V-7. Gooloogong, Lachlan Valley, New South Wales **>34,000**

Wood, probably *Eucalyptus resinifera* (id. by R. K. Bamber), from depth of 86 ft in Bore 12437 (33° 38' 20" S Lat, 148° 31' 30" E Long), Portion 56, Parish of Gooloogong, County of Forbes; ca. 3 mi upstream

of village of Gooloogong, Lachlan River Valley, New South Wales. See Williamson (1964) for discussion of groundwater investigations in area; geology of area is also described by Williamson (1961). Coll. June 1960 by B. McDonald; subm. by W. H. Williamson, Water Conservation and Irrigation Comm., N.S.W. *Comment* (W.H.W.): date confirmed that age of sediments being test-bored was beyond radiocarbon dating limits; subsequent geological and palynological information indicates Pleistocene age.

V-32. Captain Cook graving dock, Sydney **8035 ± 110**
6085 B.C.

Wood from outer section of root of *Eucalyptus gummifera* (id. by H. D. Ingle), part of tree stump taken from position of growth 48 ft below sealevel. Stump was found during excavation of Captain Cook graving dock (33° 52' 0" S Lat, 151° 13' 40" E Long), Sydney, New South Wales, and was covered by 6 ft of sediment. Sample has also been dated at 8360 ± 110 yr (NZ—lab. no. not available, ref. no. R1219/1, private commun.). Coll. ca. 1940 by Forestry Comm. of New South Wales; subm. by Quaternary Strandlines Comm., ANZAAS, per E. D. Gill. *Comment* (E.D.G.): as specimen was in position of growth, sea at that time must have been lower by at least 48 ft plus depth of roots, estimated (from photograph) at 10 ft.

B. Victoria

V-23. Murrumbidgee 38, Ovens Valley, Victoria **>31,000**

Eucalyptus camaldulensis (id. by J. Douglas) from 95 ft below present Ovens Valley surface, in black carbonaceous clay horizon of alluvium-filled valley of Ovens River, 3½ mi N of Myrtleford, Victoria (36° 32' S Lat, 146° 41' E Long). Coll. Oct 1961 and subm. by B. R. Thompson, Mines Dept., Victoria. *Comment* (B.R.T.): date supports conclusion that alluvial material in these valleys is considerably older than Recent period (Thompson, 1965).

Ford's Creek series, Mansfield, Victoria

Wood samples from trunks of red gum, probably *Eucalyptus camaldulensis*, in exposed banks of two eroded creeks; soil layers are thought to be latest pre-white settlement deposits in Mansfield area. Collection sites were on Graves and Kelleher properties (37° 6' S Lat, 146° 7½' E Long), 2½ mi E of Mansfield, Victoria. Coll. Dec 1962 and subm. by A. Rundle, Soil Conserv. Authority, Victoria.

V-38. Graves property **290 ± 50**
A.D. 1660

Wood near base of soil profile in exposed bank of eroded creek, ca. 200 yd N of Mt. Buller road.

240 ± 85

V-37. Kelleher property **A.D. 1710**

Wood near base of soil profile in exposed bank of eroded creek, ca. 250 yd S of Mt. Buller road. *Comment* (K. Rowe, Soil Conserv. Authority): V-37 was thought to be younger than K₃ in Butler's cycle (Butler, 1959); V-38 was tentatively regarded as being of K₁ age. These tentative K-cycle designations were derived from a study of relative relationships of local soil layers by stratigraphic and pedogenetic means, particularly in terrace sequences. Samples were dated to provide a time marker in recent soil history and, by comparison with other dates for soil material, principally those for Nowra, New South Wales (NZ-198, NZ-199, NZ-200, NZ-201, New Zealand I-V; Walker, 1962), to help demonstrate extent of processes resulting in formation of the layers. On basis of dates for Nowra area, both logs are no older than K₁.

II. ARCHAEOLOGIC SAMPLES

A. New South Wales

Seelands series, Clarence Valley, New South Wales

Charcoal samples from rock shelter at Seelands (29° 35' 20" S Lat, 152° 54' 30" E Long), 12 mi NW of Grafton, Clarence Valley, New South Wales. Shelter is on S bank of Clarence River and is one of series in low sandstone cliff whose rock wall bears simple linear engravings. Coll. Aug 1960 (V-24, V-25, V-26, V-27) and June 1961 (V-10, V-11) and subm. by Isabel McBryde, Univ. of New England.

4040 ± 65

V-24. Seelands, Trench 2(f), V **2090 B.C.**

Charcoal from Trench 2, Zone (f), Layer V, ca. 30 in. below surface of deposit in rock shelter. One of lowest levels of deposit within shelter; stratigraphically below V-10, V-26, V-25. *Comment* (I.McB.): dates an industry of predominantly uniface pebble tools and the first appearance of backed blade tools on this site.

870 ± 80

V-25. Seelands, Trench 2(c), III **A.D. 1080**

Charcoal from Zone (c), Layer III, 12 in. below surface of deposit in rock shelter. Implements included blade and uniface pebble tools as well as bone artifacts; a level rich in animal bone, stone, and bone artifacts. Stratigraphically below V-10 and V-26.

350 ± 60

V-26. Seelands, Trench 2(d), II **A.D. 1600**

Charcoal from Zone (d), Layer II, 6 to 9 in. below surface of deposit in shelter; same stratigraphic level as V-10. Stone artifacts from this level, and Level III below, included uniface pebble tools and blade tools, associated with bone implements.

V-27. Seelands, Trench 1(c), IV**6445 ± 75****4495 B.C.**

Charcoal from Trench 1, Zone (c), Layer IV, 18 to 24 in. below surface of deposit outside rock shelter and 20 ft NW of Trench 2. Associated with large primary flakes and uniface pebble tools; no blade tools.

V-10. Seelands, Trench 5(d), II**625 ± 85****A.D. 1325**

Charcoal from Zone (d), Layer II, 9 to 12 in. below surface of deposit in rock shelter. Stratigraphically the same level as V-26; stone artifacts included uniface pebble tools and blade tools, including geometric microliths, associated with bone implements. *Comment:* date for this sample published by I. McBryde (1961, 1962, 1963) was withdrawn.

V-11. Seelands, Trench 5(e³), IIIA**2850 ± 50****900 B.C.**

Charcoal from Zone (e³), Layer IIIA, 18 in. below present surface outside limits of shelter overhang. *Comment:* date for this sample published by I. McBryde (1961, 1962, 1963) was withdrawn. *Comment* (I.McB.): this level of dark black soil contained few animal bones and no bone artifacts, but was rich in stone artifacts, with blade tools (including *Bondi* points and geometric microliths) and uniface pebble tools which, in this level, are in the highest proportion for any level assemblage at this site. First evidence for edge-ground artifacts at this site (a broken axe-head) was stratified below sample. Charcoal sample taken from this level, but further down talus slope to NW, gave date of 1210 ± 30 (GaK-370, Gakushuin IV) which is markedly more recent, but in accord with stratigraphic position of this level below Levels II and III of Trenches 2 and 5 (V-10, V-26, V-25). It suggests that this level represents a long period in history of site (McBryde, 1965).

General Comment (I.McB.): this site was the first excavated in north-eastern New South Wales and this, with the long period of occupation represented by its dated levels, makes it of considerable interest for establishing local regional sequence of cultural change, and for comparison with that established for eastern New South Wales in Sydney area (McCarthy, 1961, 1964; Mulvaney, 1961; Megaw, 1965).

Chambigne series, Clarence Valley, New South Wales

Small rock shelter with shallow occupation deposit at Chambigne, SW of Grafton, Clarence Valley, New South Wales (29° 47' S Lat, 152° 46' E Long). Art consists of a group of white hand stencils on rear wall of shelter. Coll. May 1962 and subm. by I. McBryde.

V-39. Chambigne, Trench 2(a), I**1350 ± 75****A.D. 600**

Charcoal from Layer I, 3 in. below surface of shallow cave deposit in shelter; associated with animal bones, shell, and stone implements, chiefly use-polished pieces, geometric microliths and flake fabricators.

1640 ± 40**V-40. Chambigne, Trench 3(d), I****A.D. 310**

Charcoal from Zone (d), Layer I, 21 to 30 in. below surface of deposit of talus slope outside rock shelter and beneath a rock fall. Layer rich in cultural material; implements include pebble tools and the greatest number of geometric microliths from site. *Comment* (I.McB.): cultural material of site, with association of uniface pebble tools and blade tools (especially geometric microliths), shows close relationship to that of Seelands rock shelter (this list); here the blade tools form dominant element.

Jacky's Creek series, Clarence Valley, New South Wales

Rock shelter with occupation deposit at Jacky's Creek, 14 mi SW of Grafton, Clarence Valley, New South Wales (29° 42' S Lat, 152° 36' 30" E Long). Red ocher and charcoal drawings on wall. Samples coll. May and June 1962 and subm. by I. McBryde.

