University of Michigan Radiocarbon Dates I

H. R. Crane

The radiocarbon dating laboratory of the University of Michigan has been in operation since 1950 (*1*). A curatorial committee has carried the responsibility for negotiating for specimens, for determining the relative priorities of dating specimens, and for cataloging and reporting information concerning specimens. The committee is composed of H. H. Bartlett, department of botany; S. A. Cain, chairman of the department of conservation, School of Natural Resources; C. W. Hibbard, curator of vertebrate paleontology, Museum of Paleontology; V. H. Jones, curator of ethnology, Museum of Anthropology; J. H. Zumberge, department of geology; and J. B. Griffin, director and curator of archeology, Museum of Anthropology, and chairman of the committee (*2*).

In the years 1950–52, the technical method used for carbon-14 determination was very similar to that developed by W. F. Libby and his coworkers (*3*). Some additional features, principally an automatic sample-changing mechanism, were incorporated, as described in earlier articles (*4*). This apparatus operated successfully, but because of the fact that it employed an open carbon-black sample, it was subject to contamination by radioactive fallout from atomic bomb tests. Operation had to be suspended during periods when fallout was present. The interference caused by the atmospheric contamination increased steadily, and in late 1952 the decision was made to suspend operation and to turn to the development of a method that would use a gas sample. Work was begun on a system employing a carbon dioxide-carbon disulfide Geiger counter, and successful operation was resumed with the new method early in 1953. After a period of shakedown and improvement, the steady production of radiocarbon dates with the new method began in early 1954.

Table 1 is the first installment of the list of results obtained from the beginning of operation of the Michigan laboratory in 1950 to the present. Ages obtained with the carbon-black method are marked by an asterisk. In all cases, the type of material of the raw sample is indicated.

Standard deviation figures attached to the ages are in all cases larger than the purely statistical error, which is derived from the number of counts. The figure is chosen in each case so as to be a composite of both the statistical error and our best estimates of the other factors that influence the precision, such as the general consistency of the calibration runs, consistency within the individual run, and so forth. Errors inherent in the samples themselves, such as those caused by the presence of intrusive material, are of course outside our control and are not allowed for in the stated limits of precision. Such possible causes of error should not be forgotten, however, in the interpretation of the results. In cases in which there was any visible reason for suspecting an alteration of the sample material, the fact is noted in the description of the sample.

Kinds of Errors

Some remarks of a general nature are in order concerning the kinds of errors that may arise in four particular types of measurements: (i) those in which the sample is derived from shell; (ii) those in which the sample is derived from bone, tusk, or antler; (iii) those in which the raw material contains roots; and (iv) those in which the sample is measured in the form of carbon black.

Shell samples have, in our experience and in the experience of others, often yielded ages that are much too large. The effect has been noticed particularly with regard to samples collected in inland waters, bays, and estuaries. The obvious inference that can be drawn from this is that in certain kinds of environment the shell does not get built entirely of carbon that is in carbon-14 equilibrium with the atmosphere. The conditions under which shells will grow with a true "contemporary" carbon-14 content are not sufficiently well understood so that any assurance, one way or the other, can be given a priori concerning a given collected sample. All that we can do at this point is to urge caution in the acceptance of shell dates that are not supported by results on other kinds of material, and to say that where there is an error, it will be expected to be in the direction of making the specimen appear older than it actually is. We include our shell dates in the following list, but do so only with the qualifications given.

The technique that employs a carbon-black sample is open to the possibility of contamination by airborne radioactive debris. When such contamination occurs, it increases the count given by the sample, and thus makes the sample appear to be younger than it actually is. Why is the error predominantly in one direction, that of too small an age? The procedure in measuring a carbon-black sample is to alternate the unknown sample, in the counter, with a standard sample, which is normally one of zero age (from contemporary wood) or of "infinite" age (from petroleum or coal). Contamination of the standard will cause an increase in the apparent age of the unknown, while contamination of the unknown will cause a decrease in its apparent age. The important difference is, however, that if the standard becomes contaminated, the investigator becomes aware of it on the basis of his past data on standard samples, while if the unknown sample becomes contaminated he will not be aware of it. Thus, when contamination affects either the standard or both the unknown and the standard, there is no danger of error because the increased count of the standard warns the experimenter and causes him to reject the whole measurement.

The time when an error may go undetected is when the unknown carries contamination and the standard does not. On the basis of a single run, the experimenter has no way of detecting such an error. The likelihood of such a situation is greatest if the unknown and the standard are prepared at different times, as, unfortunately, must be the case in small laboratories where samples must be processed one at a time. It is therefore of great value to make two measurements, if not at different laboratories, then at least at different times and on carbon prepared from the raw sample at different times. We, and other users of the carbon-black method, have been on constant guard against contamination effects, and we do not believe that the results have been in error in many cases. Nevertheless, we have thought it worthwhile to explain in some detail what the

The author is professor of physics at the University of Michigan and a member of the staff of the Harrison M. Randall Laboratory of Physics.

character of the error is likely to be when it does occur, and to say that its direction is such that it makes the specimen appear to be younger than it really is. When a number of carbon-black measurements on the same sample show a considerable spread, we would, on the basis of the foregoing reasoning, be inclined to adopt a value near the top end of the spread, rather than the average.

Bone, antler, and tooth material bring their own possibilities for error. These materials are porous and may accumulate calcium carbonate from percolating water. Therefore, there are risks in using carbon from the inorganic compounds in these materials for dating. We have, in all cases except where expressly stated, discarded the acid-soluble component of these materials and have obtained our carbon samples from the organic residue. This procedure was discussed in an earlier article from this laboratory (*5*). A very similar procedure has also been described by May (*6*).

In many of the charcoal and peat samples we have processed, we have found the remains of small roots that have intruded, supposedly, from plants or trees growing above the deposit. Such roots have been removed as far as possible with tweezers. However, we have no defense against roots which have intruded and which have become pulverized or otherwise unrecognizable. We can only point out, again as a precaution, that this is a source of error which is at present beyond the control of the measuring technique. When root remains are present, they will, of course, make the sample appear to be younger than it really is.

Table 1. Radiocarbon dates. Ages obtained by the carbon-black method are marked by an asterisk. The other ages were obtained by the gas-sample technique.

