of growth at this temperature is ten times that at 20° to 25°C. The roots of mesquite, another common desert shrub, have their maximum growth rate at a temperature of 36°C and grow nearly as rapidly at 41.5°C. As shown in Fig. 3, these temperatures do actually occur in the upper regions of the soil, and many desert plants have the majority of their roots in this region.

The seeds of desert plants are even more remarkably tolerant to high temperatures. In our work with the giant cactus or saguaro, we were not too surprised to find that the dry seed was still viable after being cooked continuously for seven days at 83°C. Such heat resistance is essential for survival of the cactus, because the seed must be able to tolerate extremely high temperatures for days or weeks as it lies on the soil surface waiting for a rain to set the germination process into action. And this is not an isolated example, for Faith Poole found that the seeds of three desert shrubs—ironwood, mesquite, and blue paloverde—also remain viable after exposure for six hours to temperatures up to 82°C on four consecutive days. Obviously, not just the seeds of these plants are able to survive the high temperatures encountered at the soil-air interface; the tender seedlings and young plants also must be extremely heat-tolerant.

Implications

Unfortunately, no mechanisms are yet known that explain the ability of desert plants to prevent heat damage at the high temperatures in which they must live. Nevertheless, the few examples given here in support of the chemical basis for heat tolerance suggest a new approach to the study and understanding of desert plants. From an agricultural viewpoint, research along these lines may permit increased yields of crops or even the cultivation of economically desirable plants in areas that normally would not support their growth. The arid and semiarid areas of the earth account for more than one-third of the total land surface, and many of these regions not only are arid but also have high temperatures. As a consequence, the agriculture of these areas is restricted to a relatively few plants, often with poor yields. There is, then, the possibility that a knowledge of how desert plants tolerate high temperatures, and the use of this information for the chemical cure of climatic ills of economic plants, will help to solve the critical food problem of the world by permitting agriculture to extend into new lands and by increasing yields of presently cultivated areas. There is much to be understood about the plants and environment around us, but the concept that temperature damage of plants has a chemical basis, as actually demonstrated experimentally in a few cases, offers a new and fascinating avenue of exploration.

Bibliography and Notes

J. Bonner, *Botan. Gaz.* 104, 475 (1943); *Eng. and Sci.* 20, 28 (1957).

Carnegie Inst. Wash. Yr. Book, No. 13 (1914); *No. 15* (1916).

A. W. Galston, in F. W. Went, *Experimental Control of Plant Growth* (Chronica Botanica, Waltham, Mass., 1957), chap. 25.

A. W. Galston and M. E. Hand, *Arch. Biochem.* 22, 434 (1949).

H. R. Highkin, *Plant Physiol. Suppl.* 32, 1 (1957).

A. Lang, *Naturwissenschaften* 43, 284 (1956).

W. D. McElroy and H. K. Mitchell, *Federation Proc.* 5, 376 (1946).

D. T. MacDougal and E. B. Working, *Science* 54, 152 (1921).

H. K. Mitchell and M. B. Houlahan, *Am. J. Botany* 33, 31 (1946); *Federation Proc.* 5, 370 (1946); *ibid.* 6, 506 (1947).

F. Poole, thesis, University of Arizona (1948).

J. G. Sinclair, *Monthly Weather Rev.* 50, 142 (1922).

B. B. Stowe and T. Yamaki, *Ann. Rev. Plant Physiol.* 8, 181 (1957).

This article is University of Arizona Agricultural Experiment Station Technical Paper No. 489.

University of Michigan Radiocarbon Dates III

H. R Crane and James B. Griffin

The list of 94 dates shown in Table 1 is a continuation of our previous lists (*1*). The introductory statements concerning the method of measurement and the meaning of the stated limits of error given in list II (*2*) apply to this list also.

Since this is our final list to be published in *Science* (*3*), and since we have not previously included more than a brief mention of the technical method, it seems appropriate at this time to give a somewhat more complete statement about the technique we use.

We use a CO_2-filled counter, which is operated in the Geiger, rather than the proportional, voltage range. The envelope is a copper tube of 3-inch inside diameter and 22 inches total inside length. The anode wire is of 0.005-inch platinum, and is 14 inches in active length. There is a cylindrical grid 2¼ inches in diameter, composed of 0.01-inch copper wires spaced ¼ inch apart, situated concentrically with the anode and cathode, and extending well beyond the active region at either end. The grid normally has a potential of about 150 volts positive with respect to the cathode, and it is pulsed to about 1000 volts positive with respect to the cathode to quench each discharge. The active counting region extends radially all the way to the cathode surface, inasmuch as the grid is at a positive potential. The counter is filled to a pressure of 74 centimeters of mercury by admission of 3 centimeters of CS_2 vapor, 3 centimeters of hydrogen, and 68 centimeters of CO_2. The counting threshold is at 5000 volts, and the plateau extends to about 5400 volts. The anticoincidence ring consists of eight 2- by 20-inch copper, neon-filled Geiger tubes, in a single layer around the CO_2 counter. The tubes are connected in parallel and are operated with a univibrator type quench circuit. We have found that the use of the external quench is a worthwhile economy. Tubes give perfect performance in externally quenched operation far beyond the time that would mark the end of their useful life as self-quenched counters.