1310 ± 70**V-41. Jacky's Creek, Trench 1(b), I****A.D. 640**

Charcoal from Zone (b), Layer I, 5 to 6 in. below surface of deposit in rock shelter. Artifacts from level include bone points, stone use-polished edges, and part of a ground-edged axe.

1465 ± 75**V-42. Jacky's Creek, Trench 1(a), III****A.D. 485**

Charcoal from Layer III, 15 in. below surface of deposit in rock shelter, stratigraphically below level from which V-41 was collected. Level poor in artifact content.

1225 ± 70**V-43. Jacky's Creek, Trench 1(e), IIA****A.D. 725**

Charcoal from Zone (e), Level IIA, 6 to 9 in. below surface of deposit in rock shelter at its entrance where stratigraphic pattern changes, probably due to redeposition. Level was richest in cultural material; implements included uniface pebble tools, broken ground-edged axes, and use-polished pieces. A few blade tools were found, but no bone artifacts.

1285 ± 90**V-44. Jacky's Creek, Trench 3, IIA****A.D. 665**

Charcoal from Layer IIA, Trench 3 (an extension of Trench 1), 9 in. below surface of deposit in rock shelter. From same area and stratigraphic level as V-43. *Comment* (I.McB.): date agrees well with V-43 and dates same cultural material.

585 ± 90**V-45. Jacky's Creek, Trench 2(d), I****A.D. 1365**

Charcoal from Zone (d), Layer I, 6 in. below surface of deposit in rock shelter. First occupation layer encountered; thought to correspond to Layer I in Trench 1 (V-41). *Comment* (I.McB.): date is much more

recent than V-41 from same level, and may represent later intrusive evidence of occupation. There were some signs of disturbance in this zone. Cultural material was similar to that for V-41, but sample was directly associated with small piece of sandstone bearing marks in red ocher and may, therefore, throw light on age of red ocher art of site.

General Comment (I.McB.): evidence from this site supplements and confirms that of Seelands and Chambigne for chronology and associations of various stone industries.

Capertee Valley series, New South Wales

Charcoal samples from two rock shelters, Site 3 and Noola, in the Capertee Valley, New South Wales. Site 3 is on S bank of Capertee River, 2½ mi E of junction with Running Stream and 4 mi NE of Glen Davis (33° 7' S Lat, 150° 20' E Long). It has been described fully by F. D. McCarthy (1964). Noola rock shelter, Noola Station, 20 mi NW of Site 3 shelter, has been described by N. B. Tindale in a preliminary report (Tindale, 1961). Date of $11,600 \pm 400$ (GaK-334, Gakushuin III) was previously obtained for finely dispersed charcoal at depth of 121 in. *Comment*: this date and V-35 (this list) are incompatible with gradual deposition from 121 to 74 in. levels during long occupation of narrow shelter (ca. 2 ft wide).

V-33. Site 3, 8 to 10 in.

2865 ± 60
915 B.C.

From 8 to 10 in. below surface; associated with Bondaian implements. Coll. Dec 1960 and subm. by F. D. McCarthy, Australian Mus. *Comment* (F.D.McC.): dates upper period of Bondaian phase of Eastern Regional Sequence which consists, in this site, of ground-edge axes, knapped scrapers, knives, burins, *Bondi* points, geometric microliths, flake fabricators, gum hafting, *elouera* adze flake. Bones of living species of lizards and mammals present. Bondaian is middle phase of above sequence.

V-34. Site 3, 41 to 43 in.

3625 ± 70
1675 B.C.

From Layer 6, 41 to 43 in. below surface. Coll. Dec 1960 and subm. by F. D. McCarthy. *Comment* (F.D.McC.): dates upper period of Capertian culture. Uniface pebble implements in Layers 7 to 8 (49 to 72 in. below surface).

V-18. Site 3, 68 to 76 in.

7360 ± 125
5410 B.C.

From Layers 8 to 9, 68 to 76 in. below surface; associated with Capertian (oldest) phase of Eastern Regional Sequence. Coll. May 1961 by F. D. McCarthy and Donald Currie; subm. by Donald Currie. *Comment* (F. D. McC.): sample from fireplace at bottom of deposit associated with large primary flake and blade implements with dentated edges. No bone material present.

12,550 ± 185**V-35. Noola, 74 in.****10,600 B.C.**

Charcoal at depth of 74 in.; top layer of a hearth resting on a prepared floor of rounded stones. A large and characteristic implement of nosed-graver type was found in ashes. Coll. May 1961 and subm. by N. B. Tindale, South Australian Mus. *Comment* (N.B.T.): dates a Tartangan horizon.

5320 ± 90**V-36. Noola, 25 in.****3370 B.C.**

Charcoal forming single hearth at depth of 25 in., sealed below large rock slab. Coll. May 1961 and subm. by N. B. Tindale. *Comment* (N.B.T.): dates end of relatively long sterile period after Tartangan hearth (V-35), and beginning of a more intense Mudukian occupation of upper layers.

General Comment: terminology for cultural sequence in descriptions of these two sites differs due to differing interpretations of Australian pre-history by F. D. McCarthy (1948, 1949, 1958, 1963) and N. B. Tindale (1957).

200 ± 65**V-49. Mt. Grenfell Station, New South Wales****A.D. 1750**

Charcoal from depth of 7 to 8 in. in rock shelter, Mt. Grenfell Station, 30 mi NW of Cobar, New South Wales (31° 30' S Lat, 145° 35' E Long). Shelter is one of seven containing an elaborate series of paintings; deposit yielded implements characteristic of lower Murray River deposits excavated at Fromm's Landing (Mulvaney, 1960) and Devon Downs (Hale and Tindale, 1930). Implement range comprised high proportion of *tula* slugs, a few scrapers and *tula* chisels, fragments of millstones and ground edge axes, and represents most recent and modern phase of Tula Inland Sequence in central western New South Wales. Coll. Oct 1960 and subm. by F. D. McCarthy. Project was financed by Nuffield Foundation of Australia.

310 ± 75**V-50. Wuttagoona Station, New South Wales****A.D. 1640**

Charcoal from depth of 8 to 10 in. in rock shelter at Wuttagoona Station, 30 mi NW of Cobar, New South Wales (31° 20' S Lat, 145° 50' E Long). Shelter lies 10 mi NE of Mt. Grenfell Station shelter (this list, V-49) and contains similar implements and paintings. Coll. Oct 1960 and subm. by F. D. McCarthy. Project was also financed by Nuffield Foundation of Australia.

*B. Queensland***V-22. Polka Point, Stradbroke Island,
Queensland****765 ± 45****A.D. 1185**

Charcoal from shell midden at Polka Point, 1 mi N of Dunwich, Stradbroke Island, Queensland (27° 29' 40" S Lat, 153° 24' 10" E Long).

From Layer 4, ca. 1 ft below existing surface (Univ. of Qld. Anthrop. Mus. cat. no.: Brisb/1/L20/4/153). Sample coll. Aug 1961 by J. Golson and D. J. Tugby; subm. by D. J. Tugby, Univ. of Queensland.

C. Northern Territory

Macassar Well series, Milingimbi Island, Northern Territory

Shell midden at Macassar Well Mound, 500 yd W of Milingimbi Methodist Mission, Arnhem Land, Northern Territory (12° 6' S Lat, 134° 51' E Long). Well and its surrounding trees (*Tamarindus indicus*) are traditionally ascribed to Macassan trepang fishers. Site was excavated by W. L. Warner in 1927 (Warner, 1937) and, in 1948, by F. D. McCarthy and F. M. Setzler (McCarthy and Setzler, 1960). Samples were taken from an eroded section between Warner's trench and Trench B of McCarthy and Setzler. Coll. Aug 1965 and subm. by D. J. Mulvaney, Australian Nat. Univ.

V-59. Macassar Well 1

2370 ± 90

420 B.C.

Charcoal, Sample 1, from 5 ft 8 in. to 5 ft 10 in. below surface of shell mound.

V-60. Macassar Well 2

2445 ± 80

495 B.C.

Charcoal, Sample 2, from base of shell mound, 5 ft 10 in. to 6 ft 2 in. below surface. Dates earliest occupation of site.

General Comment (D.J.M.): Macassan contact is inferred to belong to the past few centuries, but it is evident from these dates that original occupation around well was much earlier than this contact period. The traditional name is, therefore, a late attribution. No Macassan-type objects have, so far, been found in excavations at the site.

Garrki series, Milingimbi Island, Northern Territory

Garrki shell mound is ca. 1½ mi SW of Milingimbi Methodist Mission, Arnhem Land, Northern Territory (12° 7' S Lat, 134° 50' E Long). Mound, now partly destroyed, is one of largest known shell mounds (diam 70 ft, present height 13 ft, but probably once over 20 ft) in Australia. Coll. Aug 1965 and subm. by D. J. Mulvaney.

