[RADIOCARBON, VOL. 6, 1964, P. 138-159]

UNIVERSITY OF TEXAS RADIOCARBON DATES II

M. A. TAMERS, F. J. PEARSON, JR., and E. MOTT DAVIS
Radiocarbon Dating Laboratory, Balcones Research Center
The University of Texas

The Radiocarbon Dating Laboratory of the University of Texas was reorganized in late 1962. The dates reported in this list were obtained from February to November, 1963. The laboratory uses liquid scintillation counting with benzene solutions (Tamers, Stipp, and Collier, 1961; Noakes *et al.*, 1963). The chemical synthesis has been modified and improved in several ways in order to permit one worker to produce a sample per day.

The counting is done with a Packard "Tri-Carb" liquid scintillation spectrometer equipped with two counting channels and a print-out recorder. The solutions used are half benzene and half toluene. The toluene is a commercial product in which the scintillators PPO (0.4% by total scintillator solution volume) and POPOP (0.01% by total scintillator solution volume) are dissolved. The toluene solution is pipetted into the counting cell. The benzene is synthesized from the sample to be dated and the amount determined by weighing the filled cell. In those cases where the sample sizes are too small to produce a sufficient amount of benzene, the cell is brought up to volume with commercial benzene. The counting bottles were constructed by us and are of a special metal-glass arrangement to minimize the background. The solutions are cooled to –20°C during the counting to reduce thermal noise in the photomultipliers and to prevent loss from evaporation of the solution.

The counting cell used for most of the measurements made in this list holds 4 cc of solution (2 cc benzene). This size has been chosen for convenience in handling the smaller samples, but it is still large enough to give good statistics for samples of ordinary size. The background is 4.5 cpm at 53% counting efficiency. No barometric effect has been seen. The contemporary reference has been taken as 95% of the activity of the NBS oxalic-acid standard and shows $7.35 \pm 0.04_4$ cpm/gm carbon. This activity is statistically indistinguishable from that of our 100 yr old wood corrected to 1950 (see Tx-43, this date list). As recommended by the last Radiocarbon Dating Conference (Godwin, 1962), a C^{14} half life of 5568 yr has been used in the date calculations. The errors quoted with the dates are the standard deviation.

Our 4 cc cell has a limit of detection of about 40,000 yr (2σ statistics, 48 hours counting). Several other types and sizes of cells have also been used. Up to a point, the figure of merit increases with the volume, and the benzene method should be capable of dating 60,000 yr old samples if sufficient material is available for 50 cc of benzene (Léger and Tamers, 1963).

Three possible sources of error have been made the object of special studies.

1. *Radon.* This impurity has been looked for many times, but has never been seen to contaminate the solutions. It should be removed by the procedure of pumping during and after the strongly exothermic reaction which produces the strontium carbide mixture. Furthermore, the alpha particles from the radon

disintegration would give pulse heights approximately five times larger than those of the highest energy C^{14} beta particles. The high pulses are discriminated against by the counter.

2. *Isotope effect.* Since the chemical yield of the benzene method is not 100% and may vary considerably from its average of 50%, an isotope effect is possible. However, it will not introduce errors into the dating if it can be shown to be reproducible. From studies carried out this past year, it seems that this criterion is met. The four measurements of Tx-43 illustrate the reproducibility obtained. As expected, one of the four dates has its 1σ limits of error outside of the known age and average of the four measurements, but all of these activities are within the 2σ limits.

There are also several other samples in this list which were run twice and show that the isotope effect is reproducible or small. Samples Tx-91, Tx-93, Tx-94, and Tx-95 of the ground water series and Smith Shelter samples Tx-23 and Tx-26 were all split and run twice. All agree within 1σ limits except Tx-91 which is within 2σ. Likewise, the Bonfire Shelter pair Tx-47 and Tx-106 and the Candelaria Cave pair Tx-50 and Tx-51, which, on strong field associations, should be identical in age, give essentially the same date.

