Yale Natural Radiocarbon Measurements II

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In the first paper of the Yale University series of radiocarbon measurements (*1*), and in an article published separately (*2*), we reported measurements of natural carbon-14 made by Libby's solid-carbon counting method. Acceptable assays were possible only during periods when nuclear weapons were not being tested in Nevada or in the Pacific, mainly during each July to February period. In August 1954, however, some anthracite blanks were found to be contaminated, presumably as a result of Soviet activity, and this unhappy experience led us to abandon the solid-carbon method. Most of the data reported in this article (*3*), which include all satisfactory figures obtained since February 1954, have been taken by the acetylene method of Suess (*4*). Among several important advantages, Suess' method has the outstanding attraction that the carbon to be measured is never exposed to airborne contamination; a sample is converted to acetylene, and during its purification and subsequent manipulation the glass walls of the vacuum system shield it from external influences.

We have made few important changes in the counting system designed by Suess. Each of our two counters has an inside diameter of 7 centimeters and contains 2.5 liters of acetylene. The counters are filled to a pressure of 68 centimeters (mercury); they give a higher net counting rate (and also a higher background) than Suess' 1-liter counters. The counters are shielded by 20 centimeters of iron, and one of them, counter 1, is surrounded by an additional 1.25 centimeters of iron inside the ring of anticoincidence counters. The additional iron was intended to be a partial substitute for a mercury mantle. A calculation based on Suess' background counting rate and on the dimensions of Suess' counters and ours indicates that with a mercury mantle we should have a background counting rate of about 6 counts per minute. We find that the counter without additional shielding has a background rate of about 9.7 counts per minute, while the counter with the extra shielding has a background rate of about 8.2 counts per minute.

We have installed a system for monitoring counting rates during runs, which typically are 24 hours long. Pulses from four channels are monitored. Two of these channels are the ones that transmit all of the pulses from each of the proportional counters; the other two channels transmit only those pulses from the proportional counters that are in anticoincidence with pulses from their surrounding rings of Geiger counters. After passing through scaling circuits, the pulses from the different channels are fed to different keys on a 13-column adding machine, and totals are printed on tape at preset intervals such as 1 hour. By using this device, we maintain constant check on instrumental aberrations of various sorts.

Calibration assays are given in Table 1. Modern carbon (a sample of hemlock, tree-ring dated as A.D. 1840–1850, from Norfolk, Conn.) gave a mean counting rate of 28.36 counts per minute in counter 1, and 29.11 counts per minute in counter 2. Anthracite samples averaged 8.25 counts per minute in counter 1 and 9.74 counts per minute in counter 2 for the whole period under consideration. Review of all the components of these averages shows that our background is not quite so stable as that of the Washington laboratory—fluctuations above or below the means are greater than 2 σ (as calculated from $\sqrt{\text{number of counts/time}}$) more often than chance alone would dictate. Recently we identified and corrected a defect in the electrostatic shielding associated with counter 2 so that the background in this counter has been reduced. However, it may be more than a coincidence that the largest fluctuations occurred during the most intense period of nuclear weapons testing in the spring of 1955.

Since the duplicate measurements of the same samples, other than those of modern wood and anthracite, have always agreed within statistical expectation, we have accepted all values obtained for unknown samples, but have been more conservative than usual in stating their standard errors. Moreover, because there is evidence of a downward trend in the background count over the whole period from December to June, we have divided the series into two parts and have calibrated and calculated dates separately for each. This accounts for the differences given below in the ages of "infinitely old" samples (based on background + 2 σ), and it also accounts for the variations among the standard errors (based on ± σ) in some cases where the ages are approximately the same.

A few samples have been measured at half the standard pressure because of the lack of sufficient material for a full-pressure run; these have exceptionally large standard errors because there have been few calibration runs at half pressure.

Our conservative procedure in calcu-

Table 1. Calibration assays, counts per minute. All dates are 1955.

Date	Counter 1	Date	Counter 2
*Anthracite: four separate preparations**			
25 Jan.	8.74	4 Mar.	9.89
24 Feb.	7.99	10 Mar.	10.03
25 Feb.	8.24	13 Mar.	10.06
26 Feb.	8.50	15 Mar.	10.36
1 Mar.	8.32	16 Mar.	10.21
5 Mar.	8.29	23 Mar.	9.91
13 Mar.	8.54	24 Mar.	9.81
4 Apr.	8.24	1 Apr.	9.69
6 Apr.	8.39	3 Apr.	9.61
7 Apr.	8.11	11 Apr.	9.53
8 Apr.	8.23	12 Apr.	9.47
10 Apr.	7.94	22 Apr.	9.64
15 Apr.	8.15	16 May	9.29
3 May	8.31	9 June	9.20
27 May	8.05	10 June	9.40
28 May	8.01		
Mean, Jan.–Apr.	8.28	Mean, Mar.–Apr.	9.85
Mean, May–June	8.12	Mean, May–June	9.30
σ, Jan.–Apr.	0.222	σ, Mar.–Apr.	0.277
σ, May–June	0.163	σ, May–June	0.100
σ_B, Jan.–Apr.	0.062	σ_B, Mar.–Apr.	0.080
σ_B, May–June	0.094	σ_B, May–June	0.058
Modern wood: two separate preparations†			
31 Jan.	28.15	28 Mar.	29.25
5 Feb.	28.49	13 Apr.	29.11
16 Feb.	28.15	3 May	29.13
31 Mar.	28.63	26 May	28.94
Mean	28.36	Mean	29.11
σ	0.244	σ	0.128
σ_M	0.122	σ_M	0.064
Standard error of a single run (σ_S)			
Jan.–Apr.	0.219	Jan.–Apr.	0.244
May–June	0.196	May–June	0.107

* $\sqrt{\text{No. of counts/time}}$ ranges from 0.05 to 0.1 for individual runs on anthracite samples.