We find that the CO_2-CS_2 Geiger counter has an advantage and a disadvantage, in comparison to the pure CO_2-

Dr. Crane is professor of physics at the University of Michigan, Ann Arbor. Dr. Griffin is director of the Museum of Anthropology at the University of Michigan.

filled proportional counter used by most other laboratories. If a CO_2-filled counter is to be operated in the Geiger range of voltage, the addition of a "quench vapor" is necessary. CS_2 works admirably, giving the counter a long flat plateau, and producing very stable operation. However, the electrons released in the gas by the disintegration of the C^{14} or by other radiation do not remain free as they move to the anode, but attach to molecules (presumably the CS_2) to form negative ions (*4*). It is the negative ions which are drawn to the anode and which initiate the Geiger discharge. The fact that the count is triggered by the slow-moving ions, rather than by free electrons (as in the pure CO_2-filled counter) introduces a time delay which may range up to about 4 milliseconds. Thus the penalty is that after each count of the anticoincidence ring the CO_2 counter channel must be blanked out for several milliseconds, to allow time for the negative ions to reach the anode. This is but a small penalty in a counter of the size and pressure we use, but it does place a "law of diminishing returns" on the extension to higher pressures or larger dimensions, since an increase in either of these factors will increase the delay time, and consequently require a larger fraction of the total time to be taken out by blanking. In our counter, the blanking time amounts to 15 percent of the total counting time.

The advantage of the CO_2-CS_2 counter is that it has a very high tolerance for nonradioactive impurities. In the pure CO_2-filled counter, slight traces of impurities (oxygen in particular) will capture the electrons and result in delayed counts. Since the blanking time is short in these counters, delayed counts are not canceled by the anticoincidence ring and they result in a vitiated counting rate. For example, de Vries (*5*) has found that 1 part of oxygen in 10^{12} in his pure CO_2 proportional counter will cause a spurious counting rate. In contrast, in the CO_2-CS_2 counter a moderate amount of impurities (for example, 0.1 percent) has no perceptible effect, because in the normal operation all of the electrons become attached, and the circuit is designed to allow for the consequent delay time. Consequently, the chemical preparation of the samples is somewhat simpler and the risk of errors resulting from impurities is practically eliminated.

A word should be said about the 3 centimeters of H_2 which is mixed with the sample. This, for reasons which are not understood, lowers the voltage threshold by about 500 volts, lengthens the plateau, and improves the constancy of the counting rate over long periods of time.

The circuit is such that the quench pulse applied to the grid of the CO_2 counter is triggered by the firing of either the anticoincidence ring or the CO_2 counter itself. The quench pulse lasts for about 9 milliseconds. Thus, when a cosmic ray particle passes through both the anticoincidence ring and the CO_2 counter, the latter is made insensitive by the quench pulse *before* it has a chance to fire. This is true because of the inherent lag in the arrival of the negative ions at the anode of the CO_2 counter, as described in the preceding paragraph. Of course, particles which go only through the anticoincidence ring trigger the CO_2 counter also. Thus the CO_2 counter does not, in this arrangement, fire at all when cosmic ray particles pass through it. The quench is of great enough duration to assure the complete clearing of the negative ions formed by the passage of the particle. No further blanking is used. When the CO_2 counter is fired by a C^{14} disintegration the pulse length again constitutes the blanking time.

An important characteristic of the quench circuit used on the CO_2 counter is that the quench pulse does not end until an interval of 9 milliseconds has elapsed in which no ionizing particle has passed through the anticoincidence ring. This takes care of the occasional situations in which cosmic ray particles follow one another within 9 milliseconds or less. For example, if a cosmic ray particle passes through, starting the quench, and another follows 7 milliseconds later, the quench pulse will last 16 milliseconds, allowing the full 9-millisecond clearing time for the CO_2 counter after the passage of the last particle. The 9 milliseconds allowed for the clearing of the ions is actually about twice the maximum time required for a negative ion to be drawn to the anode, so we have an ample safety factor. The time lost because of blanking has been measured under these conditions and found to be, as already noted, 15 percent of the total time. An ordinary Rossi type anticoincidence circuit is connected to the CO_2 quench and the anticoincidence quench, and effects the registering of only those counts in which the C^{14} counter quench fires unaccompanied by the firing of the anticoincidence ring.

Some figures on the performance of the counter will be of interest. The total counting rate of the anticoincidence ring is 800 per minute. The rate at which cosmic ray particles pass through the CO_2 counter is 220 per minute. Two complete counter systems are in operation. Until the summer of 1957 the two counters were housed in individual iron shields of about 10-inch wall thickness. The counting rates in these shields were, with anticoincidence cancellation, 6.5 per minute for dead carbon and 14.5 per minute for modern carbon. A new shield was then built, having a single cavity which housed both counters, and the result was an increase of about 1 count per minute in both modern and background rates. This shield is in use at present but a modification which we hope will restore the background to the previous value will be made in the near future.