V-62. Garrki 2

1170 ± 85

A.D. 780

Charcoal, Sample 2, from 7 ft 6 in. below existing surface of shell mound.

V-61. Garrki 1

1305 ± 80

A.D. 645

Charcoal, Sample 1, from base of shell mound, 13 ft below existing surface.

General Comment (D.J.M.): no evidence is available on rate of accumulation on Australian shell middens. At Garrki mound shells are loosely

piled; at Macassar Well mound they are compacted. Garrki samples were collected near perimeter; interior has been entirely removed and it was impossible to make observations on processes of stratigraphic accumulation.

D. India

Ahar mound series, Rajasthan, India

Mound of Ahar, situated 220 yd E of Ahar village and ca. 2 mi E of Udaipur city, Rajasthan, India (24° 40' N Lat, 73° 50' E Long), is a "tell" consisting of some 11 acres of occupational debris rising to maximum height of ca. 45 ft above surrounding fields. It lies on NE bank of Ahar River and is traversed by two modern roads. Since excavations there in 1955 by Shri R. Agrawala (Sankalia, 1962), mound has been known to be center of a Chalcolithic culture rich in wares of black-and-red family found at Harappan Lothal (Rao, 1959-1960) and elsewhere. It is now known that the particular ceramic complex identified at Ahar in the 1961-1962 excavations is peculiar to basin of Banas River, of which the Ahar River is a tributary. The dating range of black-and-red ware is an important desideratum because of its probable diffusion from the Banas into adjacent cultures (e.g., in Deccan and Gujarat). Ahar (Aghātapura) is first mentioned in historical literature ca. A.D. 900 (Culican, 1961-1962) when it was almost extinct.

The 1961-1962 excavations were undertaken as a joint project of Deccan College of Postgraduate Research, Poona, Rajasthan Government, and Univ. of Melbourne. Preliminary report has been published by Sankalia (1961-1962); full report is in preparation. Charcoal samples were taken from two parts of the mound: (1) Trenches Y, Z and (2) Trenches H, J, K which lie 35 yd SE of Y, Z. Datum line 00 was used for all parts of the mound, the datum point being an erect stone on highest part of mound. Dates previously obtained for Ahar mound (TF-31, TF-32, TF-34, TF-37, Tata I) indicated that Chalcolithic occupation there was largely in earlier part of second millennium B.C. (Lal, 1962-1963).

3835 ± 95

V-54. Ahar mound, Trench Z

1885 B.C.

Charcoal from hearth below shallow pottery dish in Layer 9 (37 ft below datum). Dish was associated with a jar containing copper sheeting and with piriform vessels of an unusual fabric, found also in Trench H. Coll. Feb 1962 by C. E. V. Nixon and W. Culican; subm. by W. Culican, Dept. of Semitic Studies, Univ. of Melbourne.

3715 ± 95

V-56. Ahar mound, Trench Y

1765 B.C.

Charcoal from hearth in Layer 8, ca. 37 ft below datum; associated with "tan wares", a phase of black-and-red pottery in which a light brown ochreous wash was applied to the surface. It is possible that this phase

of "tan wares" was relatively restricted. Coll. Jan 1962 and subm. by W. Culican.

V-57. Ahar mound, Trench H

3975 ± 95

2025 B.C.

Charcoal from Layer 7, 37 ft below datum; a particularly rich ceramic horizon associated with tan-slipped-and-burnished pottery. Coll. Feb 1962 and subm. by W. Culican. *Comment* (W.C.): there is some possible stylistic connection between pottery associated with V-57 and that associated with V-56.

V-58. Ahar mound, Trench J

3890 ± 100

1940 B.C.

Charcoal from Layer 10, 41 ft below datum; a level containing little pottery and lying immediately upon the shingle of an extinct river bank. Possibly represents earliest Chalcolithic occupation on the site. Coll. Feb 1962 and subm. by W. Culican.

V-55. Ahar mound, Trench K

3825 ± 120

1875 B.C.

Decayed wickerwork, probably a basket, embedded in Layer 11, a stratigraphically sealed sterile riverine clay and shingle layer, ca. 41 ft 6 in. below datum. Mud impressions of bamboo sticks were found near sample. Coll. Jan 1962 by C. E. V. Nixon; subm. by W. Culican.

III. CROSS-CHECK SAMPLES

For dates published before 1961, allowance should be made for some variation due to the differences in laboratory reference standards and also, for the earliest published dates, for absence of Suess effect correction.

V-3. Lake Nemi, Italy

Average: 2110 ± 50

160 B.C.

Wood from remains of Roman vessels attributed to Emperor Caligula (A.D. 37 to 41) which were lying at bottom of Lake Nemi, Alban Hills, near Rome (40° 43' N Lat, 12° 42' E Long, these coordinates taken from Rome II). Part of material supplied to Hl. de Vries, Groningen. Dates obtained by other laboratories: 2030 ± 200 (Ballario *et al.*, 1955); R-1, 2125 ± 75, average of 6 measurements (Bella and Cortesi, 1957); T-9, 1880 ± 130 (Nydal and Sigmond, 1957); St-103 A, 1940 ± 70, St-103 B, 2090 ± 75, av. 2010 ± 65 (Stockholm I); U-68, 1980 ± 70 (Uppsala I) to which should be added 135 ± 35 (Uppsala III); BM-15, 2080 ± 150 (British Museum I); Q-112, 1904 ± 95 (Cambridge I); R-1 remeasured, 1990 ± 85 (Rome II); U-239, 2120 ± 80 (Uppsala IV).

V-3 B.

2075 ± 70

V-3 C.

2145 ± 70

1170 ± 70

V-28. St. Walburg church, Netherlands

A.D. 780

Wood from St. Walburg church at Groningen, Netherlands (53° 12' N Lat, 6° 36' E Long. Groningen lab. obtained an average age of 1000

yr based on nine measurements (de Vries and Barendsen, 1954; for correction see Groningen IV). Other results obtained include: C-621, 2222 ± 200 (Libby, 1955); GL-23, 950 ± 80 (Zeuner, 1955); T-29, 1050 ± 100 (Nydal and Sigmond, 1957); H-8-7, 1245 ± 130 (Münnich, 1957); U-69, 1095 ± 70 (Uppsala I), to which should be added 135 ± 35 (Uppsala III); A-81 A/B, 900 ± 160 (Arizona II); L-292, 1250 ± 150 (Lamont V); K-143, 1380 ± 120 (Copenhagen III); A-81 bis, 1080 ± 140 (Arizona III); Hv-63, 1075 ± 95 (Hannover I).

2695 \pm 85

V-31. Nabu Temple, Nimrud, Iraq

745 B.C.

Charred wood from Nabu Temple at ancient Nimrud on E bank of Tigris, 22 mi S of modern Mosul ($36^\circ 11' \text{ N Lat}$, $43^\circ 20' \text{ E Long}$), Iraq. Coll. April 1962 by M. E. Mallowan, Univ. of London. Archaeological date of material should be some decades before 612 B.C. Sample has been dated by British Mus. lab. at 2400 ± 150 (BM-59, British Museum II) and by Dublin lab. at 2506 ± 140 (D-70, Dublin I). A second dating by Dublin lab., using NBS oxalic-acid standard, gave 2730 ± 120 (Dublin I).

11,660 \pm 135

V-29. Two Creeks, Wisconsin

9710 B.C.

Wood from Two Creeks forest bed (approx. $44^\circ 15' \text{ N Lat}$, $87^\circ 34' \text{ W Long}$); part of material dated by Arizona lab. (A-79). Age of forest bed, and dates obtained on materials from Two Creeks forest, are discussed by Broecker and Farrand (1963). Dates obtained by other laboratories: Y-141, 9929 ± 406 (Yale I); W-42, $11,350 \pm 120$, W-83, $11,410 \pm 180$, av. $11,370 \pm 100$ (USGS I); Y-227, $11,130 \pm 350$ (Yale II); Chicago, av. of 5 measurements, $11,404 \pm 350$ (Libby, 1955); M-342, $10,700 \pm 600$, M-343, $10,400 \pm 600$ (Michigan I); A-79 A, $12,150 \pm 400$, A-79 B, $12,000 \pm 400$, av. $12,000 \pm 280$ (Arizona II); W-670, $12,200 \pm 400$, W-698, $11,550 \pm 300$ (USGS V); L-607 A, $11,850 \pm 100$, (Broecker and Farrand, 1963).