† $\sqrt{\text{No. of counts/time}}$ ranges from 0.8 to 0.14 for individual runs on modern wood samples.

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lating standard errors is to ignore the standard error derived from the statistics of a single run ($\sigma = \sqrt{\text{number of counts}/\text{time}}$), and to regard each run of 24 hours or longer as an independent variate, with variations over a period of weeks assumed to be Gaussian. An unknown sample is assigned a standard error σ_S representing the standard deviation from the mean values of all background and all modern wood counts obtained during the appropriate period. Standard deviations of the background σ_B and of modern wood σ_M also enter into the calculations; they are the standard errors of the appropriate means,

$$\sigma/\sqrt{n},$$

where n is the number of independent measurements.

The final calculation of the standard error is by the formula

$$\sigma = \frac{\sqrt{(S-B)^2\sigma_M{}^2 + (M-S)^2\sigma_B{}^2 + (M-B)^2\sigma_S{}^2}}{(S-B)^2},$$

where σ is the standard error of the ratio

$$\frac{M-B}{S-B},$$

and S, M, and B are the sample counting rate, the mean modern counting rate and the mean background counting rate, respectively, and σ_S, σ_M and σ_B are their standard errors as defined in the previous paragraph. This formula for σ results from the rule that when $X, Y, \ldots$ are average values of measured quantities with standard errors of $\sigma_X, \sigma_Y, \ldots$, respectively, then a function

$$Z = f\,(X, Y, \ldots)$$

has a standard error given by

$$\sigma_Z = \sqrt{\left(\sigma_X \frac{\partial Z}{\partial X}\right)^2 + \left(\sigma_Y \frac{\partial Z}{\partial Y}\right)^2 + \ldots}\ .$$

In terms of the statistical procedure suggested by the Copenhagen conference (*5*), we include e_s and e_r, the errors of the sample and of the reference standard, but combine them in a more accurate way; we do not include e_f, the error introduced by the fractionation of isotopes in the synthesis of acetylene, or e_h, the error of the half-life determination; our calculations assume a half-life of 5568 years.

The dates reported in Table 2 are mainly related to three projects, each of which is to be more fully discussed in papers now in preparation by collaborators. The longest series is entitled "North American Geology"; the principal collaborator is R. F. Flint. Partly related to this project is a series covering the Alaskan Little Ice Age that is being conducted in collaboration with D. B. Lawrence and K. B. Bengtson. The third series bears on Caribbean archaeology; Irving Rouse is mainly responsible. The miscellaneous samples are less directly related to these chief projects; dates from Iceland and Greenland are relevant to some from arctic America that are included under North American geology, while the samples from the Pacific and from the Southern Hemisphere were considered of interest in connection with results from Pyramid Valley, New Zealand, that were reported in the first paper of the Yale series (*1*). Three projects now under investigation will be reported later: Paleolithic and Neolithic of northwestern Europe, Southern Hemisphere, and a study of modern assay.

When two dates are given without brackets in Table 2, they represent independent preparations of fresh portions of the original sample; duplicate 24-hour measurements of the same gas have been combined into a single date according to the usual practice, unless they were measured at widely separate times or in different counters, in which case the less reliable dates are enclosed in parentheses. Dates enclosed in square brackets were obtained by Libby's solid-carbon counting method.