Not only is the isotope effect reproducible within the limits of precision of our counting statistics, if it exists it cannot be too large. With the counter calibrated as 53% efficient (by a standard good to within 2%), our measured contemporary standard indicates that the activity of uncontaminated modern carbon should be 13.9 cpm/gm, which is reasonable. Using this figure, it can be said that the isotope effect is probably less than $\pm 10\%$ and is constant.

3. *Quenching.* A common difficulty encountered in liquid scintillation counting is the presence of small amounts of impurities which cause significant decreases in solution scintillating efficiencies. The resulting smaller pulse heights are eliminated by the discriminator and the observed counting rate is lower than it would be otherwise. Serious quenching occurs in benzene solutions synthesized by pyrolysis, because of concentrations on the order of 1% of 1, 3–cyclohexadiene. In earlier work, this impurity was successfully removed by a purification procedure and the resulting benzene solutions had scintillation efficiencies close to that of pure commercial benzene (Léger and Tamers, 1963).

In our present benzene synthesis, we solve this problem by purifying the acetylene before it is reacted catalytically to form benzene. We have found that without acetylene purification the majority of the benzene solutions synthesized are quenched to the extent that the observed counting rates are lowered from a few percent to more than 50%. Our acetylene purification eliminates this quenching. However, we feel it advisable to verify the absence of quenching in every synthesis, either by the external source method (Léger and Tamers, 1963) or by comparison of the ratio of counting rates observed in the two channels of the counter. Both of these methods can detect as little as 1% quenching. C^{14} dating with the liquid scintillation counter must use routine quenching checks if maximum reliability of results is to be maintained.

In the samples reported by previous workers at the University of Texas laboratory (Texas I), lack of quenching was not verified, and there is now

reason to believe that it was present in some of the cases. It is recommended that those dates not be used until it can be ascertained which ones are correct.

ACKNOWLEDGMENTS

Technical assistance in the preliminary treatment of the samples was provided by James Crowhurst, whose support was contributed to our laboratory by the Texas Archeological Salvage Project and the Geology Department of the University of Texas. We are especially grateful to the Packard Instrument Company of La Grange, Illinois, for the loan of our first counter, and to Mr. J. J. Stipp, head of Packard's Low Level Counting Laboratory, through whose good offices the loan was made and who has helped us in many other ways.

SAMPLE DESCRIPTIONS

I. CHECK SAMPLES

Under the heading of "check samples" are those samples whose age is already known or approximately known. They have been run to check the stability of the system and the possibility of fractionation.

Tx-43. Greenwade House, Texas **100 ± 80**
A.D. 1850

Wood from foundation post of the Greenwade House, a log cabin built in the middle 1850's in the Brazos River valley near Whitney, Texas (31° 54′ N Lat, 97° 23′ W Long). Coll. 1950 by R. L. Stephenson and subm. by E. B. Jelks, Texas Archeol. Salvage Project, Univ. of Texas, Austin.

The above date represents an average from 4 completely separate syntheses and countings in order to check fractionation and stability of the system. Individual runs are as follows:

Synthesis No.	cpm/gm carbon	Age B.P. (1950)
1	7.09 ± 0.11	260 ± 125
2	7.32 ± 0.11	<150
3	7.30 ± 0.10	<160
4	7.24 ± 0.09	<200
Average	7.24 ± 0.05	100 ± 80

For comment, see the introductory statement to this list.

Tx-48. Fort St. Louis 26, Texas **195 ± 105**
A.D. 1755

Charcoal from the large mound at site of old Fort St. Louis on Garcitas Creek in Victoria County, Texas (28° 45′ 50″ N Lat, 96° 40′ 30″ W Long). This site was first occupied by the French in the 1680's and later by the Spanish. The sample should date between about 1684 and 1730. Coll. 1950 by Glen Evans; subm. by W. W. Newcomb, Jr., Texas Memorial Mus., Austin. *Comment*: date correct within 1σ statistics.