Performance records have now been accumulated for over four years, and they show that, except for occasional aberrations due to the failure of specific components such as tubes, anticoincidence counters, and so forth, the constancy of the counting rates has been that expected on the basis of statistics. There have been some slow variations over times of many weeks, of the order of a half a count per minute, due presumably to changes in the level of local radioactivity. Transient effects lasting a day or two have been seen, due to atomic bomb fallout, and once (22 Jan. 1956) a large increase due to solar activity was seen. Such effects as the latter are easy to recognize as external, because they follow the same pattern on the two independent counters.

The foregoing description has been rather general, and has not given any circuit or construction data. Such detailed information can be made available, however, to anyone seriously interested.

References and Notes

1. This work was supported by the Michigan Memorial-Phoenix Project.
2. H. R. Crane and J. B. Griffin, *Science* 127, 1098 (1958).
3. Editorial in the 2 August 1957 issue of *Science* [126, 189 (1957)]. The editors of *Science* announced that, because of the increasing volume of the C^{14} date lists, their publication as articles in *Science* would have to be discontinued, and some other means of distribution substituted. We wish to say that *Science* has rendered a tremendously valuable service in carrying essentially the full publication load for the first decade of C^{14} work.
4. E. W. McDaniel and H. R. Crane, *Rev. Sci. Instr.* 28, 684 (1957).
5. H. de Vries, *Appl. Sci. Research* B5, 387 (1955).
6. W. F. Libby, *Radiocarbon Dating* (University of Chicago Press, Chicago, ed. 2, 1955).

Table 1. Radiocarbon dates.

Description	Sample No.	Age (yr)
I. *Upper Mississippi Valley and Great Lakes*		
George Reserve Lake, Livingston County, Mich. Collected and submitted by Stanley A. Cain, University of Michigan.		
Lake bottom muck from a depth of 20 ft.	M-220	4550 ± 500
Lake bottom muck from a depth of 25 to 26 ft.	M-221	5970 ± 900
Fort Dodge, Webster County, Iowa. Two miles west and one mile north of town, along north slope of major stream valley, well within present (1951) Mankato area. The exposure had the following composition: 0 to 3 ft, friable till, presumably Mankato, leached to a depth of 2 ft; 3 to 3½ ft, mixed sands and gravels, calcareous; 3½ to 4 ft, unoxidized calcareous till; 4 to 6 ft, oxidized calcareous sand and gravel; 6 to 9 ft, unoxidized calcareous fine sandy loam with wood encountered in abundance at 7-ft depth; 9 ft +, unoxidized calcareous till. Collected and submitted by Wayne H. Scholtes, Iowa State College.		
Wood sample from 7-ft depth in east part of section.	M-226	> 20,000
Wood sample from 7-ft depth in west part of section.	M-227	> 20,000
East Steubenville shell heap (46 Br 31), Brooks County, W.Va. Fresh-water mussel shells from this Upper Ohio Valley Archaic occupation. Collected and submitted by W. J. Mayer-Oakes, University of Toronto.	M-229	4220 ± 500
Weaver Site, Fulton County, Ill. Fresh-water mussel shell from a house site of the Hopewell culture. The pottery is identified by Wray as 90 percent Hummel Stamped and 2 percent Classic Hopewell. Collected and submitted by Donald Wray, Champaign, Ill.	M-256	2300 ± 250
Beaver County, Pa. Charcoal from Site 36 Mv 29. The sample should date the end of the manufacture of Half-Moon Cord Marked. It was found in a fire pit in the next to the highest level in the site. Collected and submitted by W. J. Mayer-Oakes.	M-345	2130 ± 200