11,245 \pm 180

V-30. Ruds Vedby, Denmark

9295 B.C.

Wood from thin layer representing pollen zone boundary II/III, Allerød-Younger Dryas, at Ruds Vedby, Zealand, Denmark ($55^\circ 32' \text{ N Lat}$, $11^\circ 22' \text{ E Long}$). Dates obtained by other laboratories: K-101, av. 3 measurements, $10,890 \pm 240$ (Copenhagen I); W-82, $10,260 \pm 200$, W-84, $10,510 \pm 180$, av. $10,400 \pm 160$ (USGS I); H-105-87, $11,500 \pm 300$ (Münnich, 1957); St-18, $10,200 \pm 370$ (Stockholm I); Gro-454, $10,995 \pm 250$ (Groningen II, for correction see Groningen IV); U-20, $10,830 \pm 130$, U-75, $10,680 \pm 130$ (Uppsala I), to which should be added 135 ± 35 (Uppsala III); BM-19, $11,333 \pm 200$ (British Museum I); K-101 bis, recalculated, $11,090 \pm 240$ (Copenhagen III); R-64, $11,900 \pm 170$ (Rome II); R-64, remeasured, $11,200 \pm 145$ (Rome III); K-101, remeasured, $10,970 \pm 120$ (Copenhagen VI).

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UNIVERSITY OF WISCONSIN RADIOCARBON DATES II

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This report summarizes the radiocarbon dates obtained at the University of Wisconsin since November 1964; the procedures followed have been described previously (Wisconsin I, 1965).

The counting equipment has been supplemented with a second detector of 500 ml volume for which the nominal background at 1 std atm, 298.2° K, is 2.1 cpm as determined with petroleum methane (Phillips Petroleum Co.). The corresponding standard count for contemporary methane derived from NBS oxalic acid 95% A_{ox} , is nominally 2.8 cpm at 1 std atm, 298.2° K. The additional counting equipment was also obtained from the Sharp Division of Beckman Instrument Co.

The dates reported have been calculated on the assumption of a half-life of 5568 yr for C^{14} , with 1950 as the reference year. Samples have normally been run at 3 atm pressure for a minimum of 15,000 counts. The standard deviation quoted includes only the 1σ of the counting statistics of background, sample, and standard counts.

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Mill Creek Series, Iowa

Witrock site, Iowa 130B4

Samples from Witrock village site (43° 0' N Lat, 95° 30' W Long), coll. in 1963 by A. E. and D. R. Henning, Univ. of Wisconsin, Madison; subm. by D. A. Baerreis.

WIS-51. Witrock site (130B4)

440 ± 80

A.D. 1510

Bone from uppermost level of occupation of site, 9 in. below surface; represents most recent occupation of site.

B. Oneota Series, Iowa

Units of the widely distributed Oneota culture have been interpreted as reflecting a shift from a marked dependence on agriculture to a heavier emphasis on hunting which is associated with a decline in cultural level. These changes are regarded as being the consequence of the

onset of cooler weather conditions with a shorter growing season. The period of gradual decline is thought to fall between A.D. 1300 to 1650, during the episode dating between A.D. 1200 and 1700 and having the appropriate climatic characteristics (Griffin, 1961). The dates were secured as part of a project to test the hypothesis of climatically induced culture change.

Correctionville site, Iowa (13WD7)

Correctionville site (13WD7) located on Little Sioux River in Woodbury County, Iowa (42° 30' N Lat, 95° 45' W Long) is in process of being destroyed by gravel removal operations. Since no white trade goods have been found, it is assumed to be prehistoric. Charcoal from site was obtained in 1963 by D. R. Henning, Univ. of Wisconsin; subm. by D. A. Baerreis.

290 ± 90

WIS-35. Correctionville site (13WD7) A.D. 1660

Sample was collected from Trash Pit #1 and was in association with artifacts typical of Oneota occupation in NW Iowa.

410 ± 80

WIS-71. Correctionville site (13WD7) A.D. 1540

Sample from Trash Pit #3 which contained an abundance of cultural material.

Dixon site, Iowa 13WD8

Dixon site is located on Little Sioux River S of Anthon, Woodbury County, Iowa (95° 45' W Long, 42° 15' N Lat). Site has been described as covering at least 80 acres and as being prehistoric in that no trade goods indicative of white contact have been found (Henning, 1961, p. 17). Charcoal samples dated were secured in excavations conducted in 1964 and 1965 under supervision of A. E. and D. R. Henning; subm. by D. A. Baerreis.

a) 280 ± 70

A.D. 1670

b) 350 ± 80

A.D. 1600

WIS-59. Dixon site (13WD8)

Sample from Feature 13 (Sq. 60 R 5), a storage pit within house pattern along N wall.

500 ± 75

WIS-104. Dixon site (13WD8) A.D. 1450

Sample collected from Pit #7, one of many trash pits along river bank. As in the other features, cultural material, ash, and charcoal occurred throughout pit.

575 ± 70

WIS-105. Dixon site (13WD8) A.D. 1375

Sample collected from upper half of Pit #6, a trash pit along river

bank. Cultural material was found throughout pit; human bones lay in lower portion.

- 690 ± 80**
- WIS-107. Dixon site (13WD8)** **A.D. 1260**
 Sample from bottom of Pit #6. Human bone described in WIS-105 lay immediately above matrix from which WIS-107 was collected.
- 590 ± 100**
- WIS-91. Dixon site (13WD8)** **A.D. 1360**
 Collected from Pit #2, a trash pit along river bank.
- 680 ± 75**
- WIS-106. Dixon site (13WD8)** **A.D. 1270**
 Sample from Pit #5, a trash pit along river bank.
- 650 ± 80**
- WIS-111. Dixon site (13WD8)** **A.D. 1300**
 Sample from Pit #11, a trash pit along river bank.
- 630 ± 90**
- WIS-86. Dixon site (13WD8)** **A.D. 1320**
 Collected from Feature 8, Sq. 50 R 15, 8 to 12 in. below surface. Feature 8, a deposit of ash, charcoal, and trash, was within the house pattern.
- 640 ± 80**
- WIS-87. Dixon site (13WD8)** **A.D. 1310**
 Collected 12 to 14 in. below surface in an area of burned earth, probably hearth or fireplace, within house pattern, in Sq. 45 R 20.
- 820 ± 80**
- WIS-56. Dixon site (13WD8)** **A.D. 1130**
 Collected from Pit #3, one of many trash pits along river bank.
- 850 ± 80**
- WIS-53. Dixon site (13WD8)** **A.D. 1100**
 Collected from an ash lens just exterior to S wall of house pattern, 14 to 16 in. below surface (Sq. 30 R 25).
- 1020 ± 80**
- WIS-54. Dixon site (13WD8)** **A.D. 930**
 Collected at 12 to 18 in. below surface in Feature 1 (Sq. 35 R 25), a concentration of cultural debris along S wall of house pattern.

C. Oneota Series, Missouri

Guthrey site, Missouri 23SA131

This prehistoric Oneota component is located in Saline County, Missouri, adjacent to Missouri River (93° 11' W Long, 39° 20' N Lat). Charcoal samples were recovered in excavations conducted in summer of 1964 under supervision of D. R. Henning; subm. by D. A. Baerreis.

- WIS-75. Guthrey site (23SA131)** **560 ± 80**
A.D. 1390
Collected from Feature 2 (Sq. 45 R 40, Area #1), a trash pit containing cultural material. Sample was collected 12 to 18 in. below surface from same trash pit as WIS-64.
- WIS-64. Guthrey site (23SA131)** **750 ± 80**
A.D. 1200
Charcoal from Feature 2.
- WIS-65. Guthrey site (23SA131)** **520 ± 75**
A.D. 1430
Sample collected from concentration of trash in pit, Feature 14 (Sq. 2) in Test Area F. Matrix included pottery, artifacts, bone, ash, and charcoal.
- WIS-82. Guthrey site (23SA131)** **620 ± 75**
A.D. 1330
Sample from Feature 6 (Sq. 50 R35, Area 1), a trash pit, 12 to 18 in. below plow zone.
- WIS-78. Guthrey site (23SA131)** **580 ± 80**
A.D. 1370
Sample collected 16 to 20 in. below surface in Feature 9 (Sq. 45 R 25, Area 1), a double trash pit; sample from E pit which contained pottery fragments, stone, bone, and an antler tool.
- WIS-81. Guthrey site (23SA131)** **600 ± 80**
A.D. 1350
Sample collected from Feature 12 (Sq. 1, Test Area E), a trash pit containing pottery, chert flakes, bison scapula, and a corn cob fragment.

D. Oneota Series, Wisconsin

Lasley's Point village site, 47WN96

This site (88° 41' W Long, 44° 08' N Lat) on E shore of Lake Winnebago in Winnebago County, Wisconsin, has been assigned to Lake Winnebago Focus (McKern, 1945, p. 126, 163). The series of "mounds," of which 55 have been listed in print (Bullock, 1942, p. 35-36), are discrete refuse accumulations. Earlier dates for this complex as opposed to the Midway site would seem to confirm Hall's interpretation (1962, p. 107) of the resemblances of some Lasley's Point materials to his Developmental Oneota horizon. Charcoal samples were collected in summer of 1964 through excavations supervised by G. Richard Peske, Univ. of Wisconsin; subm. by D. A. Baerreis.

- WIS-62. Lasley's Point (47WN96)** **780 ± 80**
A.D. 1170
Sample from refuse heap, Test Pit 15, Mound K, which contained bone, charcoal, shell, pottery, and copper.