Description	Sample No.	Age (yr)
I. *Lower Mississippi Valley and southeastern United States*		
Spiro mound, Okla. Section of solid, well-preserved juniper log from the central tomb of the main Spiro mound. Should be classic Spiro and should equate with sample M-54. Submitted by Robert E. Bell, University of Oklahoma.	M-14	2400 ± 400* 1800 ± 400* 2700 ± 400* 2500 ± 400* 2030 ± 500* Average 2286 ± 200
Emerald mound (Selzertown), Miss. Animal bone from stage E, located in deep drift of village detritus at the south base of the primary platform. Presumably laid down during the early occupational stage of the site, prior to the final stage of the erection of secondary mounds. Emerald mound is located 9 mi northeast of Natchez. Submitted by John L. Cotter, National Park Service.	M-27	470 ± 250
Gordon site (Coles Creek type site of J. A. Ford), near Fayette, Miss. Charred vegetal specimens (charcoal, wood, grass, and so forth), from a burned floor level (F.S. 451, feature 4 house site) within a rectangular structure of vertical posts set in trenches and associated with a Plaquemine occupation. The site is 18 mi northeast of Natchez. Submitted by John L. Cotter.	M-30	350 ± 250
Newt Kash Hollow, Menifee County, Ky. Desiccated grass and other plant material from a Bluff shelter which is a relatively homogeneous site attributable to early Woodland (*7*). The material used for the radio-carbon analysis was submitted by W. S. Webb of the University of Kentucky, for an ethnobotanical study by V. H. Jones of the University of Michigan. Jones' study has been published. (*7*).	M-31	2650 ± 300 2600 ± 300
Sapelo Island, McIntosh County, Ga. Shell specimens from a late Archaic level with plain fiber-tempered pottery, overlain by ornamented pottery. Should date early fiber-tempered pottery period on the coast. Submitted by A. J. Waring, Jr., Savannah, Ga.	M-39	3600 ± 350 3800 ± 350 Average 3700 ± 250
Anna mound group, Adams County, Miss. The charcoal sample was taken from high in the fill of mound 5; it represents a late occupancy of the site, which is located on bluffs overlooking a former channel of the Mississippi River, 8 mi north of Natchez. Submitted by John L. Cotter.	M-47	640 ± 250
Kolomoki, Early County, Ga. Charcoal from a small fireplace at the eastern edge of a mass pottery deposit in mound D. Sequentially, the deposition of the sample fell about midway in the mound-building program, following two or three stages of fill or deposition, and followed by two or three stages. The sample was submitted (i) to check mound E sample (M-50) for culture-period date and (ii) to check the sequence within the local development. Submitted by W. H. Sears, University of Georgia.	M-49	1920 ± 300
Kolomoki, Early County, Ga. Charcoal from burned timber over the central grave of mound E. It was covered by all of the mound fills but was placed after the grave fill. On the basis of ceramic typology, this sample should be slightly older than the mound D sample (M-49.) Submitted by W. H. Sears.	M-50	2120 ± 300
Spiro site, Le Flore County, Okla. Wood from Craig burial mound, exact provenience unknown. Should equate with sample M-14, which came from the same site. Submitted by Robert E. Bell.	M-54	640 ± 250
Kays Landing, Humphrey County, Tenn. Submitted by T. M. N. Lewis and M. Kneberg, University of Tennessee.		
Antler from occupation of old land surface that was separated from a shell mound above by a 2-ft stratum of alluvium. The antler is from stratum IV at this site, which is part of the Early Kays Landing culture complex.	M-108	4750 ± 500
River shells from the shell mound overlying the earlier occupation. This sample was from the upper portion of the shell mound, and is either contemporaneous with or just prior to the arrival of Baumer pottery at the site. Ledbetter culture complex.	M-109	4050 ± 300
Jaketown site, Washington County, Miss. Solid charcoal from feature 92 (*8*). The origin of the specimen was north 22.3 m, east 0.5 m at an elevation of 111.79 ft (10.30 ft below the surface). This is level U in square O–2 in Fig. 39b (*8*). It is well within the Poverty Point cultural deposits. Submitted by William G. Haag, Louisiana State University.	M-216	2830 ± 300