Bedford mound group, Pike County, Ill. Excavated by Gregory Perino for Thomas Gilcrease. Specimens submitted by Dan Morse, Peoria, Illinois.		
Charcoal from crematory basin between mounds Pk°10 and Pk°11. A Hopewell site.	M-443	1930 ± 250
Charcoal from ceremonial log structure under crematory basin between mounds Pk°10 and Pk°11.	M-444	1940 ± 250
Charcoal of grass or mat under burial 19 in mound Pk°4. There were no burial goods with this inhumation, but the mound is Illinois Hopewell.	M-445	1720 ± 250
Wakenda Village site (23CA1), Carroll County, Mo. Collected by F. A. Winfrey, DeWitt, Mo. and submitted by Carl H. Chapman, University of Missouri.		
Charcoal from pits on east side of road with Hopewell pottery and other artifacts. Original sample I.	M-448	1820 ± 250
Charcoal from west of highway where late pottery is predominant. Original sample III (1).	M-450	720 ± 200
Renner Village site (23PL1) Platte County, Mo. Charcoal samples from four different pits in the same excavation trench. Original number 2. This is a Hopewellian village site. Collected by J. M. Shippee and submitted by Carl H. Chapman.	M-454	1270 ± 250
Chrisman site, Pike County, Ill. Mussel shell from an Archaic site which is largely a clam shell deposit with some chipped stone points, slate ornaments, and short three-quarter grooved axes. M. M. Leighton has suggested a geological date of about 3000 yr ago. Collected and submitted by J. C. McGregor, University of Illinois.	M-485	6490 ± 300
Spring Creek site, Muskegon County, Mich. Charcoal from this Late Woodland complex at a "pure" site which suggests that it is relatively early within Late Woodland. The estimated date was about A.D. 900. Collected by Edward Gillis and George Davis, Grand Rapids, Mich., and submitted by James B. Griffin, University of Michigan.	M-512	990 ± 150
Toepfner mound, Columbus, Ohio. Charcoal samples from five different features in this Adena mound. Two other samples from this site have been dated at the Chicago laboratory. Sample C-923, on charred logs from feature II, gave a date of 2377 ± 150 yr, and C-924, on charcoal from feature VII, gave a date of 2780 ± 410 yr (*6*, p. 104). Collected and submitted by Raymond S. Baby.		
From log tomb, feature 2, 7.5 ft above floor of mound.	M-517	2300 ± 200
From log tomb, feature 3.	M-518	2280 ± 200
From log tomb, feature 4.	M-519	2200 ± 200
From log tomb, feature 5.	M-520	2350 ± 200
From charred log, feature 9.	M-521	2410 ± 200
Crable site, Fulton County, Ill. Mussel shell from pit 1 in a Spoon River focus, Middle Mississippi site. Collected and submitted by Dan Morse.	M-556	1150 ± 200
Wilson mound (Wh-6) White County, Ill. Charcoal from the central tomb. Field catalog No. Wh 6-150. This Wabash Valley Hopewell site has been dated (C-684) at 723 ± 180 and 2086 ± 160 yr (*6*, p. 98). Collected by M. L. Fowler and submitted by Thorne Deuel, Illinois State Museum.	M-559	2000 ± 200
Rutherford mound site (Hn252), Hardin County, Ill. Charcoal sample from the floor of the mound in square 25R10. This is regarded as a late Hopewell mound. Collected by M. L. Fowler and submitted by Thorne Deuel.	M-560	1525 ± 200
Wagner Merk mound in Sayler Park area of West Cincinnati, Hamilton County, Ohio. Charcoal from a log tomb about the middle of this Adena mound. Excavated by James Keller and submitted by Ralph Dury, Cincinnati Natural History Museum.	M-570	1860 ± 200
Rocky Fork Lake site, Highland County, Ohio. Charcoal from a charred log around the top edge and the charred bark lining of a rectangular subfloor burial pit beneath the south-central part of the mound. A cremated burial was deposited at the bottom of the feature. This mound had at	M-650	1890 ± 200