WIS-47. Lasley's Point (47WN96) 780 ± 80 A.D. 1170

Collected from Feature 2, an aboriginal fire pit or hearth, 10 to 12 in. below surface. Feature (excavation unit 1550-5090) was located in unstratified refuse midden heap.

WIS-50. Lasley's Point (47WN96) 960 ± 70 A.D. 990

Sample from Test Pit 16, Levels 2 and 3 in N portion of site. Levels are within an unstratified refuse heap which included sherds, animal bone, corn, nuts, and seeds.

WIS-57. Lasley's Point (47WN96) 680 ± 80 A.D. 1270

Collected 8 to 10 in. below surface from Level 4 of excavation unit 1550-5090 within a refuse heap.

Carcajou Point site, Wisconsin, 47JE2

Recent work of Robert L. Hall (1962) at Carcajou site on Lake Koshkonong, Jefferson County, Wisconsin (42° 53' 22" N Lat, 88° 57' 30" W Long), has demonstrated that the occupation spans several stages in the development of the Oneota tradition. Two radiocarbon dates (M-786: A.D. 900 ± 250, and M-785: A.D. 1020 ± 250, Michigan IV) place "Emergent Oneota horizon" as represented at Carcajou component of Koshkonong focus as roughly ca. A.D. 1000. A third date (M-747: A.D. 1520 ± 250, Michigan IV) is indicative of the range of occupation as indeed are the abundant trade goods of the historic period. Charcoal from site was coll. by G. R. Peske in 1964; subm. by D. A. Baerreis.

WIS-76. Carcajou Point (47JE2) modern
Sample from Feature 12, a refuse pit with Koshkonong focus materials.

WIS-77. Carcajou Point (47JE2) 1060 ± 80 A.D. 890

Sample from Feature 2, Level 2, a refuse pit with Koshkonong focus material, animal bones, corn, and copper.

Midway village site, Wisconsin, 47LC19

One of the three components, located in La Crosse County, on the basis of which W. C. McKern (1954) described the Orr focus in Wisconsin. Limited excavations were conducted at the site (43° 55' N Lat, 91° 30' W Long) by Guy Gibbon, Univ. of Wisconsin, during the summer of 1964 at which time the charcoal samples were obtained. Although trade goods are absent in the Wisconsin site, a late time placement is to be expected considering the resemblances to the related Orr focus sites in Iowa, where trade goods are prevalent.

320 ± 60

WIS-79. Midway village site (47LC19) A.D. 1630

Sample was collected from 36 to 40 in. below surface from Feature 5, Test Pit 1, in association with artifacts of Upper Mississippi temper and design.

530 ± 70

WIS-61. Midway village site (47LC19) A.D. 1420

Sample was 2.5 to 3 ft below surface in Test Pit 20 in center of small refuse area. Associated with pottery, shell, and bones of fish and mammals.

E. Aztalan Series, Wisconsin

The dates now available for Aztalan (M-1307: A.D. 750 ± 150, Michigan VII), M-1214: A.D. 1370 ± 100, Michigan IX, and M-642: A.D. 1620 ± 200, Michigan IV), a Middle Mississippi site on Crawfish River in Jefferson County, Wisconsin, represent an unacceptable span of time for the site. Robert Ritzenthaler (1963, p. 180) regards the A.D. 1370 date as the most "agreeable" thus far obtained for the site. James B. Griffin (1964, p. 250-1) interprets the northern and northwestern push of the Old Village culture as taking place during a relatively mild climatic period from ca. A.D. 700 to 1200. From this point of view, the A.D. 1370 date would be too late while the earlier A.D. 750 date is within the suggested span of time. The tight cluster of new dates from the twelfth and early thirteenth centuries supports the later time placement but also confirms the appropriateness of the climatic episode assignment.

Aztalan village site, 47JE1

Charcoal samples from Aztalan (43° 04' N Lat, 90° 29' W Long). Coll. 1964 under supervision of J. E. Freeman and J. Brandon, Wisconsin Hist. Soc., Madison; subm. by D. A. Baerreis.

820 ± 80

WIS-63. Aztalan site (57JE1) A.D. 1130

Sample coll. 0.9 ft from surface from ash layer in Feature 1 (64) in Sq. N 275-R 83 and R 84, N 276-R 83 and R 84. Feature was 0.5 ft from present surface, maximum depth 1.2 ft.

730 ± 80

WIS-74. Aztalan site (47JE1) A.D. 1220

Sample from pit 1 ft below present surface, maximum depth 3.0 ft in Feature 42 (64), Sq. N 261-R 81. Charcoal was in association with double-pointed bone needles, shell, and grit tempered pottery.

820 ± 80

WIS-73. Aztalan site (47JE1) A.D. 1130

Collected from Mound 3, Feature 49, N 299-R 111, maximum depth 1.1 ft. In association with grit and shell tempered pottery.

850 ± 80

WIS-68. Aztalan site (47JE1)**A.D. 1100**

Sample collected from Feature 17a (64), Sq. N 279-R 83 and N 280-R 83, at depth of 2.5 ft from present surface. Feature was circular in plan, 4.4 ft in diam, contained charred corn cob, sherds of shell and grit tempered wares, charcoal, and a piece of sheet copper.

F. Panhandle Aspect Series, Texas and Oklahoma

Samples from various Panhandle aspect sites were dated to test a hypothesis, based on climatological data, that the Panhandle region of Texas and Oklahoma was occupied by farming peoples derived from a Central Plains tradition after a climatic shift dated around A.D. 1250 produced drought conditions in western Kansas and Nebraska. Trade sherds from the Pueblo area had indicated a time range between A.D. 1300 and 1450 but no sites had been dated by radiocarbon techniques. Samples from the site in the Oklahoma Panhandle (TxStI) were provided by James A. Brown, Stovall Mus. of Science and History, Univ. of Oklahoma, Norman. Those from site PT-25 were subm. by F. E. Green, The Museum, Texas Technological College, Lubbock. The remaining samples were provided by Jack T. Hughes, Panhandle-Plains Hist. Mus., Canyon, Texas. Six samples from the same series were also dated by the Radiocarbon Dating Lab. of the Univ. of Texas, four of these being from sites that were also dated in the Wisconsin lab.

Stamper site, Texas County, Oklahoma TxStI

Charcoal from Stamper site (36° 43' N Lat, 101° 20' W Long). Coll. in 1934 by C. S. Johnston.

650 ± 70

WIS-83. Stamper site (TxStI)**A.D. 1300**

Sample from refuse pit in a trench NE of House 3 ("large house") and E of House 8 ("kiva") at depth of 20 in.

650 ± 80

WIS-84. Stamper site (TxStI)**A.D. 1300**

Charcoal from charred posts overlying a layer of charred seeds and grass upon SE corner of floor of House 3 ("x" [H & B] #335), evidently part of burnt walls or roof of house.

Coetas ruin, P-PHM site A611, Texas

Charcoal from Panhandle aspect village near Canadian River, Site A611, Studer site 55 (35° 30' N Lat, 101° 44' W Long). Coll. 1965 by J. T. Hughes; subm. by D. A. Baerreis.

690 ± 60

WIS-92. Coetas ruin**A.D. 1260**

Sample from midden.

	a)	490 ± 70
		A.D. 1460
	b)	520 ± 85
		A.D. 1430

WIS-94. Coetas ruin
Sample from room fill.

	520 ± 70
	A.D. 1430

WIS-89. Coetas ruin
Sample from room fill.

	800 ± 75
	A.D. 1150

WIS-95. Coetas ruin
Sample from room floor.

Alibates ruin, P-PHM site A45, Texas

Charcoal from Alibates ruin, Studer site 28, Panhandle aspect village on Canadian River ($35^{\circ} 34' N$ Lat, $101^{\circ} 40' W$ Long). Coll. 1939 by Ele M. Baker, Panhandle-Plains His. Mus., Canyon, Texas; subm. by D. A. Baerreis.

	600 ± 70
	A.D. 1350

WIS-101. Alibates ruin
Sample from Room 24.

Potter County site, Texas, PT-25

Charcoal from Antelope Creek focus, Potter County, Texas ($35^{\circ} 32' 20'' N$ Lat, $101^{\circ} 46' 25'' W$ Long). Coll. 1964 by F. E. Green; subm. by D. A. Baerreis.

	a)	420 ± 80
		A.D. 1530
	b)	520 ± 80
		A.D. 1430

WIS-99. Potter County, Texas (PT-25)
Sample from floor of Room 1 (15N-7W).

	520 ± 70
	A.D. 1430

WIS-102. Potter County, Texas (PT-25)
Sample from Room II, Post Hole 2.

Handley ruin, P-PHM site A609

Charcoal from Texas Panhandle aspect village on Wolf River, P-PHM site A609 ($36^{\circ} 13' N$ Lat, $100^{\circ} 40' W$ Long). Coll. 1965 by J. T. Hughes; subm. by D. A. Baerreis.