Tx-49. San Lorenzo, Texas **380 ± 100**
A.D. 1570

Charcoal (burned roof material) from Structure No. 10, Mission San Lorenzo de la Santa Cruz, at Camp Wood, Real County, Texas (29° 41′ N Lat, 100° 01′ W Long). The mission was occupied by the Spanish between A.D. 1762 and 1769 and the sample should date in that interval. Coll. 1962 and subm. by C. D. Tunnell, Texas Memorial Mus., Austin. *Comment*: date correct within 2σ statistics.

Tx-45. Sambrito, Pit House 17, New Mexico **1360 ± 100**
A.D. 590

Juniper post, specimen 42 from SW part of pit house 17 in Sambrito site, LA4195, W side of San Juan River in Navajo Reservoir, Rio Arriba County, New Mexico (36° 58′ 00″ N Lat, 107° 26′ 15″ W Long). Pit house 17 was a Piedra Phase house, dated by pottery associations, and through that by dendrochronology, at A.D. 850 ± 25. Coll. 1961 by Dittert and Davis; subm. as check sample by A. E. Dittert, Jr., Mus. of New Mexico, Santa Fe. *Comment*: date outside of 2σ statistics of predicted age. Date appearing on the early side might be explained by the observed variation of the rate of deposition of C^{14} on the earth.

Tx-44. Appleton, Wisconsin **10,700 ± 210**
8750 B.C.

Wood, spruce (*Picea*) from Appleton, Wisconsin, 14 ft below the plain of glacial Lake Oshkosh, in SE¼, Sec. 28, T 21 N, R 17 E (44° 20′ N Lat, 88° 25′ W Long). This was a log imbedded in a diagonal position in clayey red Valders till; should be same age as Two Creeks Forest Bed. Wood from this same find was previously dated as C-800, 10,856 ± 410 (Chicago IV) and Lamont has an Appleton date, L-698D, of 11,830 ± 100 and an average of 11,840 for this and five other Two Creeks dates (Broecker and Farrand, 1963).

II. GROUND-WATER SAMPLES

The following samples are ground water from wells in the Carrizo Sand in Atascosa and surrounding counties, south central Texas. This is one of the principal aquifers of the region and is now being studied in detail by the Texas Water Comm. and the U. S. Geol. Survey. These C^{14} measurements are the first of a series being taken to investigate the effect of factors other than time on the C^{14} content of ground water. No interpretation of the data is given here, as the sampling program has not been completed, nor will the characteristics of the aquifer be known until the study mentioned above is complete.

Samples coll. the late summer and fall of 1963 by O. C. Dale and F. J. Pearson, Jr.; subm. by Pearson. C content given is the total of dissolved carbonate species, $CO^{=}_{3(aq)}$, $HCO^{-}_{3(aq)}$, and $CO_{2(aq)}$, expressed as equivalents per million (epm). The δC^{13} values, which were determined by Nuclides Associates, are those of the dissolved carbonate, not of the benzene counted. Since the variation in δC^{13} is probably due as much to the introduction of carbonate from the aquifer as to natural fractionation, the C^{14} results are reported as % of modern rather than as Δ, which would be misleading.

Number	Owner County—Well number Lat Long Depth	Total C epm	δC^{13} ‰	C^{14} % of Modern
Tx-90	M. W. Parchman Atascosa—AL6851803 29°08′ N 98°41′ W 166′	1.65	–18.31	76.9±1.0
Tx-91	R. L. Bruce estate Atascosa—AL6860302 29°07′ N 98°31′ W 104′ (C^{14} average of two syntheses: 76.1±1.0% and 73.7±0.9%)	1.90	–17.87	74.9±0.7
Tx-92	Alex Ross Atascosa—AL6859504 29°03′ N 98°41′ W 411′	2.00	–17.41	50.1±0.7
Tx-93	City of Pleasanton #4 Atascosa—AL7805104 28°58′ N 98°29′ W 1688′ (C^{14} Average of two syntheses: 17.7±0.7% and 16.5±0.5%)	4.10	–10.38	17.1±0.4
Tx-94	Joe J. Vyvlecka Atascosa—AL7812201 28°51′ N 98°34′ W 2075′ (C^{14} Average of two syntheses: 6.72±0.68% and 7.12±0.47%)	5.00	–9.34	6.92±0.41
Tx-95	J. T. Harris Wilson—J-5 (Anders, 1957) 28°57′ N 98°15′ W 2500′ (C^{14} average of two syntheses: 2.38±0.40% and 2.88±0.41%)	6.35	–12.78	2.63±0.28
Tx-96	Gulf Oil Co. Atascosa—AL7815504 28°48′ N 98°10′ W 4258′	8.80	–14.37	2.54±0.20
Tx-97	Humble Oil Co. Live Oak—A-4 (Anders and Baker, 1961) 28°40′ N 98°11′ W 4789′	15.60	–3.15	1.19±0.17