Table 2. Radiocarbon dates

Sample No.	Description	Age (years)
I. *Alaskan Little Ice Age and related samples*		
Y-4	*Bengtson 27.* Hemlock stump in upright position, sheared by ice and buried in 30 to 40 feet of outwash, overlain by 25 to 30 feet of till, exposed in valley of Fossil Tree Creek, about ½ mile from tidewater at 300-foot altitude, on south side of Geikie Inlet of Glacier Bay. Collected in 1950 and submitted by K. B. Bengtson.	1540 ± 130
Y-5	*Bengtson 49.* Fragment of gnarled alpine timber, not rooted in place but probably of local origin, on terrain thinly mantled by till at 2700-foot altitude on south side of a nunatak on north part of Brady Glacier, near present firn line but below former maximum height of firn. Collected in 1950 and submitted by K. B. Bengtson.	Modern [Modern]
Y-6	*Bengtson 54.* Stump, rooted in place, sheared by ice and buried under 5 to 10 feet of till at 1200-foot altitude, 75 feet above present ice surface of Geikie Glacier near Hugh Miller Col. Moraine evidence indicates ice surface was 700 feet above this point at the latest maximum. Collected in 1950 and submitted by K. B. Bengtson.	1520 ± 140 [430 ± 170]
Y-7	*Bengtson 55.* Stump, apparently rooted in place, sheared by ice and buried in till at 650-foot altitude ¾ mile from tidewater, exposed in a stream valley on the north side of Geikie Inlet. Collected in 1950 and submitted by K. B. Bengtson.	760 ± 130 (950 ± 110)
Y-8	*Bengtson 56.* Stump, rooted in place, and probably sheared by ice after burial by water-laid sands and clays, below present high tide line on west shore of Glacier Bay opposite Willoughby Island. Collected in 1950 and submitted by K. B. Bengtson.	4040 ± 150
Y-9	*Bengtson 60.* Fragments, mostly from small deciduous trees, in very compact till 50 to 60 feet below till surface on east side of terminus of Reid Glacier (the northeastern tidewater distributary of Brady Glacier). Collected in 1950 and submitted by K. B. Bengtson.	4680 ± 160 [4600 ± 105]
Y-10	*Bengtson 62.* Stump, apparently rooted in place, sheared by ice and buried in 60 feet of sand, silt, and clay at 50-foot altitude about ¾ mile north of the entrance to Geikie Inlet on the west side of Glacier Bay. Collected in 1950 and submitted by K. B. Bengtson.	7050 ± 240
Y-32	*Bengtson 43–45.* Remains of gnarled alpine timber, rooted in place and imbedded in till, below the upper limit of till deposition at end of a spur projecting into the east side of the south part of Brady Glacier at 1600-foot altitude. Collected in 1950 and submitted by K. B. Bengtson.	Modern [Modern]
Y-37	*Bengtson 47.* Stump of alpine timber, crushed by ice, 6 miles south along Brady Glacier from location of sample Y-32, but in the same stratigraphic position. Collected in 1950 and submitted by K. B. Bengtson.	Modern

Sample No.	Description	Age (years)
Y-132-80	*Lawrence F50-9.* Transported log, found on recently deglaciated terrain 60 feet west of (outside) edge of Mendenhall Glacier about 5 miles north of Juneau airport. Collected in 1950 and submitted by D. B. Lawrence; Lawrence's station 17. *Comment*: a similar sample was dated by the Lamont laboratory (L-106C) as 1790 ± 285 years (*6*, p. 568).	2790 ± 130 [3010 ± 140]
Y-132-84	*Lawrence F50-8.* Stump, rooted in place, exposed in a gravel pit on north side of valley of Mendenhall Glacier on terrain deglaciated before A.D. 1910 but inside the belt of first-generation forest. Collected in 1950 and submitted by D. B. Lawrence; Lawrence's station 15. *Comment*: compare with samples Y-132-80 and L-106C.	1090 ± 60 [630 ± 130]
Y-132-81	*Lawrence F50-1.* Stump, rooted in place, on terrain deglaciated between A.D. 1931 and 1941, south of Wolf Point at head of Muir Inlet, Glacier Bay. Collected in 1950 and submitted by D. B. Lawrence.	7000 ± 210 [7160 ± 240]
Y-132-82	*Lawrence F50-2.* Stump, rooted in place, similar to sample Y-132-81, but found on terrain deglaciated between A.D. 1911 and 1931, Anchorage Cove, Muir Inlet, Glacier Bay. Collected in 1950 and submitted by D. B. Lawrence.	6300 ± 200 [6930 ± 270]
Y-132-85	*Lawrence F50-3.* Stump, rooted in place, similar to samples Y-132-81 and Y-132-82, but found on terrain deglaciated between A.D. 1903 and 1911, Forest Creek, Muir Inlet, Glacier Bay. Collected in 1950 by Paul Livingston and submitted by D. B. Lawrence.	1860 ± 120 1910 ± 120
Y-132-83	*Lawrence F50-5.* Stump, rooted in place at mid-tide on south shore of Bartlett Cove, Glacier Bay, on terrain deglaciated since the 18th century. Cooper station 55; collected in 1950 and submitted by D. B. Lawrence.	190 ± 50 [Modern]
Y-132-86	*Lawrence F50-4.* Another stump found in the same locality as Y-132-83.	Modern [Modern]
Y-132-100	*Ameghino Glacier, Argentina.* Stump, rooted in place in an old soil and buried in nonweathered outwash, exposed by erosion, in front of Ameghino Glacier west of Lago Argentino, Patagonia. The stump is one of those figured in Fig. 12 of Nichols and Miller (*7*). Collected in 1949 by Maynard Miller and submitted by D. B. Lawrence; Miller's sample B-2.	Modern
Y-133	*Hanker Creek, Yukon: wood.* Poplar stump, rooted in place in the second-lowest of four organic horizons exposed by mining in the northeast wall of Hanker Creek, Klondike region, central Yukon Territory. The three lowest organic horizons are cut by a fossil ice vein that is truncated at the uppermost organic horizon. Thus the tree antedated a period of freezing that was followed by one of thawing. Collected in 1951 and submitted by John D. Campbell; Campbell's sample FF 6_2.	[8900 ± 320]
Y-134	*Hanker Creek, Yukon: peat.* Nonhumified sphagnum peat from the bottom of a bed 17 feet thick, lacking stratification and without ice veins, overlying coarse gravel on the opposite (southwest) side of Hanker Creek from position of Y-133. Apparently the peat is still forming; clearly it postdates a period of thawing when the valley was aggraded. Collected in 1951 and submitted by John D. Campbell; Campbell's sample CC16.	[6130 ± 200]
Y-140	*Mount Garibaldi, British Columbia.* Yellow-cedar wood, rooted in place, from an old forest on a barren nunatak, covered until about A.D. 1940 by the glacier on the east side of Mount Garibaldi, southwestern British Columbia. Described by Mathews (*8*); collected and submitted by W. H. Mathews.	5850 ± 180
Y-211	*Coleman Glacier, Wash.* Fir wood from moraine of Coleman Glacier, Mount Baker, about 15 feet below top of medial moraine, probably formed at the maximum advance of A.D. 1750. Collected and submitted by A. E. Harrison.	[250 ± 250]