Description	Sample No.	Age (yr)
some earlier date been disturbed by unknown diggers. Attributed to late Hopewellian occupation. Collected and submitted by Raymond S. Baby.		
Riverside Cemetery, Menominee County, Mich. Bone fragments, probably both dog and human. The specimens were coated with red ochre and were in feature 6. This is an Old Copper Culture cemetery. Collected and submitted by A. C. Spaulding, University of Michigan.	M-658	3040 ± 300
Stone County, Mo., Site 23SN137. Charcoal from a fireplace associated with pottery fragments that are grit-tempered and decorated with punch and boss and stamped designs. Submitted by Carl H. Chapman.	M-696	1230 ± 200
Jakie shelter (23BY388), Barry County, Mo. Charcoal from Square 75L7, level 4, original No. MU-7. Submitted by Carl H. Chapman.	M-701	2840 ± 250
II. *Mexico and Central America*		
Frightful Cave (CM68), Coahuila, Mexico. The site is 15 mi southeast of Cuatro Cienegas. Collected and submitted by W. W. Taylor, Jr., Mexico City.		
Wild legume pods woven into "rosettes." From the top level of the deposits.	M-186	3230 ± 350
"Agave scuffers" which are loosely and roughly made Agave sandals. From the bottom level of the deposit.	M-187	8080 ± 450
Human feces from the middle level of the cave deposit.	M-189	6170 ± 300
Warp fiber sandals from the top level of the deposit.	M-190	1770 ± 250
San Rafael de Coronado site near San Jose, Costa Rica. Charred plant material from within a pottery vessel. Collected by Jorge A. Lines and submitted by Alex D. Krieger, Riverside (California) Municipal Museum.	M-364	< 250
Schroeder site Durango, Mexico. Charcoal from 75 cm below step 2 of the rectangular unit of structure 12, and above floor 2. Excavated by Augustin Delgado. Should predate the Las Joyas phase of the Chalchihuites culture. Submitted by J. C. Kelley, Southern Illinois University.	M-613	1550 ± 250
Tlatilco, Valley of Mexico. Charcoal samples collected by R. F. Heizer, R. J. Squier, B. B. de Piña Chán, and R. Piña Chán. Submitted by R. F. Heizer, University of California (Berkeley).		
Specimens from soil surrounding a burial located approximately in the middle of the Tlatilco brickyard. The burial was accompanied by an offering of obsidian points and pottery of Tlatilco style. The burial was located 3 to 4 ft from the present surface.	M-660	2525 ± 250
Charcoal from inside offering No. 4 accompanying burial No. 193.	M-661	2940 ± 250
Zacatenco, Valley of Mexico. Charcoal from pit 1, 1950, from 2.6- to 3.0-m level. Collected by R. F. Heizer and R. J. Squier; submitted by R. F. Heizer.	M-662	2450 ± 250
Cuicuilco, Valley of Mexico. Charcoal samples collected by R. F. Heizer, René Millon, and R. J. Squier; submitted by R. F. Heizer.		
Specimen collected at Peña Pobre rock quarry, southwest and across highway from the Cuicuilco Pyramid. Sample taken from 20- to 23-in. level below bottom of lava flow in dark "midden" soil rich in potsherds. The level from which the sample was taken ranged from 14 to 17 in. below the bottom of the burned earth stratum underlying the lava at this point.	M-663	2040 ± 200
Specimen taken from a point 20 ft southeast of sample M-663 and in identical stratigraphic position.	M-664	1430 ± 200
Tlapacoya, near Ixtapaluca, Chalco, state of Mexico. Charcoal from tomb No. 2, mound 1. Sample should date the first stage of construction of the pyramid, which is believed to have been carried out at the end of the upper phase of the Preclassic occupation at this site. Collected by Beatriz Barba de Piña Chán, Mexico City, and submitted by R. F. Heizer.	M-665	2600 ± 250
III. *Lower Mississippi Valley*		
Harlan site, Cherokee County, Okla. A site of the Gibson aspect. Collected and submitted by Robert E. Bell, University of Oklahoma.		
Charcoal from unit 4, level 4, square S2L5, excavated 1 Aug. 1949. Specimen is from unit 4 of the Harlan site. The mound contained three superimposed house structures; this specimen represents charcoal from one of the houses. Original No. 11.	M-64	1280 ± 300
Charcoal from test area 4, house number 3, taken from squares N1R2, N2R2, and N3R2, 13 July 1950.	M-65	720 ± 200
Cedar Creek, near Carnegie, Caddo County, Okla. Collected and submitted by Robert E. Bell.		
Wood from a log in fill of the second deposition phase of Cedar Creek, 10 ft from the top of the high terrace.	M-210	< 200
Charcoal and ash from a hearth in the second deposition phase of Cedar Creek.	M-211	> 300
Little Woods area (Or 11) Orleans Parish, La. Rangia shells from 3½ ft below water level on the periphery of the deposit of this Tchefuncte site. Collected and submitted by W. G. McIntire, Louisiana State University.	M-218	1570 ± 250
Big Oak Island (OR6), Orleans Parish, La. Rangia shells associated with Tchefuncte pottery at a depth of 4½ ft below the mound surface in the south bank of test trench No. 8. Collected and submitted by W. G. McIntire.	M-243	2220 ± 200
O'Bryan Ridge (23 mi 20) Mississippi County, Mo. Charcoal from a refuse pit in excavation unit 3, pit 1, level 6, 30 to 36 in. deep. Pottery from this level is Mulberry Creek Cord Marked, 63 percent; Baytown Plain, 28 percent; Withers Fabric Impressed 5 percent; and unidentified cord-impressed, 4 percent. This complex is part of the Burkett focus (or phase). Collected by Stephen Williams for the University of Michigan and submitted by J. B. Griffin.	M-438	2140 ± 250
IV. *Eastern United States*		
Steppel site, Morris County, N.J. Charred grasses found in connection with a burial and grave goods at a Late Woodland site. Submitted by R. J. Mason for the New Jersey State Museum.	M-593	200 ± 200