Description	Sample No.	Age (yr)
Taney Bluff shelter, Taney County, Mo. Vegetal material from level-2 collections. Excavated by Carl Chapman, University of Missouri. Submitted by V. H. Jones from samples submitted for ethnobotanical analysis.	M-255	$200 + 250 - 200$
Kays Landing site, Humphrey County, Tenn. Antler specimens from the upper portion of the site. Should date late Archaic. Submitted by T. M. N. Lewis and M. Kneberg.	M-356	3580 ± 300
Eva site, Benton County, Tenn. Antler specimen to date the Eva complex, the earliest known Archaic in western Tennessee. Submitted by T. M. N. Lewis and M. Kneberg.	M-357	7150 ± 500
Manny site (22-M-6), *Issaquena County, Miss.* Collected by James B. Griffin, University of Michigan, from excavations by Robert Greengo, Peabody Museum, Harvard University.		
Charcoal from the west wall of cut V, level 40 to 60 cm. It is definitely later than the Issaquena complex and is probably Coles Creek in time.	M-382	640 ± 250
Mussel shells from the lower levels of the midden debris of cut V. They should date the Issaquena (Mark-Troy) complex.	M-383	2420 ± 300
Manny site (22-M-6), *Issaquena County, Miss.* Part of a charred log (southern yellow cedar) from cut Y, levels 6 to 9, from 60 to 100 cm deep. Collected by Robert Greengo. This should date the Coles Creek level.	M-384	770 ± 250
Nodena, Arkansas County, Ark. Charcoal fragments of willow (*Salix*) from excavations made by James K. Hampson, Wilson, Ark. They should date within the well-advanced Middle Mississippi occupation of this site. Submitted by Hampson through James B. Griffin.	M-385	630 ± 250
II. *Northern Mississippi Valley*		
Pool site, Pike County, Ill. Assorted shells from pit debris in Hopewell village site. The sample is from the earlier occupation. It is what would be called early middle Hopewell, and it is associated with the Havana, Pool, and other stamped types. Submitted by John C. McGregor, University of Illinois.	M-15	2500 ± 300*
Drake mound (Fa 11), *Fayette County, Ky.* Bark preserved by contact with copper reel-shaped breast plate in association with burial No. 7, lying on the bottom of the pit, the central feature of this Adena Site. This sample is the same as University of Chicago sample C-126, which was dated 1168 ± 150 yr. It was collected by W. S. Webb and turned over to the University of Michigan for comparative purposes.	M-19	2200 ± 250
Havana, Ill. Wood from mound 9 which was submitted by Thorne Deuel, Illinois State Museum, to the University of Chicago laboratory. It was processed there (sample C-152), and the age was found to be 2336 ± 250 yr. A prepared carbon sample from the University of Chicago was presented to the University of Michigan.	M-20	2200 ± 250
Madison County, Ill. Charred miscellaneous plant material from a pit underneath the slope of mound 34, Cahokia mound group. The sample was submitted by James B. Griffin.	M-33	700 ± 300* 900 ± 300* Average 800 ± 200
Washtenaw County, Mich. Experiment to determine whether aquatic vegetation and contemporaneous marl from a fresh-water lake checked as to C^{14} age (*9*). The material was collected by Stanley A. Cain, University of Michigan.		
Recently deposited marl.	M-34	< 200
Aquatic vegetation from the same location. It was living when it was collected.	M-35	< 200
Effigy Mounds National Monument, McGregor, Iowa. Charcoal from a conical mound (No. 55). The site contained evidence of cremations as well as Hopewellian blades and a bear canine ornament. Excavated by Paul Beaubien (*10*), National Park Service.	M-40	900 ± 300*
Effigy Mounds National Monument, McGregor, Iowa. Charcoal from Effigy mound No. 30. There is no evidence of a burial in this bear or buffalo mound, but some charcoal and a layer of nondescript rocks are present. Excavated by Paul Beaubien (*11*).	M-41	930 ± 300*
Brems site, Starke County, Ind. Charcoal from two different pits eroding out of dunes. This site contains a wide range of evidence of Woodland and late-Mississippi period occupation. Collected by George Birdsell, South Bend, Ind., and submitted by J. B. Griffin.	M-48a M-48b	1400 ± 300 500 ± 250
Orleton Farms, Madison County, Ohio. Wood from immediately underneath a mastodon skeleton in a marl layer about 2 ft 8 in. below the surface. Submitted by Raymond S. Baby and Edward S. Thomas, Ohio State Museum.	M-66	8420 ± 400* 8460 ± 400* 9600 ± 500
Woods site, Clay County, Kan. NW¼ of the NW¼, section 34, T 9S, R4E. Charcoal from an Upper Republican site in the middle period of the development of this culture. Field specimen Col. 2829. Collected from the floor of an earth lodge. Submitted by Carlyle Smith, University of Kansas.	M-113	780 ± 150
Kossuth County, Iowa. WC of section 22, T100N, R28W. Bones of *Equus* imbedded in lake silt associated with the Algona moraine, the youngest Mankato end morainal system in Iowa. Submitted by Robert Ruhe, Iowa State College.	M-115	100 ± 250
Graham Cave, Montgomery County, Mo. The samples from Graham Cave come from cultural horizons representing stages within one culture complex which is in the process of change from an Early-Man hunting complex to an Archaic hunting-foraging complex with more emphasis upon foraging. There is no good evidence of any significant changes in the economy from the cave floor to level 4 at this part of the cave. The greatest change appears to be in the projectile points, which are more varied in form in the upper levels. Use of the cave by different wandering		