III. GEOLOGIC AND PALEONTOLOGIC SAMPLES

A. Texas

Tx-69. Miller's Cave **7290 ± 260**
5340 B.C.

Unburned bone fragments from travertine unit, S chamber of Miller's Cave, Llano County, Texas (30° 35′ 12″ N Lat, 98° 38′ 12″ W Long). Much $CaCO_3$ was deposited on and in the bone material. Patton (1963) reports that associations are with *Synaptomys cooperi*, *Microtus ochrogaster*, and other forms indicating that rainfall was then greater and more evenly distributed

throughout the year, in contrast to semiarid conditions prevailing today. A preliminary date was publ. by Patton (1963, p. 37) as sample A-326, 7200 ± 300; the figure cited here represents the final calculation. Coll. 1961 and subm. by T. H. Patton, Dept. Geology, Univ. of Texas, Austin. *Comment* (T.H.P.): faunas elsewhere in Texas and the Great Plains with which the Miller's Cave fauna has been correlated are older. The date indicates that withdrawal of these animals from the Llano region may have been much more recent than had been expected.

Barton Springs Road Site series

Charcoal from Barton Springs Road Site (41 TV 87), 1 block W of Lamar Blvd., Austin, Texas (30° 15′ N Lat, 97° 46′ W Long). Site was the rear part of a rock shelter, most of which had fallen away. Samples are from three stratigraphic zones in Square N95-W95. Zone III (lower) contained bones of mammal species no longer living in this area, including *Blarina brevicauda*, *Geomys bursarius*, and *Pitymys pinetoreum*. Zones V and VI contained a fauna of microtines and other species (yet to be identified), different from the fauna in Zone III; and a Scallorn arrow point was found in Zone V. Coll. 1960 by C. D. Tunnell; subm. by E. L. Lundelius, Jr., Univ. of Texas, Austin.

Tx-73. Barton Springs Road, Zone III **3480 ± 1060**
1530 B.C.

Chemical yield on this sample was small; hence the large error quoted. *Comment* (E.L.L.): this fits dates on similar faunas from other sites in central Texas.

Tx-74. Barton Springs Road, Zones V-VI **1040 ± 120**
A.D. 910

Sample from Zones V and VI mixed. *Comment* (C.D.T.): date is reasonable for Scallorn point type.

B. Western Australia

Tx-31. Mammoth Cave **>31,500**

Charcoal from Mammoth Cave, SW corner of the state of Western Australia (34° 04′ S Lat, 115° 01′ E Long). Coll. from top of Glauert excavation, from immediately below to 4 ft below a dripstone floor. A sample from the same spot was dated at >37,000 yr (0-657; Merrilees, personal communication). The Mammoth Cave deposit, at present the main source of information on the Pleistocene fauna of western Australia, has yielded a number of extinct forms, several of them not recorded elsewhere. Coll. 1961 by Cliff and Merrilees; subm. by Duncan Merrilees, Western Australian Mus., Perth. *Comment* (D.M.): the date being a limiting one rather than a probable point in time, it is doubtful if there is any significance in the difference between Tx-31 and 0-657.