II. *North American Geology*

A. *Eastern Sector*

Sample No.	Description	Age (years)
Y-123	*North Bay, Ontario.* Layer of peat with wood fragments, containing 62 percent birch, 27 percent pine, and 10 percent hemlock pollen, suggesting early postglacial time (zone C-1?), covered by 3 to 4 feet of coarse till-like material, believed to be till reworked by Lake Algonquin, exposed at east end of North Bay airport, 5 miles northeast of North Bay; altitude 1204 feet. Collected in 1951 and submitted by A. Dreimanis. *Collector's comment*: the peat lies close to the present surface and was evidently contaminated by tree roots.	[400 ± 200] [400 ± 200]
Y-164	*St. Narcisse, Quebec.* Wood, buried beneath 8.5 feet of sediment, originally believed to be outwash from Saint Narcisse moraine and overlying thick marine clay, Becancour map area (National Topographic Series, sheet 31 I/8), north branch of Champlain River below hydroelectric power line, 1000 feet downstream from wooden bridge on town road, near Vincennes. Collected in 1952 and submitted by N. R. Gadd; Gadd's wood sample No. 2.	[3260 ± 210]
Y-215	*Champlain Sea: Hull, Quebec.* Shells, *Saxicava and Macoma*, from Champlain Sea deposit about 30 feet below former surface of gravel pit on Mountain Road, 6 miles west northwest of Hull, National Topographic Series sheet 31 G/5, altitude 392 ± 4 feet. Collected in 1953 and submitted by J. A. Elson.	10,630 ± 330 [11,050 ± 400]
Y-216	*Champlain Sea: Uplands, Ontario.* Shells of *Macoma* with some *Balanus* and *Saxicava* from Champlain Sea deposit in an old pit or gully at northwest corner of Uplands airport, about 5 miles south of center of Ottawa; altitude 323 ± 2 feet. The section has been fully described by Johnston (*9*). Collected in 1953 and submitted by J. A. Elson.	10,850 ± 330 [8900 ± 320]
Y-233	*Champlain Sea: Notre Dame des Neiges, Quebec.* Shells, *Macoma* and *Saxicava,* from 3 feet or less below surface of Champlain Sea deposit, Notre Dame des Neiges cemetery, Mount Royal; surface altitude 545 feet. Collected by F. J. E. Wagner and submitted by V. K. Prest. *Comment*: the three dates (samples Y-215, Y-216, and Y-233) for Champlain Sea deposits are all based on shells, which probably con-	11,370 ± 360