Description	Sample No.	Age (yr)
bands of hunters, or close cultural contact by one band with numerous others, might be explanations for this apparent difference. In general, levels 4 through 6 on the west side of the cave appear to represent one complex. The samples were submitted by Carl Chapman, University of Missouri.		
Charcoal and bone. 23 MT 2-Graham Cave. NW¼-Sq. 10 L3, depth from datum 6 to 7 ft, level 6, from fireplace on original cave floor. This is a thin, distinct level in parts of the deposit. The fireplaces on the old cave floor include, in association with them, lanceolate projectile points [Graham Cave fluted and Dalton (Meserve)] plus some basal-notched and side-notched projectile points, basal-thinned, expanding-base drills, plano-convex scrapers, curved or straight-sided blades, sandstone mortars and cupstones, palettes or thin flat mealing stones, split-bone awls, a roller pestle, and a flaked-hematite adz. The horizon may mark a change from an Early-Man hunter-gatherer to Early-Archaic hunter-forager complex, for there is a greater variety of projectile point types, some of which occur consistently in the eastern Archaic, than are reported from Early-Man sites.	M-130	9700 ± 500
Charcoal and bone. 23 MT 2-Graham Cave. NW¼-Sq. 10 L3 datum depth 6 to 7 ft, level 6 in compact, wind-blown soil and above the fireplace level of the cave floor. The associated cultural complex may differ from that on the cave floor, but if so, primarily in the addition of a greater variety of projectile point forms such as corner-notched and stemmed. Side-notched projectile points may occur in great numbers. A perforated-shell pendant and a coiled basketry impression on clay were found at this level elsewhere in the cave. The serrated flake knives are distinctive but may be a continuation from the lower horizon. The complex is not readily separable from that on the cave floor.	M-131	8830 ± 500
Charcoal and bone. 23 MT 2-Graham Cave. NW¼-Sq. 10 L3, depth from datum 4 to 5 ft, level 4, still in compact, wind-blown deposit, but definitely later. The associated complex consists of a wide variety of side-notched, stemmed, basal-notched, and corner-notched projectile points and a relatively small number of lanceolate forms. The full grooved ax appears for the first time and bone artifacts are of more frequent occurrence, but otherwise the complex is similar to that of level 6. Owing to the heavy accumulation of wind-blown material on the west side of the cave where this sample was taken, it is probable that there is a shorter time interval between the levels here than there is in other parts of the cave, and it is not certain, for example, that the grooved ax found nearer the center of the cave is of comparable age.	M-132	7900 ± 500
Cromwell, Noble County, Ind. Wood associated with the "Richmond mastodon." Submitted by Irving G. Reiman, University of Michigan, and Everett Burmaster, Irving, N.Y.	M-138	5300 ± 400
Calhoun County, Ill. Busycon shell dipper from the Knight site, mound No. 8, found under limestone slabs at a depth of 6 ft. It should be the same age as the Hopewell material from the mound, including the famous figurines. Submitted by P. F. Titterington, St. Louis, Mo.	M-164	1700 ± 300
Pool site, Pike County, Ill. Charcoal from within a vessel of the type Baehr Brushed in section V and area A3. Submitted by J. C. McGregor.	M-183	1740 ± 250
Effigy Mounds National Monument, Allamakee County, Iowa. Mound 33 of the Sny-Magill group. This mound is regarded as representative of the late Hopewell period. Submitted by W. D. Logan, National Park Service.	M-310	1750 ± 300
Atchison County, Kan. Peat from an artesian marsh at the 37-ft level, where pollen is chiefly *Abies* and *Tsuga*. The raised artesian marsh from which the material for this study was obtained is located at the east edge of the flood plain of the Delaware River, 1.5 mi south of Muscotah in the NE¼ sec. 16, T6S, R17E. Submitted by W. Horr, University of Kansas.	M-352	15,500 ± 1500
III. *Great Lakes and northeastern United States*		
Lamoka Lake, Schuyler County, N.Y. Charcoal lumps from under 5 ft of undisturbed refuse. Submitted by W. A. Ritchie, New York State Museum, to the University of Chicago laboratory, which later presented this extra charcoal to Michigan for comparative purposes. Two Chicago runs gave ages that averaged 4369 ± 200 yr. Compare also with sample M-195.	M-26	3650 ± 700* 4300 ± 700* 5380 ± 700* Average 4440 ± 400
Snell site, Johnsville, Montgomery County, N.Y. Charcoal from pit 12. Should date early Owasco culture. Excavated in 1949 by the Rochester Museum of Arts and Sciences in cooperation with the New York State Museum. Submitted by W. A. Ritchie.	M-28	1670 ± 300
Williams mound, near Akeley, Warren County, Pa. Charcoal from pit 2, section 13, lens 30 to 33 in. below the surface of the mound. This is a Hopewellian site. Submitted by A. K. Guthe, Rochester Museum of Arts and Sciences.	M-51	2800 ± 300
Williams mound, near Akeley, Warren County, Pa. Charred wood from 13 in. below the surface in section 14, probably the result of the burning of a tree stump. Submitted by A. K. Guthe.	M-52	250 ± 200
Washtenaw County, Mich. Fragments of mastodon tusk, partly mineralized from outwash sand and gravel. Found 12 mi southwest of Ann Arbor. Identified and submitted by Claude W. Hibbard, University of Michigan. Acid-soluble carbonates were used for the sample.	M-67	6100 ± 400* 6300 ± 500
Ellsworth Falls, Hancock County, Me. Smith farm. Two charcoal samples submitted by Douglas S. Byers, Peabody Foundation, Phillips Academy, Andover, Mass. (*12*).		

Description	Sample No.	Age (yr)
Square D 2/100, pit 35 to 38 in. deep. Archaic level associated with rubbed slate and large, coarse, chipped cleavers.	M-89	4150 ± 450 3800 ± 400 Average 3975 ± 300
Square C /8-14, pit 20 to 22 in. below the reference mark. Belongs to the later stages of Archaic. Pottery of the Vinette 1 type was not far above.	M-90	3350 ± 400
Sodom Lake, Oakland County, Mich. Borings from the lake bottom. The samples from the 22-ft (M-162) and 23-ft (M-163) levels were combined. Submitted by Stanley A. Cain.	M-162, M-163	7000 ± 400
Muskalonge Lake site, Jefferson County, N.Y. Charcoal from burned rock feature overlying Point Peninsula burial pit. The stone feature is definitely subsequent to the burial pit, and the date is inconsistent with the findings on other sites of this culture. Collected and submitted by W. A. Ritchie.	M-175	650 ± 250
White site, Norwich, Chenango County, N.Y. Charcoal found by Theodore Whitney, New Berlin, New York, with partially cremated skeleton accompanied by grave goods. The site is very early Owasco with marked transitional features from Point Peninsula and is highly significant from the point of view of cultural continuity. Submitted by W. A. Ritchie.	M-176	1050 ± 250
Willow Tree site, Herkimer County, N.Y. Charcoal from the lower level (32 to 40 in. deep) of shell midden 1. Very early Owasco culture. Submitted by W. A. Ritchie.	M-177	1000 ± 250
Castle Creek site, Broome County, N.Y. Charcoal from pit 138, from section excavated by the Broome County Historical Society. Late Owasco culture. Submitted by Foster Disinger, Binghamton, N.Y., through W. A. Ritchie.	M-179	520 ± 200
Killarney Bay, Ontario. Charcoal from site KB 1. From a narrow streak of black sand and charcoal apparently carried from the bottom of a hearth by wave action. Should date Point Peninsula in this area. The beach is at an elevation of 27.3 ft above Lake Huron. The hearth was about 26 ft above the lake. Collected and submitted by E. F. Greenman, University of Michigan.	M-194	2180 ± 300
Lamoka Lake, Schuyler County, N.Y. From a hearth situated in sand and gravel under 3 to 4 ft of refuse midden in the north field of the Lamoka Lake site. Collected by A. F. Barrott in 1941 and submitted by W. A. Ritchie.	M-195	4530 ± 400
Leelanau County, Mich. Humus from station No. 2, Sleeping Bear sand dune, located on top of a valders moraine. Significant because of its association with the prairie vole (*Microtus ochrogaster*), which is now found only in extreme southwestern Michigan. Collected and submitted by W. O. Pruitt, Jr., University of Michigan.	M-208	730 ± 250
George Reserve Lake, Livingston County, Mich. Lake-bottom muck. Used for both pollen analysis and radiocarbon dating. Collected by Stanley A. Cain.		
Muck from a depth of 30 to 31 ft.	M-222	8570 ± 400
Muck from a depth of 35 to 36 ft.	M-223	11,450 ± 600
Muck from a depth of 40¼ to 41¼ ft.	M-224	11,450 ± 600
Gibraltar site, Wayne County, Mich. Charred corncobs in deposit 2, a pit 16 in. in diameter and 21 in. deep. The sample was not associated with any other material. The corncobs are of the eastern type. Submitted by E. F. Greenman.	M-228	350 ± 200
Lenawee County, Mich. J. W. Bruggeman farm, sec. 5, T8S, R2E. Wood from a location immediately above a mastodon tusk. Submitted by Claude Hibbard.	M-282	9568 ±1000
South Haven site, Van Buren County, Mich. Peat and wood on the east shore of Lake Michigan from a wave-cut exposure of buried peat bog interbedded with lacustrine deposits of glacial Lake Chicago and later lake sediments (*13*). Submitted by James H. Zumberge, University of Michigan.		
Peat from the lowest 2 in. of the 30-in. peat layer. This sample dates the time when the waters of Lake Algonquin had already begun to drop to the Lake Chippewa level. The date is thus a minimum for Lake Algonquin and for the time that the North Bay outlet became ice-free. Judging from the pollen at this level in the peat, the waning phase of the spruce-fir period in the South Haven latitude is also coincident with this event.	M-288	8350 ± 500 7500 ± 500 Average 7925 ± 350
Wood from the top of the basal blue silt. This sample dates the Bowmanville low-water phase in the Lake Michigan basin.	M-288a	11,200 ± 600
Peat from 7 in. above the base of the 30-in. peat layer, stratigraphically above the location of sample M-288. A post-Algonquin, pre-Chippewa date. According to the pollen profile of the South Haven peat, this sample also dates the pine period.	M-289	6330 ± 400
Wood from the central part of the 30-in. peat layer. The date is interpreted as a date for the minimum level of Lake Chippewa in the Lake Michigan basin. According to the pollen at this level of the peat, this date marks the oak-pine period at the South Haven latitude.	M-290	5000 ± 400 5185 ± 400 Average 5090 ± 300
From the upper 2 in. of peat in the exposure. Marks the time just before dune activity was renewed as a result of the return of the water from the Chippewa low-water phase to the Nipissing stage. This date thus just precedes the Nipissing maximum and, according to the pollen at this level, just precedes the Xerothermic period (oak-pine-hemlock-broadleaved forest in the South Haven latitude). By inference, then, the Nipissing stage and the Xerothermic period were coincident.	M-291	4000 ± 300 4000 ± 350 Average 4000 ± 250
Flint, Mich. Wood taken from the top of a marl pile during excavation for a pond: 1 ft of muck and 5 ft of marl. Associated with caribou. Collected by the late C. M. Barber, Genesee County Museum. Submitted by William H. Burt, University of Michigan.	M-294	5870 ± 400
Isle Royale, Keewenaw County, Mich. Pieces of white or black spruce from a location 70 in. deep in a pit of excavation for native copper, Minong	M-320	3000 ± 350