Description	Sample No.	Age (yr)
V. *Plains*		
Site 25 HK 13, Hitchcock County, Neb. Fresh-water shell from a Woodland site related to the Keith focus. Collected and submitted by Marvin F. Kivett, Nebraska State Historical Society.	M-181	2080 ± 250
Site 25 Vyl, Valley County, Neb. Fresh-water shell from a Woodland site of the Valley focus. Collected and submitted by Marvin F. Kivett. The date is regarded by the collector as much too early.	M-182	3830 ± 300
VI. *Western United States*		
Sorrento site, (W-316) San Diego County, Calif. Miscellaneous local marine shells from the 18- to 24-in. level. Dates a phase of the La Jolla culture. Collected and submitted by Carr Tuthill, Scripps Institution of Oceanography.	M-114	6950 ± 350
Site A:10:1, Moffat County, Colo. Uncharred corn cobs of predominantly Mexican pyramidal type (according to V. H. Jones) associated with beehive-shaped masonry granaries. No Pueblo artifacts, pottery, or architecture is in association. Some of the stone material resembles Shoshonean types. Collected for the University of Denver and submitted by G. R. Wenger, U.S. National Park Service.	M-285	400 ± 150
Grants, New Mexico, area. Charcoal from an old dune site (site No. 1) of the San Jose complex. From a hearth associated with uncultivated *Amaranth* seeds. This is a local variant of the Pinto-Gypsum-Chiricahua hunting-gathering complex. Collected by G. A. Agogino and J. Hester for the University of New Mexico and submitted by G. A. Agogino, Syracuse University.	M-346	6880 ± 400
Wakemap site (45KL26), Klickitat County, Wash. Collected by University of Washington excavators and submitted by Douglas Osborne.		
Charcoal from stratum B, test trench 2. Original number 22.	M-423	1050 ± 200
Charcoal from stratum A, test trench 2. Original number 26.	M-424	620 ± 200
Charcoal from stratum B, test trench 2. Original number 31.	M-425	615 ± 200
Charcoal from stratum A, test trench 3. Original number 39.	M-426	890 ± 200
Charcoal from stratum A, test trench 3. Original number 41.	M-427	1080 ± 200
Little Harbor site, Santa Catalina Island, Calif. Charcoal fragments from bottom of shell midden (pit 60, 24-in. depth, resting on sterile clay beneath midden). Charcoal was under inverted *Haliotis* shells which protected it from moisture and penetration by plant rootlets. The culture is pre-Canalino and represents one of the Intermediate cultures of southern California. Collected and submitted by C. W. Meighan, University of California (Los Angeles).	M-434	3880 ± 250
Jemez Cave, Jemez Canyon, Sandoval County, N.M. Corn cobs of early type believed by V. H. Jones to be of generalized Bat Cave character. From square IX, levels 7 to 9. Collected by P. Reiter and submitted by V. H. Jones, University of Michigan.	M-466	2440 ± 250
Lake LeConte, Riverside County, Calif. Charcoal from an unnamed site along the eastern beachline close to siphon 27 of the Coachella Main Canal, 22 to 30 in. deep in a clay deposit behind an old longshore gravel bar, at the lowest fire level. In addition to the charcoal, this layer contained fireplace ash, stone, and fish bone. The fish bone is regarded as midden material indicative of fresh-water lake conditions. The object of the dating was to determine the age of this lake stage and of the occupation. Collected by B. E. McCown and party, San Diego, Calif., and submitted by Carl L. Hubbs, Scripps Institution of Oceanography.	M-596	450 ± 200
Lake LeConte, Imperial County, Calif. Charcoal from the lower level of the Split Mountain dune site at approximately lat. 33°2.2′ N., long. 116°1.9′ W. The lower occupation level, only a few inches thick, is separated by about 2 ft from the surface midden. It contains only a trace of pottery, whereas the surface abounds in potsherds. The few projectile points resemble Playa points and contrast sharply with the more modern types on the surface. Fish bone indicative of fresh-water lake conditions is included. This is taken to represent the lake stage preceding the last relatively recent and much better known stage. Collected by B. E. McCown and party; submitted by Carl L. Hubbs.	M-597	130^{+200}_{-130}
Lake LeConte, Imperial County, Calif. An unnamed site between Kane Springs and Truckhaven at approximately lat. 33°11.8′ N., long, 115°56.3· W. Charcoal from fire pits about stone house rings in the ancient beach line. This occupation appears to have been associated with the last filling of Lake LeConte. The charcoal from this site was selected to date the relatively recent stage of Lake LeConte, and of the accompanying fish fauna (of ascertained species) and human occupation (with much pottery, late projectile points, and so forth). Collected by Carl L. and Laura C. Hubbs and submitted by Carl L. Hubbs.	M-598	120^{+200}_{-120}
Santa Rosa Island, Calif. Charcoal from the west side of Garonon Cañon about 100 ft from its mouth, 2.7 mi (in straight line) from west end of island. This specimen is from a definite, rather large, almost solid mass about seven-tenths of the way up steep canyon side about 50 to 60 ft high. The site is near the middle of the Pleistocene beds from which many dwarf mammoth remains have been taken, of which some were found partly burned in what appear to be hearths. The only traces of artifacts have been crude flaked stones of disputed human origin. The sample is well below the level of middens that have been dated 6500 and 7000 yr before the present. Collected and submitted by Carl L. Hubbs.	M-599	16,700 ± 1500
Blossom site (4-SJo-68), San Joaquin County, Calif. Collected and submitted by Robert F. Heizer.		
Charcoal sample No. 1 is a composite sample from various depths in a midden of the Windmiller facies. Early Horizon with an estimated date of about 2000 B.C. Previous samples from this single phase site (C-440 and C-522 combined) were dated	M-645	4100 ± 250