	360 ± 75
	A.D. 1590

WIS-97. Handley ruin
Sample from midden near Moorehead's "Handley Ruin."

a) 640 \pm 70

A.D. 1310

b) 740 \pm 80

A.D. 1210

WIS-90. Handley ruin

Sample from midden near Moorehead's "Handley Ruin."

Palisades shelter, P-PHM site A530

Charcoal from Texas Panhandle aspect site, Palisades shelter, in Palo Duro Canyon (35° 04' N Lat, 101° 48' W Long). Coll. by J. T. Hughes; subm. by D. A. Baerreis.

a) 630 \pm 75

A.D. 1320

b) 600 \pm 75

A.D. 1350

WIS-108. Palisades shelter

Samples from Sq. 5, 30 to 36 in. depth.

330 \pm 75**WIS-98. Palisades shelter**

A.D. 1620

Collected from fire pit at depth of 36 in.

Currie ruin, P-PHM site A254

Charcoal from Panhandle aspect house in Palo Duro Canyon (35° 03' N Lat, 101° 46' W Long). Coll. 1956 by J. T. Hughes; subm. by D. A. Baerreis.

670 \pm 75**WIS-100. Currie ruin**

A.D. 1280

Sample from house fill.

II. GEOLOGIC SAMPLES

*A. Northwest Territories***Southwest Keewatin series**

Previous samples of this series were from charcoal layers over podzol soils, collected to establish dates and extent of former forest in southern Canadian tundra (Bryson *et al.*, 1965). Two extensive podzol-forming episodes were identified. Present samples are mostly from a muskeg monolith taken from one of the sites used in that study (WIS-7, Wisconsin I) to study vegetative history of the region in greater time detail.

This monolith was coll. by R. A. Bryson in 1963 from a peat bank on shores of Ennadai Lake at 61° 10' N Lat, 100° 55' W Long, ca. 5 km N of Ennadai Aeradio Station. It consisted of ca. 1.5 m of sphagnum peat including several charcoal horizons, and extended from the present surface down to permafrost. Two-cm-thick slices were cut from the block and subm. by H. Nichols, Univ. of Wisconsin, for dating.

The Ennadai peat bank began to accumulate after the draining of glacial Lake Kazan, which in turn is post-Cochrane-Cockburn according to the map of Falconer *et al.* (1965).

The latitude and longitude given above is corrected location for WIS-7 (Wisconsin I).

WIS-88. Ennadai Lake, N.W.T. **1510 ± 80**
A.D. 440

Sample from peat bank, 20 to 22 cm depth.

WIS-96. Ennadai Lake, N.W.T. **1530 ± 80**
A.D. 420

Humified sphagnum peat with charcoal fragments, 32 to 34 cm depth.

WIS-93. Ennadai Lake, N.W.T. **2670 ± 105**
720 B.C.

Sample from peat bank, 54 to 56 cm depth.

WIS-80. Ennadai Lake, N.W.T. **3650 ± 100**
1700 B.C.

Wood of *Larix* from 88 to 90 cm level in peat bank. Sample is from charcoal horizon which includes *Picea* wood and carbonized needles.

a) **5570 ± 100**
3620 B.C.

b) **5720 ± 110**
3770 B.C.

WIS-85. Ennadai Lake, N.W.T.

Fossil sphagnum peat, 130 to 132 cm below surface.

WIS-67. Ennadai Lake, N.W.T. **5780 ± 110**
3830 B.C.

Fossil sphagnum peat 148 to 150 cm below surface, immediately overlying a charcoal horizon. Is deepest level of organic samples recovered from Ennadai Lake. It thus provides minimum age for disappearance of late-Wisconsin ice in this area and for subsequent draining of glacial Lake Kazan.

WIS-52. Dubawnt Lake, N.W.T. **3540 ± 110**
1590 B.C.

Charred wood and forest duff from a 15-ft square of charcoal overlying grey and red soil presumed to be A₂ and B horizon of a podzol exposed by recent deflation of (presumably thin) sand overburden. From S end of Dubawnt Lake, 10 mi N of mouth of Kamilukuak River on a low gravel point, E of sand dunes 100 yd N of a bedrock hill (62° 47' 45" N Lat, 101° 48' 45" W Long). Coll. 1963 by W. N. Irving, Natl. Mus., Ottawa; subm. by R. A. Bryson.

B. Manitoba

Samples from near Lynn Lake, Manitoba, were coll. from a 1.5-m peat bank overlooking a lake (56° 50' N Lat, 101° 3' W Long). The

organic material rested conformably on a grey-blue lacustrine clay deposited in the proglacial lake during melting of late-Wisconsin ice in this area. Most of the section consisted of lake mud and sedge peat with sphagnum peat only in the top 20 cm. Samples were analyzed for fossil pollen and spores and a pollen diagram has been constructed. Dates reported here are for vegetational changes reflected in the diagrams. Since lower m of Lynn Lake peat bank was frozen at time of collection, dynamite was employed to shatter face of the bank in such a way that an approximately vertical and continuous section of peat could be removed. This was later divided into 2-cm-thick horizontal slices for macrofossil analysis and C^{14} assay. Coll. 1964 and subm. by H. Nichols, Univ. of Wisconsin, Madison.

WIS-113. Lynn Lake, Manitoba

**2170 \pm 80
220 B.C.**

Fossil sedge peat (*Carex*) from 34 to 36 cm below surface of peat bank.

a) **5140 \pm 100
3190 B.C.**

b) **5130 \pm 100
3180 B.C.**

WIS-112. Lynn Lake, Manitoba

Carex from 68 to 70 cm below surface.

**5970 \pm 110
4020 B.C.**

WIS-66. Lynn Lake, Manitoba

Carex from 118 to 120 cm below surface.

**6060 \pm 110
4110 B.C.**

WIS-60. Lynn Lake, Manitoba

Carex from 120 to 122 cm below surface.

**6530 \pm 130
4580 B.C.**

WIS-72. Lynn Lake, Manitoba

Blue-grey silty clay and lake mud at base of peat bank, 130 to 140 cm below surface. Date provides minimum age for local disappearance of late-Wisconsin ice sheet.

C. Colorado

**WIS-69. Engineer Mountain Bog, San Juan
Mountains, Colorado**

**2520 \pm 90
570 B.C.**

Sedge peat with wood fragments from bog 0.6 mi N of S boundary of San Juan County, W of U. S. Highway 550 (107° 48' W Long, 37° 39' N Lat), 8825 ft above sealevel. Sample taken with Livingstone piston sampler from N side of open-water section of bog on floating sedge mat, from 183 to 203 cm depth in bog sediment core; underlies sand layer at 180 cm. Coll. 1963 and subm. by L. J. Maher, Jr., to date sediments used in a pollen study.

WIS-70. Engineer Mountain Bog, San Juan Mountains, Colorado **4170 \pm 100**
2220 B.C.

Sedge peat with wood fragments from same location as WIS-69. From 243 to 261 cm depth, level with lowest organic material.

III. CHECK SAMPLES

WIS-58 **1000 \pm 65**
A.D. 950

Same as M-1293, A.D. 760, charcoal from Cahokia, Illinois, Site Ms-2-2, Feature 227 (Michigan VIII).

WIS-110 **1190 \pm 80**
A.D. 760

Same as P-643, A.D. 729 \pm 54, *Sequoia gigantea*, P-SW-SEQ-2, dendrochronologically dated to A.D. 650 \pm 5 (Pennsylvania VIII).

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ON THE RELATIONSHIP BETWEEN RADIOCARBON DATES AND TRUE SAMPLE AGES

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The result of a radiocarbon determination is commonly expressed as an age given in radiocarbon years. An error is usually assigned to each value as a measure of the statistical uncertainty of the measurement. Date lists published in this journal use a standard form of reporting dates and their errors (see Editorial Statements in Radiocarbon, v. 3 and v. 4). The conversion of a radiocarbon age, given in radiocarbon years B.P. (i.e., radiocarbon years elapsed since the origin of the sample) to a true calendar year makes necessary certain assumptions with respect to: (1) the half-life of C^{14} , (2) the production rate of C^{14} by cosmic rays, (3) the size of reservoirs into which C^{14} is distributed and the exchange rate of this distribution. Libby (1955, p. 10) has shown that as an approximation one may assume that reservoir size and production and distribution rates, and therefore the C^{14} activity in atmospheric CO_2 have been constant. However, the more accurate measurements of recent years have shown that at least one of these quantities must have varied with time. This means that a more complicated relationship exists between radiocarbon age and exact calendar age of a sample than had been assumed by Libby. This relationship cannot be determined theoretically, but can be derived empirically by determination of the radiocarbon contents of samples of known age. The following summarizes our present knowledge regarding differences between radiocarbon ages and true ages and the present status of the empirical calibration of the radiocarbon time scale.