Description	Sample No.	Age (yr)
Mines area, McCargoe Cove. Should give the date of Indian mining in this particular pit. Collected by Roy W. Drier, Michigan College of Mining and Technology, and James B. Griffin. See also sample M-371e.		
Two Creeks, Wis. Log collected in 1952 by James H. Zumberge and Stephen H. Spurr, University of Michigan.		
Outer portion of log.	M-342	10,700 ± 600
Inner portion of log.	M-343	10,400 ± 600
Ellsworth Road, near Stone School Road, Washtenaw County, Mich. Charcoal associated with late Woodland Indian burials. The sample was insufficient to fill the counter. Submitted by E. F. Greenman.	M-344	< 400
Steuben County, Ind. Sample of wood from late Cary deposits, ¼ mi beyond the distal slope of the Wabash moraine. Should be the same as U.S. Geological Survey samples W-57, which dated 12,380 ± 370 yr, and W-65, which dated 13,020 ± 400 yr. Submitted by James H. Zumberge.	M-350	12,600 ± 600
Ontanogan County, Mich. Main drift of the new White Pine Copper Mine. Fragment of log buried under 80 ft of red lake clays, presumably from glacial Lake Ontanagon in Upper Michigan. Should date the early stages of Lake Duluth in Superior basin. Submitted by J. H. Zumberge and R. C. Hussey, University of Michigan.	M-359	10,220 ± 500
Isabella County, Mich., near Mount Pleasant. Fragment of a log found during the digging of a pond at depth of 3 to 8 ft. Top level (3 ft of topsoil and muck) was underlain by 8 ft of raw peat in which wood and other plant materials were frequent; this in turn rested on a layer of blue clay. Collected by Daniel J. Balog, U.S. Soil Conservation Service, Mount Pleasant. Submitted by James H. Zumberge.	M-360	7470 ± 500
Lake Nipissing, Ontario. Charcoal from the Frank Bay site. This deposit is from just above the high-water erosion mark on the Lake Nipissing shore. It should date the preceramic Mattawan complex (*14*). Submitted by Frank Ridley, Toronto, Ontario.	M-363	2920 ± 300
Isle Royale, Keewenaw County, Mich. Charred log section from the same pit as sample M-320 but from 11 to 12 ft deep. Submitted by Roy W. Drier.	M-371e	3800 ± 500
Calvert County, Md. Charcoal from site 18An18. This was a cremation ground with Ohio pipestone tubular pipes and other indications of a connection with the Adena culture. Submitted by T. L. Ford, Archaeological Society of Maryland.	M-419c	1700 ± 250
IV. *Western United States and northern Mexico*		
Crater Lake, Ore. Charcoal from trees buried by eruption of Mount Mazama. Same as University of Chicago sample C-247, which on the basis of four runs gave dates that averaged 6453 ± 250 yr. This was a reduced carbon sample obtained from the Chicago laboratory for comparative purposes.	M-21	6000 ± 700* 7000 ± 700* Average 6500 ± 500
Willow Beach site, near Lake Mead, Ariz. Submitted by Albert H. Schroeder, National Park Service, Globe, Ariz.		
Charcoal from layer B, Ceramic culture, pottery not accurately datable.	M-42	500 ± 250*
Samples from layers F–G, in stone-bearing (nonpottery) level beneath pottery-bearing layer. One of three distinct nonpottery levels.	M-43	1170 ± 300* 1500 ± 250 Average 1335 ± 200
Sample from layer J, one of three distinct nonpottery levels.	M-44	1700 ± 250
Sample from layers N–O, lowest levels of occupation.	M-45	1210 ± 300* 2200 ± 250
Bute Inlet, British Columbia. Fatty wax oozing up on beaches. Apparently it is a wax of vegetable rather than animal nature. The question is whether it is contemporary or whether it comes from under glaciers. Submitted by Lyle A. Swain, Fisheries Research Board of Canada, Vancouver, British Columbia.	M-68	< 300
West Berkeley, Alameda County, Calif. Charcoal from large shell mound on the east shore of San Francisco Bay. The mound is probably the earliest one yet excavated in that region. Submitted by W. J. Wallace, University of Southern California.		
Charcoal in level between 96 and 108 in.	M-121	2200 ± 400 2700 ± 300
Charcoal in level between 132 and 144 in.	M-122	3210 ± 300
Charcoal in level between 144 and 156 in.	M-123	2880 ± 300
Charcoal in level between 156 and 168 in., west side.	M-124	3500 ± 300 3700 ± 350
Charcoal in level between 156 and 168 in., east side.	M-125	3860 ± 450
Charcoal in level between 180 and 192 in.	M-126	3140 ± 300
Charcoal in level between 192 and 204 in.	M-127	2700 ± 400 3700 ± 300
Frightful Cave (CM68), *Coahuila, Mexico.* The site is 15 mi southeast of Cuatro Cienegas. Collected and submitted by W. W. Taylor, Jr., Santa Fe, N.M. The "bottom level" specimens came from the lowest 50 cm, which contains the Cienegas complex and the later Coahuila complex. The "top level" contained only the Coahuila complex, which is *generically* related to the Pecos River focus of the Big Bend aspect.		
Twill-pad sandals restricted to the bottom level.	M-184	7300 ± 400
Human feces from the top level.	M-185	3620 ± 300
Human feces from the bottom level.	M-188	8023 ± 350
Wood fragments from the bottom level.	M-191	8870 ± 350
Danger Cave, Tooele County, Utah. Submitted by Jesse D. Jennings, University of Utah. As a result of radiocarbon dates, all the previous interpretations of Pleistocene lake history, depth, and position in geologic time must be reassessed. The Danger Cave specimens are among the most complete from any early site. The cultural material from Danger Cave shows strong west-coast, western-desert affiliations. Well represented in the collection are (i) projectile points and knives found in the Pinto basin and Mohave Desert		