Description	Sample No.	Age (yr)
4052 ± 160 (6, p. 112). The soil is highly calcareous.		
Calcined bone, sample 3, in cremation pit 3, at a depth of 50 in.	M-647	4350 ± 250
Johnson site (4-Sac-6) near Sacramento, Calif. Charcoal from basketry and wood of grave pit burning of burial 67. The burial represents the late phase 1 period of the Late Horizon culture, and should date later than 1229 ± 200 yr (C-689), already obtained for a middle phase 1 burial. Collected and submitted by Robert F. Heizer.	M-648	620 ± 200
Humboldt Lake bed site (26-Ch-15), Churchill County, Nev. Charcoal and charred basketry from cremation and surface pit. This is an open-site manifestation of the Lovelock culture for which there is a known radiocarbon range from about 3200 to 1700 yr before the present. Lovelock culture persisted until, or nearly until, the opening of the historic period in western Nevada. Collected and submitted by Robert E. Heizer.	M-649	2690 ± 250
VII. *Far East and Pacific*		
Yoshiga shell mound, Aichi Prefecture, Honshu, Japan. Attributed to the later Jomon period. Collected and submitted by Eiji Nakayama, Catholic University of Nagoya.		
Marine shell associated with burial 1 in trench 1a.	M-165	2800 ± 600
Marine shell from lowest stratum of section H, trench 3.	M-174	2870 ± 250
Kishima, off Ushimado Peninsula in Okugun, Okayama, Japan. Shell from the Initial Jomon period, equivalent approximately to the Tado component of the Kanto area. Collected by Yashimasa Kamaki, Kurashiki Archaeological Museum, and submitted by Richard K. Beardsley, University of Michigan.	M-237	8400 ± 350
Kori shell mound, Okayama Prefecture, Japan. Shell from deposits of the Middle Yayoi (Yayoi II) period. Collected by Yashimasa Kamaki and submitted by Richard K. Beardsley.	M-239	2350 ± 200
Rupkund site, Nepal. Human skeletal material collected by D. N. Majumdar, Lucknow University, and submitted by him. According to H. R. Crane, it is probable the true date is toward the upper limit of the given range.	M-652	650 ± 150
South Pacific, various islands. Specimens collected by Thor Heyerdahl and party and submitted by him through William Mulloy, University of Wyoming.		
Charcoal from Tipona Meae, Hive Oa Island. Marquesas No. 16. Original number Journ X352.	M-704	470 ± 150
Charcoal from hill terraces at Vaiuru, Raivaure. Found in refuse heap at northern end of construction A, terrace 1. Original number Journ X350.	M-705	180^{+200}_{-180}
Charcoal from Tipona Meae, Hiva Oa Island, Marquesas No. 1. From trench through terrace in front of tiki. Horizontal, 5.5 to 6 mi; vertical, 90 to 95 cm. Bones of pig found at the same depth. Original number Journ X351.	M-706	460 ± 200
Charcoal from Rapa Island pit in house terrace at head of bay.	M-707	620 ± 200
Charcoal from site E-11, Orongo, Easter Island. From level 1, horizon A. Strat. trench 1. Original No. 3.	M-708	100^{+200}_{-100}
Charcoal from platform surface back of Ohu No. 1, Vinafru, Easter Island. Level of second occupation. Original No. 4.	M-709	120^{+200}_{-120}
Charcoal sample No. 6 from beneath dirt wall surrounding plaza of Ohu No. 2, Vinafru, Easter Island.	M-710	1100 ± 200
Charcoal from Rapa Iti Island, Morongo Uta Fort, section 2, terrace 5, room 1, floor level surrounding fireplace.	M-712	310 ± 200
Charcoal from Rapa Iti Island, Morongo Uta Fort, section 1, terrace 2, room 4. Recovered from floor level.	M-713	210 ± 200
VIII. *Southeastern United States*		
Wilbanks farm site (Ck-5), Cherokee County, Ga. Charcoal from burned log sealed under fill of earth lodge walls. Earth lodge was built in Etowah III period after debris of earlier occupations had been removed from the building site. Etowah III is the peak period of Southern Cult activity and mound usage both at CK-5 and at the Etowah site. Collected and submitted by W. H. Sears, Florida State Museum.	M-112	340 ± 150
Cotten site (V-2), Volusia County, Fla. *Fasciolaria gigantea* shell from square 15R1, level 16, associated with Orange Plain and Orange Incised pottery exclusively. Collected and submitted by John W. Griffiin, St. Augustine Historical Society.	M-215	3020 ± 200
Dulany site, Chatham County, Ga. Oyster shell 18 in. from the base of the midden in association with a plain fiber tempered pottery complex which closely resembles that at Sapelo Island, Ga., which was dated (M-39) at 3700 ± 250 yr. Collected and submitted by A. J. Waring, Jr., Savannah, Ga.	M-236	3770 ± 200
Refuge site, Jasper County, S.C. Shell from a "clambake" at a depth of 36 in. in an 8-ft shell midden. The pottery associated is the Refuge complex which is the earliest Woodland pottery at the mouth of the Savannah River. Estimated date 500 to 1000 B.C. Collected and submitted by A. J. Waring, Jr.	M-267	2920 ± 200
Camp Creek site (1GN1), Greene County, Tenn. Charcoal from the bottom level (c) of the site, about 3 ft below the plow line, and about 1 ft above the base of the cultural zone. The site has 85 percent fabric impressed pottery. Collected by members of the Tennessee Archaeological Society and submitted by T. M. N. Lewis, University of Tennessee.	M-516	2050 ± 250
Roanoke Rapids site (Hx v7), Halifax County, N.C. This is a stratified site running from Archaic to almost historic times. Collected and submitted for the University of North Carolina by Joffre Coe.		
Charcoal associated with Halifax-Archaic type points. Original numbers 619 eb 178 from 63 to 68 in. and 619 eb 179 from 70 to 76 in.	M-522	4280 ± 350
Charcoal associated with Halifax-Archaic type points. From fireplaces 1, 2, and 3, from 54 to 62 in. deep.	M-523	5440 ± 350
Charcoal associated Savannah River-Archaic type points. From fireplaces 1 and 6, from 38 to 49 in. deep.	M-524	3900 ± 250
Charcoal associated with the Clements-Uwharrie focus of the Piedmont area.	M-525	370 ± 200