Sample No.	Description	Age (years)
	tained some proportion of old carbon derived from limestone in the drainage basin.	
Y-242	*St. Pierre-Les-Becquets, Quebec.* Wood underlying varved silt, which is overlain elsewhere by gray till, St. Pierre-les-Becquets. Collected and submitted by N. R. Gadd. *Comment*: this sample serves as an interlaboratory check; it was dated (sample W-189) as more than 40,000 years by the U.S. Geological Survey's Washington laboratory (*10*, p. 485).	> 30,840 > 29,630
Y-254	*Les Vieilles Forges, Quebec: wood.* Wood from below 204 feet of stratified deposits including till and laminated silt, in measured section near Les Vieilles Forges on west bank of St. Maurice River ¼ mile downstream from an unnamed stream that crosses the highway near Les Vieilles Forges village. Collected in 1954 and submitted by N. R. Gadd. *Comment*: this bed of peat and wood is believed to be correlative with that at St. Pierre-les-Becquets from which Y-242 was collected.	> 29,630
Y-255	*Les Vieilles Forges, Quebec: peat.* Peat from the same layer as the wood, sample Y-254. Collected and submitted by N. R. Gadd.	> 30,840
Y-256	*Pierreville, Quebec.* Compressed peat with some wood from below 38.5 feet of thin-bedded silt and sand overlying a thick measured section, including varved sediments that are believed to be correlative with the varved material overlying samples Y-242 and Y-255. The section is at Pierreville in a ravine on the east bank of the St. Francis River 1.7 miles upstream from bridge on Highway No. 3 (Yamaska map sheet, 31 I/2). Collected in 1954 and submitted by N. R. Gadd.	> 29,630
Y-251	*Hartford, Conn.* Log, exposed in a sewer excavation, in alluvium that seems to be graded to a Connecticut River terrace at 30- to 40-foot altitude, overlying varved clay and silt, in Hartford North quadrangle, about 200 feet west of New York, New Haven and Hartford Railroad tracks and 2000 feet north of the junction of a tributary with the North Branch of the Park River. Collected after the excavation had been made in 1954 and submitted by R. E. Deane.	10,650 ± 320
Y-253	*New Britain Channel, Conn.* Wood from cross-bedded gravel member exposed in the northeast face of Stiles-Reynolds Brick Company pit, south of South St., New Britain, in mouth of New Britain Channel. Wood is in transported fragments, deposited contemporaneously with pebbles in the gravel; the gravel should date the discharge from the lake in which the Hartford "varved clay" accumulated. Collected in 1954 by Kurt Servos, Estella Leopold, and R. F. Flint.	10,710 ± 330
Y-282	*Durham, Conn.* Gyttja from upper part of the Durham spruce-pollen zone, Durham Meadows, Durham, 2.35 to 2.55 meters in Boring Dur-C. Collected in 1953 and submitted by Estella B. Leopold. *Comment*: this sample and Y-285 are discussed by Leopold in an unpublished Ph.D. dissertation and in a paper now in preparation.	8155 ± 410
Y-285	*Totoket, Conn.* Gyttja from lower part of the Durham spruce-pollen zone, Totoket Bog, North Branford, 2.75 to 3 meters at base of gyttja, immediately above second high-nonarboreal-pollen zone. Collected in 1954 and submitted by Estella B. Leopold.	13,550 ± 460
	B. *Central Sector*	
Y-155	*Dufresnoy, Ontario.* Wood, under 3 feet of a till-like deposit and overlying varved clay and silt, Dufresnoy Township, 1 mile south of Destor; altitude about 1100 feet. If the overlying material is till, the sample should antedate the "Cochrane" glaciation. Collected by A. S. MacLaren and submitted by J. A. Elson and Heikki Ignatius. *Comment*: the overlying material is evidently not till, as was suspected by several students of the Cochrane problem. Compare samples W-176, 5300 ± 300 years (*10*, p. 485); W-136, 6380 ± 350 years (*10*, p. 485); and Y-222, for post-Cochrane dates.	[Modern]
Y-165	*Rossendale, Manitoba: peat.* Peat, buried under 13 feet of alluvium associated with Lake Agassiz II, from reservoir in gully in SW¼ sec.25, T9, R2., W. Prin, Manitoba, 3 miles south and 1 mile east of Rossendale; altitude 1052 ± 5 feet. Collected in 1952 and submitted by J. A. Elson; Elson's No. F52-22.	12,400 ± 420 [13,230 ± 600]
Y-166	*Rossendale, Manitoba: shells.* Freshwater clam shells from same alluvium as Y-165, Assiniboine estuary, SW¼ sec.13, T9, R9, W. Prin, Manitoba, 6 miles south and 2.25 miles east of Rossendale, 15 feet below terrace. Collected in 1952 and submitted by J. A. Elson; Elson's No. F52-24. *Comment*: the dates for samples Y-165 and Y-166 are considered to represent the age of a delta built into Lake Agassiz.	[11,230 ± 480]
Y-11 Y-13 Y-64 Y-65	*Cypress River, Manitoba.* Wood, charcoal, and peat from alluvium of Cypress River, a tributary of the Assiniboine River, supposedly graded to delta of Lake Agassiz, lat. 49°30′N, long. 99°04′W, NW 8-6-12, W. Prin, Manitoba. Collected in 1950 and 1951 and submitted by J. A. Elson. *Comment*: these samples were repeatedly measured by the solid-carbon method; the oldest date found was that for the charcoal sample Y-64, 2560 ± 200 years. Both peat samples, Y-13 and Y-65, consistently dated "modern." The acetylene date for Y-11, which was wood, is accepted, and the solid-carbon dates are rejected as possibly or probably contaminated.	2830 ± 130
Y-222	*Dugwal, Ontario.* Peat from a bog near Dugwal from shell-rich layer 10 to 15 centimeters thick, overlain by 3.3 meters of peat and underlain by gray homogeneous clay. Pollen analysis of the section is in preparation. Collected in 1952 by Heikki Ignatius and J. A. Elson. *Comment*: the bog overlies till laid down by the latest glaciation in the Cochrane district; compare dates for samples W-176 and W-136, which are cited under Y-155.	6730 ± 200 [6970 ± 310]