Description	Sample No.	Age (yr)
generally, on the one hand, and (ii) other types normally recovered in great numbers from the caves of Oregon on the other. It is also quite important to note that, at the McKean site in the northern Great Plains, specimens quite comparable to or identical with some of the Danger Cave specimens have been recovered. Numerous basketry fragments, several hundred flat slab metates, and a wide range of specialized flint tools indicate that, as early as 7000 B.C., there was a well-developed, specialized desert culture devoted to exploitation of the total floral and faunal offering of the environment. Small seeds were gathered in season, parched or charred, and ground, evidently in some quantity. Plain twining from level 11 is the earliest basketry technique. Coiling becomes common in level 11, and techniques generally proliferate thereafter. The culture is interpreted by Jennings to demonstrate no great difference from the general Shoshone way of life observed as late as A.D. 1850 (*15*).		
Mountain sheep dung from a sand dune resting on beach gravels in the mouth of the cave. On the sand is a layer of occupation material 11 ft in depth. Same as University of Chicago sample C-609, which was dated 11,453 ± 600 yr.	M-118	11,000 ± 700
Twigs resting on the same sand dune as sample M-118. Same as University of Chicago sample C-610, which was dated 11,151 ± 570 yr.	M-119	10,400 ± 700
Charcoal from feature 108 in square 130L5–135L5, from a low level in the cave.	M-202	10,270 ± 650
Uncharred organic materials from feature 22, 140 face, in one of the uppermost strata in the site.	M-203	4000 ± 300
Slightly charred sheep dung from feature 19 in one of the lowest levels in cave.	M-204	10,270 ± 650
Uncharred organic material from feature 17, 140 face, lying just beneath feature 22; see sample M-203.	M-205	4900 ± 350
Cochise County, Ariz. Charcoal from a fire hearth about 15 ft below the present surface in a vertical bank of the San Pedro River in NE ¼ sec. 5, T16S, R20E, Gila and Salt River meridian. Submitted by W. S. Fulton, Amerind Foundation, Inc., Dragoon, Arizona.	M-230	2450 ± 300
Sandia Cave, Bernalillo County, N.M. Fragments of ivory from the Sandia level in the cave. Submitted by Frank C. Hibben, University of New Mexico (*5, 16*).	M-247 M-349	> 20,000 > 20,000
Sandoval County, N.M. Charcoal from a deeply buried site near Santa Ana Pueblo, in the No.-2 terrace fill. The artifact assemblage is similar to that in the last two stages of the Cochise series. The site may be a semi-pithouse. According to Ernst Antevs, the site should be between 2000 and 4000 yr old. Submitted by Frank C. Hibben.	M-248	3100 ± 500
Sandoval County, N.M. Charcoal from a surface hearth in the same site as sample M-248, but not in the same stratum. Submitted by Frank C. Hibben.	M-250	2500 ± 350
Rio Puerco crossing, N.M. Charcoal from a cave in small lava butte near Rio Puerco crossing. The artifacts appear to be of the San Pedro phase of Cochise culture. Submitted by Frank C. Hibben.	M-251	680 ± 250
Angostura basin, S.D. Sites 39FA68–153 and 39FA68–145. These are composite samples of small and fairly large pieces of charcoal obtained in 1949 from a layer of charcoal-stained sand uncovered in trench B. square 2. The layer envelops rock hearths, one complete McKean point, and two proximal fragments of McKean points. Collected by R. M. Wheeler and submitted by F. H. H. Roberts, Jr., River Basin Surveys, Smithsonian Institution.	M-368 M-369	3630 ± 350 4230 ± 350
Angostura basin, S. D. Site 39FA65–382. Ray Long site. A composite sample of hundreds of minute pieces of charcoal was taken from the matrix of a massive weathered-clay, shale zone that contained unlined hearths and Angostura points *in situ*. Collected in 1950 at area A of the Ray Long site by R. M. Wheeler and submitted by F. H. H. Roberts, Jr.	M-370	9380 ± 500
Midland County, Tex. Turtle bones and other bones from the white sand at the "cut bone" locality, at the Midland Man site (*17*). Submitted by E. H. Sellards, Texas Memorial Museum.	M-388	8670 ± 600
Midland County, Tex. Concentrated carbon obtained by W. D. Armstrong, University of Minnesota, from animal bone from the grey sand at the Midland Man site, and believed to be approximately contemporaneous with the human fossils (*17*). Submitted by E. H. Sellards.	M-411	7100 ± 1000
V. *Northern North America*		
Agattu Island, Aleutians. Unworked scraps of wood from midden at Krugloi Point, excavation unit 4, bottom of muck, depth 7 to 10.5 ft. Submitted by A. C. Spaulding, University of Michigan.	M-12	2500 ± 300* 2630 ± 300*
Fairbanks region, Alaska. Cut from wood found 90 ft below the surface in a gold placer-mining pit. Collected by Otto W. Geist, University of Alaska. Submitted by Claude Hibbard.	M-37	18,300 ± 2000*
Fairbanks region, Alaska. Large bison (*Bison crassicornis*) horn sheaths taken from gold-bearing gravels by Otto W. Geist. Submitted by Claude Hibbard.	M-38	16,400 ± 2000*
Aleutian Islands. Collected and submitted by T. P. Bank III, University of Michigan.		
Kagamil Mask Cave, Kagamil Island. Uncharred wood from Aleut burial cave containing painted wooden masks. Taken from surface at rear of cave. The associated skeletal material is characteristic of recent Aleut.	M-91	1660 ± 300
Kagamil Cold Cave, Kagamil Island. Cordage and wood from Aleut burial cave. The sample was taken from the forepart of cave at a level 2 ft below the present earthen floor. This is the cold cave from which the 1936–38 Ales	M-92	900 ± 300