Description	Sample No.	Age (yr)
Estimated by Coe to date about A.D. 1500 and to just precede the Clarksville focus.		
Charcoal associated with cord-marked and fabric-marked Woodland pottery from features 20, 55, 102, and 105. Unfortunately, feature 55 belongs to the Clements level and this date is probably somewhat too recent.	M-526	1040 ± 200
Charcoal from the Clarksville focus, feature 148, which is the last prehistoric cultural material in the area.	M-527	215 ± 200
Bland Cave, Harlan County, Ky. Charcoal from station 11, in entrance to cave. Associated with a late Archaic complex. Excavated by Edward Ray, Roscommon County, Mich., and Roger Leatherman, University of Michigan; Submitted by R. Leatherman.	M-561	3030 ± 250

E. O. Lawrence—Physicist, Engineer, Statesman of Science

Ernest Orlando Lawrence's scientific accomplishments and influence on science are almost unique in this generation and rank among the most outstanding in history. His cyclotron is to nuclear science what Galileo's telescope was to astronomy. A foremost symbol of the rise of indigenous American science in the 20th century, Lawrence, perhaps more than any other man, brought engineering to the laboratory, to the great benefit of scientific progress. He originated a new pattern of research, of the group type and on the grand scale, which has been emulated the world over. Rarely, if ever, has any person given so many others, in such a small span of years, the opportunity to make careers for themselves in science. Lawrence was a leader in bringing the daring of science to technology, in wedding science to the general welfare, and in integrating science into national policy.

Lawrence was born between two pioneering eras, on 8 August 1901, in the small town of Canton, South Dakota, on the Big Sioux River—the second-generation product of educated Norwegian immigrants. When Lawrence was born, the echoes of the taming of the Great Plains had hardly died away. From this pioneering heritage and through some biogenetic conjugation still beyond the grasp of science, Lawrence derived qualities that uniquely fitted him for grand explorations in the nascent science of the 20th century. Lawrence was a big, robust son of his Norwegian forebears, with virtually unlimited energy, which he expended without reserve in long hours in the laboratory, in consultation with colleagues, in planning new projects, and in the taxing airplane trips and conferences important to national policy. He was characterized by boldness, enterprise, innate modesty, and an open, friendly spirit. His *joie de vivre* and his buoyant optimism spread to everyone around him and accounted for the attainment of many an "impossible" objective.

Lawrence attended the public schools of Canton and Pierre, South Dakota. He began college work at St. Olaf's College, in Northfield, Minnesota, and went on to the University of South Dakota for his B.S. degree. Inspired by South Dakota's Dean, Lewis E. Akeley, he entered the University of Minnesota to study physics and obtained the M.A. For two years he studied at the University of Chicago, transferring to Yale, where he received the Ph.D. in 1925. After three more years at Yale, as a National Research Fellow and as an assistant professor of physics, Lawrence (already a promising young physicist) came to the University of California in 1928 as an associate professor. In 1930, at the age of 29, he became the youngest full professor on the Berkeley faculty.

Lawrence's reputation of the late 1920's was solidly based. His doctor's thesis was in photoelectricity. Later, he made the most precise determination, to that time, of the ionization potential of the mercury atom. With J. W. Beams he devised a method of obtaining time intervals as small as three billionths of a second, and he applied this technique to study the early stages of electric spark discharge. He originated a new and more precise method for measuring e/m which was perfected by F. G. Dunnington.

In 1929 young Lawrence, who for some time had been contemplating the problem of accelerating ions, chanced, while scanning the literature, upon a sketch in a German publication. He forthwith formulated, within minutes, the principles of the cyclotron and the linear accelerator and so set himself upon a course that was to influence, fundamentally, scientific research and human events.

Between the brilliant, simple concept and operating machines lay engineering barriers not previously encountered. Lawrence's willingness to tackle new engineering problems and his success in solving them, as he reached for successively new energy ranges, was a departure in scientific research that is an important part of his contribution. The hard road he chose was recognized when W. D. Coolidge, presenting the National Academy of Science's valued Comstock Prize in 1937, said in part, "Dr. Lawrence envisioned a radically different course . . . [which] called for boldness and faith and persistence to a degree rarely matched." By 1936 the scale of research and supporting engineering development was so large that the Radiation Laboratory was created at the University of California to satisfy the administrative requirements. The prototype of the big laboratory had been born.

The range of contributions that have flowed from Lawrence's invention and his leadership are evident from some important examples: world leadership, for more than a quarter of a century, in the development and use of high-energy accelerators; the discovery of hundreds of radioactive isotopes, such as carbon-14,