Sample No.	Description	Age (years)
Y-250	*Hibbing, Minn.* Spruce or tamarack wood from a log buried under 50 feet of Pleistocene till, overlying outwash, on east face of Douglas Mine in the Mesabi Iron Range near Hibbing. Collected in 1954 and submitted by Richard L. Pierce.	> 36,490
Y-227	*Two Creeks, Wis.* Spruce wood from the type locality of the Two Creeks forest bed, Manitowoc County. Collected and submitted by F. T. Thwaites. *Comment*: this sample serves as an interlaboratory check; compare with the mean of five Chicago dates (samples C-308, C-365, C-366, C-536, and C-537), 11,404 ± 350 years (*11,* p. 117), and the mean of two Washington dates (samples W-42 and W-83), 11,370 ± 100 years (*12,* p. 471).	11,130 ± 350
Y-147X	*Green Bay, Wis.* Log, not growing *in situ* but transported by the ice that deposited gray (Mankato) till, exposed in a borrow pit in SW¼SW¼ sec. 23, T24N, R21E, Green Bay, Wis. Sand underlies the till and probably conceals the original position of the forest bed from which the trees were derived; the wood should be of Two Creeks age, transported by Mankato ice. Collected in 1952 and submitted by F. T. Thwaites.	[11,940 ± 390]
Y-237	*Menasha, Wis.* Log, supposedly crushed by ice, inclosed in red clay in a sewer trench, 15 to 16 feet deep, on Prospect St., Menasha, in NE¼SW¼ sec. 15, T20N, R17E, about 150 feet east of Little Lake Butte des Morts and 2 miles south of the locality of sample C-419 (*11,* p. 118). Collected in 1952 by the excavator for McMahon Engineering Company and submitted by F. T. Thwaites. *Comment*: this sample was expected to be of Two Creeks age.	11,690 ± 370
Y-238	*Marinette, Wis.* White oak wood from a sewer trench in Marinette collected before 1943 and stored at the Wisconsin Geological and Natural History Survey; submitted by F. T. Thwaites. *Comment*: from the altitude, 600 feet or less, and from the relationships of Algonquin and Nipissing shorelines in this district, Thwaites expected the sample to date from either the maximum or the recession of Lake Nipissing.	4880 ± 190
Y-293B	*South Haven, Mich.: Bowmanville wood.* Wood from top of basal blue silt at site described by Zumberge and Potzger (*13*), exposed by wave action on shore of Lake Michigan at South Haven. Submitted by James H. Zumberge. *Comment*: this sample has been dated by the Michigan laboratory (sample M-288a) 11,200 ± 600 years (*13,* p. 310). It dates the Bowmanville low-water phase in the Lake Michigan basin.	10,550 ± 150
Y-293A	*South Haven, Mich.: peat.* Sandy peat or gyttja from the lowest 2 inches of the 30-inch layer at South Haven. The organic material overlies the silt in which Y-293B was found and is buried by a 25-foot sand dune. Submitted by James H. Zumberge. *Comment*: this sample has been dated by the Michigan laboratory (sample M-288) 7925 ± 400 years (*13,* p. 310) and by the Chicago laboratory (sample C-846) 6744 ± 530 years (*14,* p. 735). It dates the waning of the spruce-fir pollen time at this locality. Whether it also dates the time when the level of Lake Algonquin had begun to fall is less certain, and depends on the depth of water in which the organic matter was deposited.	9500 ± 250
Y-169B Y-169	*South Haven, Mich.: wood.* White pine wood from the central part of the 30-inch organic layer at South Haven. Submitted by James H. Zumberge. *Comment*: the solid-carbon measurement was believed to be affected by contamination, and a new sample (Y-169B, the same as M-290A) was submitted after collection by J. E. Potzger. The wood has been dated by the Michigan laboratory (M-290) 5090 ± 300 years (*13,* p. 310) and by the Chicago laboratory (C-848) 6440 ± 230 years (*14,* p. 735). Pollen at this level in the organic layer belongs to an oak-pine period.	5660 ± 100 [5300 ± 250]
	C. *Western Sector*	
Y-109	*Paisley Cave, Ore.* Rodent droppings from Paisley Cave No. 3, immediately under the pumice layer from the Mount Mazama eruption that formed Crater Lake. Collected in 1951 and submitted by L. S. Cressman. *Comment*: the Chicago laboratory (*11,* p. 117) obtained a mean date of 6450 ±250 years for charcoal from a tree killed by this eruption (sample C-247). Doubts have been expressed about the Chicago date in view of the possibility of postdepositional exchange of carbon from ground water. Paisley Cave is dry and the sample is free from this objection; the acetylene date is significantly older by a small margin but probably does not change the geologic picture (*15*).	7610 ± 120
Y-267 Y-281	*Searles Lake, Calif.* Two samples of carbon purified and assayed by the Chicago laboratory from borings beneath the floor of Searles Lake.	
	Y-267: carbon residue of sample C-897, which was dated 23,920 ± 1800 years (*14,* p. 739); this sample came from the bottom 1 foot of the "mud" layer between the upper and lower salt bodies, 82.8 to 83.8 feet. The agreement is regarded as satisfactory, for the acetylene sample was run at half the standard pressure.	21,200 ± 2170
	Y-281: carbon residue from sample C-616, which was dated as more than 19,000 years (*16,* p. 138). This sample came from just below the lower salt body in another location where a sample (C-615) of the lowest 2 feet of the "mud" layer was dated as more than 16,000 years (*17,* p. 294). The acetylene sample has been measured twice, with essentially perfect agreement, but in periods a month apart when the backgrounds may have been different. Because the age of the material is uncomfortably close to the limits of acetylene counting, and because the prolonged chemical treatment these samples have received has undoubtedly given opportunity for isotopic fractionation, new samples must be obtained before the age of the lower salt body can be considered as fixed.	25,890 ± 1120 (> 29,630)