Description	Sample No.	Age (yr)
Hrdlička collections came. These collections are now in the U.S. National Museum.		
Lash Bay, Tanaga Island. Tanaga profile A. Humus intercalated between volcanic ash layers from site A. The sample was taken from a depth of 1.83 m (lower middle soil zone). The associated fossil pollen indicates vegetation more characteristic of a climate that was colder and dryer than the present climate. It may mark the beginning of amelioration in the postglacial development of the thermal maxium.	M-93	4900 ± 400
Kagamil Island rock shelter. Bird skin, feathers and matting from Aleut burial shelter. Taken from charred, mummified remains of human infant burial at the surface of a volcanic crevice. This sample agrees in age with sample M-92. The shelter is probably contemporaneous with burials in the nearby warm cave that was visited in 1936–38 by Ales Hrdlička.	M-94	980 ± 250
Mould Bay, Prince Patrick Island, District of Franklin, Canada. Submitted by C. O. Handley, Jr., U.S. National Museum.		
Wood specimens from Big Ragged Mountains, 5 mi northeast of the Mould Bay weather station, elevation 800 ft. The specimens were scattered through unconsolidated marine drift resting on bedrock.	M-116	> 25,000
Wood specimens from Walker Inlet watershed, near the divide 15 mi west of the Mould Bay weather station, elevation 700 ft. The specimens were in lenses below 50 to 100 ft of unconsolidated marine drift and lying weathered out of ridge tops.	M-117	> 25,000
VI. *Eurasia*		
Gumma Prefecture, Japan. Wood (*Fraxinus mandchurica*) from depth of 14 ft in Ozegahara peat bog. The age of the peat bog is guessed at somewhere between 6000 and 12,000 years. Submitted by Hiroshi Hara, Botanical Institute, Faculty of Science, University of Tokyo.	M-53	5678 ± 700
Yunnan Province, China. Charcoal taken from the inside of a bronze Buddhist statue said to be from Yunnan Province, the date of which has been somewhat problematical. Submitted by A. G. Wenley, Freer Gallery of Art, Washington, D.C.	M-217	1500 ± 250
Chiba Prefecture, Japan. Wood fragments from the Kamo site, Toyoda-mura, Arva-gun. The tentative date is 1500 to 2000 B.C. Submitted by R. K. Beardsley, University of Michigan, for the Japanese Archaeological Association.	M-240	5100 ± 400
Lolang, Korea, Wang Hsu's grave. Wood from grave of the 12th year of Yung-P'ing or A.D. 69. Submitted by R. K. Beardsley for the Japanese Archaeological Association.	M-241	1850 ± 250
Tung-Ling site, Ch'ing-Chou, Manchuria. Wood from a mausoleum attributed to the Liao Dynasty about 1100 A.D. Submitted by R. K. Beardsley for the Japanese Archaeological Association.	M-242	700 ± 250
VII *Pacific islands*		
New Caledonia, east coast. University of California expedition of 1952, E. W. Gifford and Dick Shutler, Jr., University of California, Berkeley.		
Charcoal from a site a few miles south of Poindimie. The cultural material extended down to a depth of 96 in., but the only charcoal sample of sufficient size was in the 24- to 30-in. layer University of California Museum of Anthropology (U.C.M.A.) No. 11-16362, site 6.	M-337	615 ± 300
Charcoal from the modern aboriginal village of Tiouande, depth from 12 to 18 in. The cultural material extended down to 42 in. U.C M.A. No. 11-16544, site 51.	M-338	385 ± 300
Charcoal from peatlike material, 78 to 84 in. deep, near the mouth of the Tiouande River. The cultural material extended down to 90 in. U.C.M.A. No. 11-15237, site 50.	M-340	1880 ± 350
New Caledonia, west coast. University of California expedition of 1952. E. W. Gifford and Dick Shutler, Jr.		
Charcoal from depth of 36 to 42 in. on shore of Anse Longue. The cultural material extended to depth of 60 in. U.C.M.A. No. 11-15321, site 20.	M-332	1335 ± 300
Charcoal from a depth of 24 to 30 in. on a low isthmus connecting the hilly parts of Foue Peninsula, 5 mi from the modern town of Kone. The cultural material extended down to 48 in. U.C.M.A. No. 11-15631, site 13.	M-341	2800 ± 350
Charcoal from a depth of 30 to 36 in. in the same location as sample M-341. U.C.M.A. No. 11-16226, site 13.	M-336	2435 ± 400
Charcoal from a depth of 42 to 48 in. on a hill slope at the edge of the Coral Sea about 1 airline mile west of site 13, on Foue Peninsula. The cultural deposit extended down to 78 in. U.C.M.A. No. 11-15660, site 14.	M-333	1700 ± 300
Charcoal from a depth of 24 to 30 in. in a site in the modern aboriginal village of Ounjo on the rocky headland between the towns of Kone and Voh. The cultural deposit extended down to 78 in. U.C.M.A. No. 11-15788, site 26.	M-335	785 ± 300
Charcoal from a depth of 30 to 36 in. in the same site where sample M-335 was collected. U.C.M.A. No. 11-15749, site 26.	M-334	905 ± 300
Viti Levu Island, Fiji; Vunda, Lautoka Province. Vunda is the site of the traditional first settlement in Fiji (*18*). University of California expedition of 1947, E. W. Gifford.		
Charcoal from a depth of 12 to 18 in. U.C.M.A. No. 11-6353, site 26.	M-373	650 ± 300
Charcoal from a depth of 24 to 30 in. U.C.M.A. No. 11-6349, site 26.	M-374	700 ± 300
Viti Levu Island, Fiji; Navatu, Ra Province. Near Narewa village, at the base of great crag Navatu (The Rock), are two deposits. At location B, the deposit was 12 ft deep; at location A, 10		