Fluctuations of the C^{14} activity of the atmospheric CO_2 with time can be expected on various theoretical grounds. A change in CO_2 content of the atmosphere or a change in the mixing rate of the ocean could lead to a perturbation of the atmospheric C^{14} inventory. It has been pointed out by Libby (1963) and Wood and Libby (1964) that these changes have to be either improbably large or of long duration in order to affect the specific C^{14} activity in the biosphere to a measurable degree. Because of the long average lifetime of C^{14} (ca. 8000 yr), the C^{14} inventory responds to such changes extremely slowly, i.e., on a time scale of thousands of years. However, because of a delay of some 10 yr in the CO_2 exchange between atmosphere and ocean (Revelle and Suess, 1957), and because of the slow mixing of surface water into deeper layers of the ocean (Bien, Rakestraw and Suess, 1963; Suess, 1954), the response of atmospheric C^{14} to such changes is faster than that of the whole C^{14} inventory on the Earth's surface. There are no observations that would indicate that a change of the required magnitude (of the order of 30

percent) has taken place in the CO_2 concentration in the atmosphere or in the mixing properties of the oceans. We know, however, that the production rate of C^{14} by cosmic rays undergoes large variations because of a modulation of the galactic cosmic ray flux by the sun. According to Lingenfelter (1963), this change in C^{14} production rate is approx. 30 percent during an 11-year cycle. J. A. Simpson, University of Chicago (pers. commun.) believes that such change can at times reach perhaps a factor of 2.

De Vries (1958) was the first who noticed discrepancies between radiocarbon and calendar ages of wood known to date from ca. A.D. 1700 and A.D. 1500. De Vries suspected a correlation with climatic events, in particular for the period often called the "little ice age." Independently, one of us (Stuiver, 1961) has pointed out that the available C^{14} data from wood of known age indicate a correlation between C^{14} inventory and solar activity. The more recent measurements by Stuiver (1965) for the 18th and 19th centuries, as well as by Suess (1965) for the second millennium A.D. confirm the correlation and show it to be the one predicted by cosmic ray observations.

Although historical records make it possible to retrace the magnitude of solar activity and sunspot numbers to the time of Christ (Schove, 1955), quantitative records of sunspot numbers date back to the 17th century only. Variations of C^{14} activity can be determined as far back as wood is available that can be precisely dated by tree-ring studies. According to C. W. Ferguson of the Arizona Tree-Ring Laboratory (pers. commun.), bristlecone pine wood more than 6000 yr old will soon be available for C^{14} measurements. So far, the oldest reliable data are for wood from *Sequoia gigantea* and for historically dated wood from Egyptian tombs from the second millenium B.C. The C^{14} measurements indicate that the solar-induced changes of a few percent in C^{14} activity are superimposed upon larger changes on a longer time scale. This appears to be true in particular for the last two or three millenia B.C., when the specific C^{14} activity of the biosphere appeared to decrease steadily by ca. 0.4 percent per century (Suess, 1960; Damon and others, 1966).

The cause for the long-term variation of the C^{14} level is not known. The variation is certainly partially the result of a change in the cosmic ray production rate of radiocarbon, but climatic conditions that affect ocean mixing or atmospheric CO_2 may contribute to its magnitude. The change in C^{14} production rate and in climate may well have a common cause in the activity of the sun (Suess, 1966). The cosmic-ray flux, and hence the production rate of C^{14} , is a function not only of the solar activity but also of the magnetic dipole moment of the Earth (Elsasser and others, 1963; Kigoshi and Hasegawa, 1966). There are indications that this dipole moment has changed over the past 6000 yr, but the extrapolation of single measurements to total earth dipole moments make quantitative correlations unreliable.

In any case it is presently impossible to determine on theoretical ground, what the relationship is between a radiocarbon date and the true age of a sample. However, the work of tree-ring laboratories promises to make available precisely dated samples many thousand years old so that it will be possible to establish an empirical correction table relating radiocarbon ages to the true ages of the sample. Establishment of such an empirical correlation table will require an enormous amount of work involving at least six precision measurements per century as far back as tree-ring dated wood is available. So far, sufficient measurements have been made only for the second millennium A.D., and for the prior time approximate corrections can be but suggested. In general, radiocarbon dates since A.D. 1000 are too young; one of the larger deviations is around A.D. 1700 when radiocarbon ages erroneously suggest 19th century material. Radiocarbon dates from the first millennium A.D. are generally 50 to 100 yr too old. However, there may be a fine structure in this trend. Samples from the 7th century A.D., for example, may not require such a correction. For the period before 250 B.C. radiocarbon ages are too young again, the correction being roughly proportional to the calendar year B.C.

Conditions during glacial times may have been considerably different. An evaluation of all the factors indicates a possibility that the C^{14} inventory differed from the present by as much as 20 to 30 percent. This would introduce an error of 2000 to 2500 yr for samples from glacial times (Suess, 1960, 1966). Such an error for many Pleistocene samples will not greatly affect conclusions based upon C^{14} measurements.

Radiocarbon data given in the literature are calculated with the so-called conventional Libby half-life of 5568 yr. The average of the most recent measurements gives the more accurate value of 5730 ± 30 yr (Mann and others, 1961; Olsson and others, 1962, 1963). An increase of 2.9 percent for all the C^{14} ages quoted in the literature would, therefore, give a better approximation to the true age than the values currently listed. The difference, however, is negligible and unimportant compared with the above-mentioned corrections necessary for converting radiocarbon years into calendar years. This is one reason that it was decided at the Pullman Radiocarbon Conference, June 1965, that the conventional Libby half-life of 5568 yr should be retained for calculating radiocarbon dates.

The possibility of establishing correction tables for the conversion of conventional radiocarbon dates to true age depends on whether or not the variations in the C^{14} activity of the atmosphere and biosphere are world-wide phenomena. A comparison of samples from different geographical areas indicates that this is indeed the case, although there are indications of small variations with geographical latitude. Vogel (1965), who compared samples from North America, Europe, and the southern hemisphere, lists differences of the order of 5 per mil (corresponding to a 40 yr radiocarbon "age" difference). In North America

the differences seem to be less than 5 per mil (Stuiver, 1965). We can therefore consider variations in atmospheric C^{14} to be world-wide phenomena.

The data obtained so far from samples of known age permit calibration of the radiocarbon time scale for the last 1000 yr. Table 1, which gives the conversion of true ages to radiocarbon ages and vice versa, is based on measurements at La Jolla (Suess, 1965) and, for the period A.D. 1700-1800, on measurements of the Yale Radiocarbon Laboratory (Stuiver, 1965).

The laboratory standard in general use for the determination of radiocarbon ages is oxalic acid, supplied by the Bureau of Standards. Ninety-five percent of the activity of the oxalic acid corresponds by international agreement with the natural C^{14} activity of wood grown in A.D. 1950, after correction for isotopic fractionation and for industrial (fossil) CO_2 in the atmosphere. The original La Jolla radiocarbon data were derived by comparison with wood from a fir tree grown in Oregon between 1870 and 1880, while the Yale measurements were made with oxalic acid as the standard. The La Jolla results have been converted

TABLE 1

Radiocarbon ages and true ages for the last 2000 yr. The radiocarbon ages are based on a half life of 5568 yr; the standard year of reference is A.D. 1950. For each calendar year only one radiocarbon age exists, whereas a radiocarbon age may correspond to more than one true age.

Calendar Year	True Age	Radiocarbon Age	Calendar Year	True Age	Radiocarbon Age
A.D. 1800	150	130	A.D. 1320	630	610
1780	170	150	1300	650	650
1760	190	100	1280	670	690
1740	210	130	1260	690	710
1720	230	100	1240	710	710
1700	250	80	1220	730	730
1680	270	120	1200	750	920
1660	290	170	1180	770	910
1640	310	280	1160	790	890
1620	330	330	1140	810	880
1600	350	340	1120	830	900
1580	370	320	1100	850	920
1560	390	270	1080	870	930
1540	410	250	1060	890	950
1520	430	280	1040	910	970
1500	450	330	1020	930	990
1480	470	370	1000	950	1000
1460	490	420	250 B.C. to A.D. 1000; radiocarbon ages are generally ca. 50 to 100 yr older than true ages, but deviations from this rule are possible.		
1440	510	470			
1420	530	490			
1400	550	550			
1380	570	580			
1360	590	600			
1340	610	610			

to the oxalic acid standard by comparing the results of 16 tree-ring measurements of the 18th and 19th centuries with similar tree-ring measurements at Yale. The resulting correction to the La Jolla measurements amounts to only 3.6 per mil in C^{14} activity, corresponding to 30 radiocarbon yr. The error introduced by the change of reference standard is small and probably does not exceed 20 yr. The statistical variations in the actual measurements are largely removed by the smoothing, necessary to graduate the data, but they leave a residual uncertainty in the calibrated data of ca. ± 30 yr. However, the existence of short-term oscillations may introduce an additional uncertainty of the same order of magnitude.