Sample No.	Description	Age (years)
	D. *Arctic America*	
Y-231	*Rankin Inlet, District of Keewatin.* Peat, rich in fungus spores, from a 6-inch layer covered by 3 to 4 feet of till, Rankin Inlet, Northwest Territories, lat. 62°50'N, long. 92°12'W. Collected in 1953 and submitted by Z. L. Sujkowski.	5220 ± 340
Y-261	*Back River, District of Keewatin.* Peat, from a layer 1 to 1½ inches thick between two silt layers, overlain by 8 feet of sediment including lacustrine silt and outwash, laid down in front of the last ice lobe known in the district; the overlying silt is divided into two parts by a zone of involutions. Exposed in the middle Back River region, Northwest Territories, lat. 66°10'N, long. 97°03'W (Canada map 1:125,000: Ogden Bay NW 66/104); University of Minnesota Museum of Natural History Station 19; collected in 1953 and submitted by R. S. Taylor.	4140 ± 150
Y-269	*Missinaibi, Ontario: peat.* Peat, underlying 19 feet of till, clay, silt, and sand, on south bank of Missinaibi River, northern Ontario, 6 miles upstream from mouth of Soweska River; surface altitude 109 feet. Collected in 1954 by Owen Hughes and submitted by V. K. Prest. *Comment*: this peat is in the same stratigraphic position as peat from the James Bay interglacial deposits described by McLearn (*18*).	> 29,630
Y-270	*Missinaibi, Ontario: wood.* Wood from 3 feet below sample Y-269 in same section and below a layer of sandy till 2.9 feet thick. Collected in 1954 by Owen Hughes and submitted by V. K. Prest.	> 30,840
Y-271	*Opasatika River, Ontario.* Shell portion of shell-and-wood sample from below 6.2 feet of sand, overlying marine clay, 2.7 miles downstream from lower end of portage, Breakneck Falls, Opasatika River, northern Ontario; surface altitude 62.5 feet. Collected in 1954 by Owen Hughes and submitted by V. K. Prest. *Comment*: this sample dates the postglacial marine overlap in the James Bay region, and was expected to be younger than Y-269 and Y-270. Its great age may be spurious, for the sample was shell.	17,000 ± 370
Y-283 Y-284	*Prince Patrick Island, District of Franklin.* Driftwood from the Beaufort formation, fluvial and deltaic deposits lying unconformably on Paleozoic and Mesozoic rocks of Prince Patrick Island, Northwest Territories, with base ranging from near sea level to 530 feet.	
	Y-283: sample came from about 50 feet above the base of the formation at 380-foot altitude, lat. 76°38'N, long. 118°33'W, 6 miles north of Salmon Point, Intrepid Inlet.	> 25,300
	Y-284: sample came from near the base of the formation at 320-foot altitude, on the hill immediately E of Landing Lake. Both samples collected in 1954 by E. T. Tozer and submitted by A. L. Washburn.	> 31,840
Y-19	*Peary Land, Greenland.* Driftwood from a marine deposit at Brønlunds Fjord, Peary Land, northern Greenland, deposited in the interval between two glacial advances, after the second of which the sea level fell at least 65 meters. Collected and submitted by J. C. Troelsen.	5870 ± 100
	III. *Caribbean archeology*	
	A. *Saladero culture, Venezuela*	
Y-42	*Saladero 5.* Charcoal from level 6 (125 to 150 centimeters deep), section T2 (T2U2 side), excavation 7, Saladero site; Saladero culture (Rouse's Periods I and II). Collected in 1950 by J. M. Cruxent and Irving Rouse; submitted by Rouse (his lot S-5). *Comment*: this sample and the next two, Y-43 and Y-44, are all from a single, small midden, underlying a much larger deposit of Barrancas-culture refuse. They give an unexpectedly early date for the first appearance of agriculture and pottery in the eastern Caribbean.	2860 ± 130 2880 ± 130 (2520 ± 140)
Y-43	*Saladero 6.* Charcoal from level 6 (125 to 150 centimeters deep), section T3 (T3U3 side), excavation 7, Saladero site; Saladero culture. Rouse's lot S-6.	2700 ± 130
Y-44	*Saladero 7.* Charcoal from level 6 (125 to 150 centimeters deep), section T3 (center), excavation 7, Saladero site; Saladero culture. Rouse's lot S-7.	2570 ± 130
	B. *Barrancas culture, Venezuela*	
Y-38	*Barrancas 1–2.* Charcoal from levels 2 and 3 (25 to 75 centimeters deep), hearths 1 and 2, excavation 6, Saladero site; late Barrancas culture (Rouse's Period IV). Rouse's lots S-1 and S-12. *Comment*: these samples and the next two, Y-40 and Y-41, were intended to date the Barrancas-culture deposit overlying the midden of the Saladero culture and thus to provide a check on the upper limit of age of the latter, but for various reasons they have failed to do so (see Y-290). In the present instance, it would appear that the deposit has been disturbed in its upper levels by modern habitation, which is intensive on the site.	Modern (300 ± 50)
Y-40	*Barrancas 3.* Charcoal from level 7 (125 to 175 centimeters deep), section P1, excavation 6, Saladero site; early Barrancas culture (Period III). Rouse's lot S-3. *Comment*: this date is too early; it corresponds to those for the Saladero culture (Periods I and II), whereas the Barrancas culture is clearly later (Periods III and IV). Since the charcoal comes from the very bottom of the Barrancas-culture deposit, at the same depth below the surface (in excavation 6) as that of the Saladero midden (in nearby excavation 7), it is possible that the charcoal was laid down during the Saladero occupation of the site and before the Barrancas refuse began to accumulate.	2850 ± 120 (2710 ± 130)
Y-41	*Barrancas 4.* Charcoal from level 5 (100 to 125 centimeters deep), section T2 (T3U3 side), excavation 7, Saladero site; intermediate Barrancas culture (Period III). Rouse's lot S-4. *Comment*: this sample was prepared for solid-carbon counting and then reburned for acetylene counting; it was inadequate and had to be run at half the standard pressure. The inconsistency may thus be explained on chemical or physical grounds, but rechecking is not possible without new excavations.	6250 ± 380