Description	Sample No.	Age (yr)
ft deep. The locations are about ¼ mi apart; B fronts on the sea, and A is inland a short distance. University of California expedition of 1947, E. W. Gifford.		
Charcoal from a hearth on virgin soil at the bottom of a cultural deposit in a rock shelter. Location A, depth 30 in. U.C.M.A. No. 11-5810, site 17.	M-36	950 ± 300*
Charcoal from a midden in front of the rock shelter. Location A, depth 104 to 110 in. U.C.M.A. No. 11-6335, site 17.	M-351	2000 ± 500
Charcoal from midden. Location B, depth 90 in. U.C.M.A. No. 11-5879, site 17.	M-367	1200 ± 500
Charcoal from midden. Location B, depth 96 to 104 in. U.C.M.A. No. 11-6342, site 17.	M-350	1300 ± 500
Ulupalakua, Territory of Hawaii. Charcoal from roots of a tree engulfed by a lava flow. Native legend is associated with same lava flow. Specimen collected and submitted by Grote Reber, Wailuku, Maui, T.H.	M-361	600 ± 300
VIII. *Middle and South America*		
Monagrillo Site, Panama. Assorted marine shells procured by Karl Curtis from the refuse pile of the Gordon R. Willey 1949 excavation. This site was considered by Willey in 1949 as contemporary with Formative levels in Middle America and South America. Submitted by Gordon R. Willey, Peabody Museum, Harvard University.	M-11	800 ± 250*
Minas Gerais, Brazil. Mae Rosa Cave (rock shelter). Collected by H. V. Walter, Minas Gerais.		
Charcoal from a depth of 2 m associated with stone anvils and hand axes of early lithic complex.	M-212	< 300
Charcoal from a depth of 1 m. Both this sample and sample M-212 are from the same layer but different spots. A recheck of the strata and the conditions of collection suggests that there has been contamination by washing from more recent deposits.	M-213	< 300
Quebrada Tocuyano site, State of Lara, Diubor Municipio, Venezuela. Soil and charcoal. Submitted by J. M. Cruxent, Museum of Natural Sciences, Caracas, Venezuela.	M-257	2180 ± 300
Lagoa Funda, Minas Gerais, Brazil. Material from this site should date the age of the extinct Giant Bear. Submitted by Clifford Evans, U. S. National Museum.	M-354	3000 ± 300

References and Notes

1. Financial support for the radiocarbon laboratory has been provided, since the beginning of the work, by the Michigan Memorial Phoenix Project.
2. I am especially indebted to two of the members of the curatorial committee, James B. Griffn and Volney H. Jones, for their constant help in the day-to-day operation of the project. A large share of the credit for building and testing the equipment belongs to E. W. McDaniel, who is now with the physics department at Georgia Institute of Technology. The chemical preparations of the samples were made by Patricia Dahlstrom and Gloria Thornton.
3. W. F. Libby, E. C. Anderson, J. R. Arnold, *Science* **109**, 227 (1949); J. R. Arnold and W. F. Libby, *Science* **110**, 678 (1949).
4. H. R. Crane, *Nucleonics* **9**, No. 6, 16 (1951); H. R. Crane and E. W. McDaniel, *Science* **116**, 342 (1952).
5. H. R. Crane, *Science* **122**, 689 (1955).
6. I May,. *ibid.* **121**, 508 (1955).
7. W. S. Webb and W. D. Funkhouser, "Rock shelters in Menifee County," *Univ. Kentucky Repts. Archaeol.* 3, No. 4 (1936).
8. J. A. Ford, P. Phillips, W. G. Haag, *Anthropol. Papers Am. Museum Nat. Hist.* 45, part 1 (1955), Figs. 9 and 39b.
9. H. H. Bartlett, *Science* **114**, 55 (1951).
10. P. L. Beaubien, *Wisconsin Archeol.* 34, No. 2, 125 (1953).
11. ——— *Am. Antiquity* **19**, No. 1, 56 (1953).
12. D. S. Byers and W. S. Hadlock, *Science* **121**, 735 (1955).
13. J. H. Zumberge and J. E. Potzger, *Science* **121**, 309 (1955); *Bulletin Geol. Soc. Amer.* 67, 271 (1956).
14. F. Ridley, *Am. Antiquity* **20**, No. 1, 40 (1954).
15. J. D. Jennings, "Danger Cave: A progress summary," *El Palacio* **60**, No. 5, 179 (1953).
16. F. C. Hibben, *Science* **122**, 688 (1955).
17. F. Wendorf, A. D. Krieger, C. C. Albritton, *The Midland Discovery* (Univ. of Texas Press, Austin, 1955).
18. E. W. Gifford, *J. Polynesian Soc.* 64, 240 (1955).