Although for each calendar year there is only one radiocarbon age, the reverse is not true. This is illustrated in Fig. 1; in some instances a series of true ages exists for one radiocarbon age. This is especially true for the last 500 yr. The figure representing the relation between radiocarbon ages and true ages is a slight modification of the figure published by Suess (1965, p. 5950); the main difference is inclusion of the correction for the La Jolla reference standard.

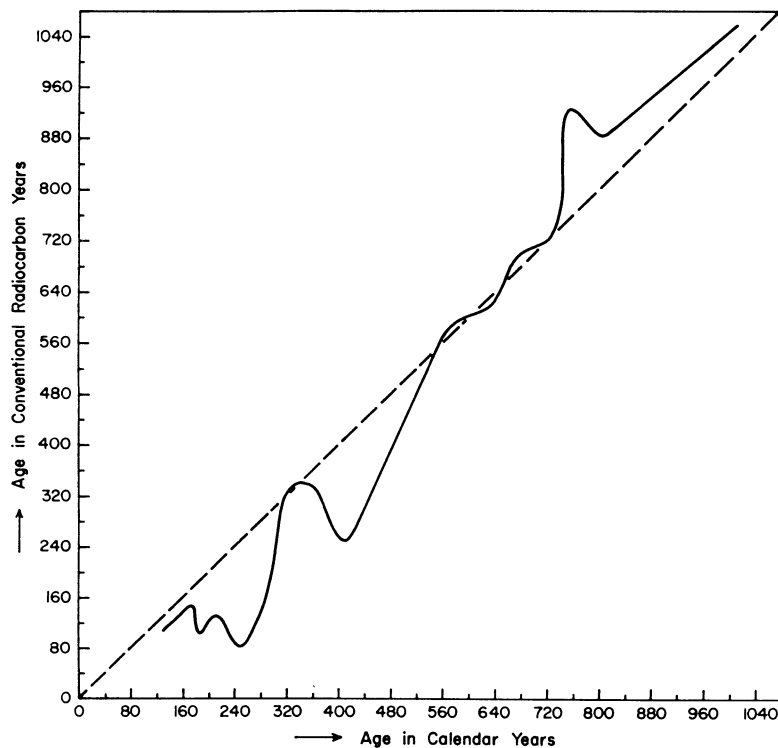


Fig. 1. The relation between radiocarbon ages and true ages for the last millennium.

Work is now in progress to extend the calibration of the radiocarbon time scale back to the time before Christ, as far as dendro-chronologically dated wood samples are available. The analyses of tree-rings and of historically dated Egyptian samples carried out so far indicate a decreasing C^{14} activity for the time from ca. 4000 B.C. to ca. 200 B.C. Therefore, the discrepancy between true ages and radiocarbon ages for this period is rapidly increasing with increasing age. A radiocarbon age of 4000 yr, for example, corresponds to a true age more than 500 yr greater. As a crude approximation the true age T can be estimated from the radiocarbon age R by using the equation

$$T = 1.4 R - 1100.$$

Superimposed upon the trend of this type, however, are fluctuations of the type observed during the past 1000 yr, as shown in Fig. 1. It therefore appears premature to attempt corrections of radiocarbon ages for B.C. times as long as the accurate calibration data have not been determined.

The ultimate refinement of the radiocarbon dating method by applying empirical corrections still leaves well-known possibilities of errors through admixture of older carbon in lacustrine materials or through contamination of the sample with foreign carbon such as that of humic acid, roots, and other substances present in soils. Other errors may arise from effects of the local C^{14} environment in dense forests and near the ground, due to bacterial decomposition of soil components (Keeling, 1961). Also, uptake of carbonate ions through the roots of the growing plants can lead to small differences of the order of a few per mil of C^{14} (equivalent to age differences of the order of 10 yr), although the uptake of carbon by the roots of trees has been found to be negligible.*

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¹ The H³-Laboratorium of this institute (directed by Klaus Fröhlich) should be addressed separately.

² This designation 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 Dates from this laboratory have usually been 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 Some dates from this laboratory were published with the code designation S (Pringle and others, 1957, Science, v. 125, p. 69-70).

⁶ See SM.

⁷ See Gif.

⁸ 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.

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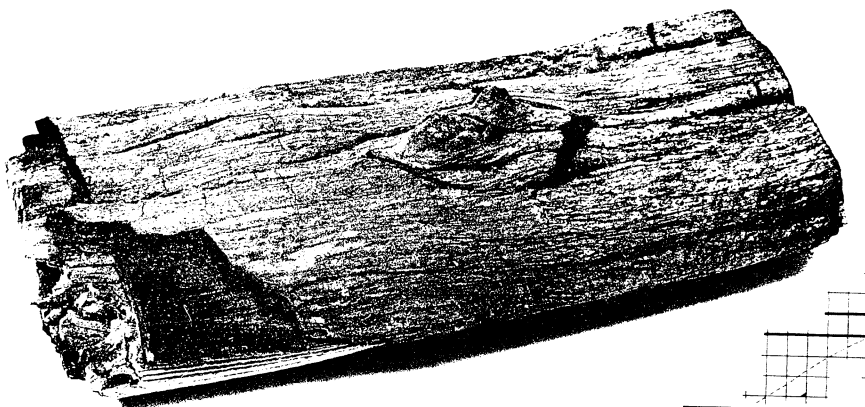
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Bln	G. Kohl and H. Quitta	27
FSU	J. J. Stipp, G. A. Knauer, and H. G. Goodell Florida State University Radiocarbon Dates I	46
Gak	Kunihiko Kigoshi and Hiromi Kobayashi Gakushuin Natural Radiocarbon Measurements V	54
Gif	G. Delibrias, M. T. Guillion, and J. Labeyrie Gif Natural Radiocarbon Measurements II	74
GSC	W. Dyck, J. A. Lowdon, J. G. Fyles, and W. Blake, Jr. Geological Survey of Canada Radiocarbon Dates V	96
Gsy	J. Coursaget and J. Le Run Gif-Sur-Yvette Natural Radiocarbon Measurements I	128
Gx	Harold W. Krueger and C. Francis Weeks Geochron Laboratories, Inc. Radiocarbon Measurements II	142
I	Milton A. Trautman and Eric H. Willis Isotopes, Inc. Radiocarbon Measurements V	161
IVIC	M. A. Tamers	204
K	Henrik Tauber	213
KI	H. Willkomm and H. Erlenkeuser University of Kiel Radiocarbon Measurements I	235
KN	H. Schwabedissen and J. Freundlich Köln Radiocarbon Measurements I	239
Lv	E. Gilot, N. Ancion, and P. C. Capron Louvain Natural Radiocarbon Measurements IV	248
M	H. R. Crane and James B. Griffin University of Michigan Radiocarbon Dates XI	256
MC	J. Thommeret and Y. Thommeret Monaco Radiocarbon Measurements II	286
Mo	A. P. Vinogradov, A. L. Devirts, E. I. Dobkina, and N. G. Markova Radiocarbon Dating in the Vernadsky Institute I-IV	292
N	Fumio Yamasaki, Tatsuji Hamada, and Chikako Fujiyama RIKEN Natural Radiocarbon Measurements II	324
NPL	W. J. Callow, M. J. Baker, and Geraldine I. Hassall National Physical Laboratory Radiocarbon Measurements IV	340
P	Robert Stuckenrath, Jr., William R. Coe, and Elizabeth K. Ralph University of Pennsylvania Radiocarbon Dates IX	348
PIC	Sandra J. Kowalski and Ariel G. Schrodtt Packard Instrument Company Radiocarbon Dates II	386
Q	H. Godwin and V. R. Switsur Cambridge University Natural Radiocarbon Measurements VIII	390
R	M. Alessio, F. Bella, B. Bachechi, and C. Cortesi University of Rome Carbon-14 Dates IV	401
SI	Austin Long and James E. Mielke Smithsonian Institution Radiocarbon Measurements III	413
SR	J. G. Sheppard and E. R. Swart Rhodesian Radiocarbon Measurements II	423
TA	A. Liiva, E. Ilves, and J. M. Punning Tartu Radiocarbon Dates I	430
TF	D. P. Agrawal and Sheela Kusumgar Tata Institute Radiocarbon Date List IV	442
Tx	F. J. Pearson, Jr., E. Mott Davis, and M. A. Tamers University of Texas Radiocarbon Dates IV	453
UCLA	Rainer Berger and W. F. Libby	467
UW	A. W. Fairhall, W. R. Schell, and J. A. Young Radiocarbon Dating at the University of Washington III	498
V	Anne Bermingham	507
WIS	Margaret M. Bender, Reid A. Bryson, and David A. Baerreis University of Wisconsin Radiocarbon Dates II	522
	Minze Stuiver and Hans E. Suess	534
	Dates and True Sample Ages	541
	List of Laboratories	541