Sample No.	Description	Age (years)
	C. *Ortoire culture, Trinidad*	
Y-260-1	*Ortoire 6–7*. Charcoal from levels 6 and 7 (100 to 140 centimeters deep), all sections, Ortoire site; Ortoire culture (Rouse's Period I). Collected in 1953 by John M. Goggin and Irving Rouse; submitted by Rouse (his lots O-6-7. *Comment*: the site is an isolated midden, pertaining to a single nonceramic culture. This sample was composed of lots from the bottom of each of two 20-centimeter levels; the two lots had to be combined to provide enough material for analysis. It and the sample that follows (Y-260-2) were intended as a check on the lower limit of the Saladero culture in Venezuela but are instead contemporary with it. Their dates are not implausible, however, since pottery and agriculture were doubtless present on the mainland before they reached the Indians of Trinidad.	2750 ± 130 (2420 ± 140)
Y-260-2	*Ortoire 5*. Charcoal from level 5 (80 to 100 centimeters deep), all sections, Ortoire site; Ortoire culture (Period I). Rouse's lot O-5. *Comment*: should have been slightly younger than the previous sample (Y-260-1), for it came from a higher level in the midden, but the difference in time was probably not great.	2760 ± 130
	D. *Irapa site, Venezuela*	
Y-290	*Irapa*. Charred bone from the Irapa site, Sucre Province; obtained 200 centimeters beneath the surface in a road cut on the Güiria highway. The accompanying pottery is a mixture of the Cedros and Palo Seco styles, as defined in Trinidad, with the latter predominant. Collected in 1951 by J. M. Cruxent and submitted by Irving Rouse. *Comment*: the site consists of a thin refuse deposit overlain by sterile soil. If the mixture of styles is not mechanical, the sample belongs to early Period III in Rouse's system, and thus can serve as a substitute for samples Y-38 to Y-41 in the problem of dating the upper time limit of Saladero culture.	1720 ± 50 1485 ± 90 1350 ± 80 Average 1580 ± 40
IV. *Miscellaneous samples*		
Y-85	*Hekla H$_3$, Iceland*. Peat from layer 0.0 to 1.5 centimeters under ash layer H$_3$ (from Hekla eruption) in a bog 2 kilometers north of Akureyri, northern Iceland. Layer H$_3$ is the most extensive ash fall in Iceland, and from its stratigraphic relationship to the sub-Atlantic climatic deterioration its age was estimated as 2500 to 3000 years (*19*). Collected and submitted by Sigurdur Thorarinsson.	2720 ± 130
Y-87	*Laxá, Iceland*. Charcoal mixed with soil immediately beneath the younger Laxá lava flow just north of Laxá Canyon, northern Iceland. The stratigraphic relationship, in soil profiles, between this lava flow and the ash layer H$_3$ shows the flow to be younger, probably 700 years younger, thus providing the predicted age (*19*) of 1800 to 2300 years. Collected and submitted by Sigurdur Thorarinsson. *Comment*: another portion of this sample (K-139) has been dated by the Copenhagen laboratory as 2110 ± 140 years (*20*).	[1940 ± 270]
Y-86	*Hekla H$_4$, Iceland*. Peat from layer 0.0 to 1.5 centimeters under ash layer H$_4$, in the same locality as Y-85. Ash layer H$_4$ was once expected to be 4500 to 5000 years old (*19*); this figure was later revised to about 4000 years (*20*). Collected and submitted by Sigurdur Thorarinsson. *Comment*: this sample, which gave an age of 3300 ± 450 years by the solid-carbon method, was believed to be contaminated; on the assumption of a probable amount of contamination, its age was estimated as 4100 ± 450 years. It has not been remeasured, for another portion (K-140) has been dated by the Copenhagen laboratory as 3830 ± 120 years (*20*).	[4100 ± 450]
Y-249	*Seltjörn, Iceland*. Gyttja from the bottom of a peat profile in the Seltjörn (lagoon) near Reykjavik, the bottom layer being just at low water level; the sample dates the end of the postglacial isostatic crustal uplift. Its estimated age was more than 5000 years. Collected and submitted by S. Thorarinsson.	9030 ± 280
Y-204	*Wairau, New Zealand*. Charcoal from an earth oven of the Wairau pre-Maori moahunter culture, quadrate XI.A.4, 17 to 30 inches below surface. Collected in 1952 by R. R. Eyles and submitted by Roger Duff. *Comment*: Duff (*21*) has shown that the wholesale slaughter of moas occurred before the arrival of the Great Fleet in A.D. 1350, while dates from Pyramid Valley (*1*) (especially sample Y-129-A, 670 years) show that moas survived almost until this date, and until after the date of the Wairau site.	940 ± 110
Y-72	*Washington Island, Pacific Ocean*. Wood from the canoe found buried under 1.37 meters of peat in the central lagoon of Washington Island (lat. 4°43′N, long. 160°25′W) in 1906 and presented to the Bishop Museum, Honolulu, in 1917 (catalog No. B.1333). This canoe is unlike any known Polynesian type and has been thought to be possibly medieval Tongan in origin (*22*). Submitted by request by E. H. Bryan, Jr. and Peter Buck.	Modern (160 ± 100)

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