Perth series

Specimens from vicinity of Perth (and one from near Madura), Western Australia, collected in a study of sealevel changes and paleoclimatological variations. Shell identifications by Judith Lundelius. Coll. 1955 and subm. by Judith Lundelius, Austin, Texas, unless otherwise stated; comments by J. L.

Tx-33. Swan River, Blackwall Reach #1 **3100 ± 260**
1150 B.C.

Charcoal from cliff of Swan River, Blackwall Reach #1 (32° 02′ S Lat, 115° 46′ E Long), 12 ft above river level. May possibly date postglacial 10 ft beach. Coll. 1955 by A. R. Main, Dept. Zoology, Univ. W. Australia. *Comment*: date within the range expected.

Tx-34. Mt. Hershell, lower layer **4950 ± 160**
3000 B.C.

Shell of oyster (*Ostrea angasi*) from lower layer of fossil section, foot of Mt. Hershell, Rottnest I., 12 mi offshore from Perth (32° 0′ S Lat, 115° 30′ E Long). Sample may date time of deposition of marine shells in what is now a brackish inland lake. *Comment*: see Tx-35, below.

Tx-35. Mt. Hershell, upper layer **5660 ± 220**
3710 B.C.

Shell (*Katelysia* sp.) from upper layer of fossil section, foot of Mt. Hershell (see Tx-34, above). It was hoped the sample, from layer of reworked brackish water shells, would date the approximate time of cut-off of lake from open ocean by dune deposition. *Comment*: Tx-34 and Tx-35 are in reverse order of stratigraphy (although they are within 2σ statistics of each other) and hence the hope of bracketing the time of cut-off was not fulfilled.

Tx-36. Minum Cove, lower layer **>32,000**

Marine shell in living position from lower layer of shell deposit in Minum Cove in bank of Swan River, Perth (32° 02′ S Lat, 115° 46′ E Long). Top of the shell bed 25 ft above sealevel. Layer may date from the 3rd Interglacial Age (Kendrick, 1960). *Comment*: date confirms antiquity of the deposit.

Tx-37. Madura Cave **>35,000**

Shell (*Glycymeris radians*) from uppermost level of cave entrance, Madura Cave, 6 mi S of Madura in SE Western Australia (32° 02′ S Lat, 127° 03′ E Long). Sample from a large assemblage of marine shells, 100 ft above sealevel, in the Pleistocene Roe Plains Formation. *Comment*: date confirms antiquity of the deposit.

Tx-52. Causeway Bridge **8270 ± 170**
6320 B.C.

Charcoal from depth of 60 ft at site of new Causeway Bridge, Perth (31° 57′ S Lat, 115° 51′ E Long). Sample, from approximate depth of fossil shell beds, will help in dating shell layer. Coll. 1955 by M. Carrigy, Alberta Research Council. *Comment*: date is in line with current thinking regarding probable age of shell layer.

IV. ARCHAEOLOGIC SAMPLES

A. Central Texas

The following series represent a continuation of the program to determine the absolute chronology of the cultural sequence in central Texas (see statement in Texas I, p. 46). The standard of acceptability used by those comment-

ing on the dates is the present agreed-on framework of local prehistory, which is based on recent stratigraphic work and on parallels with neighboring areas. This sequence is as follows: the Paleo-Indian Stage, with Angostura points, gave way to the Archaic Stage (Edwards Plateau Aspect) at a time presumed to be no less than 6000 yr ago. No absolute chronology is available within the Archaic, but the general sequence of dart point types is as follows: Nolan, Bulverde, Pedernales, Montell, Frio, Ensor, Darl, with some overlap in the time spans of the types. The Archaic Stage was succeeded by the Neo-American Stage (Central Texas Aspect) at a time believed to be between A.D. 200 and A.D. 800. The early Neo-American Stage is the Austin Focus, with Scallorn arrowpoints; the late Neo-American is the Toyah Focus, with Perdiz arrowpoints; and the Toyah Focus was followed by the Historic Stage with White trade materials. The date of the change from Austin to Toyah focus is not known, and the change to the Historic Stage was probably some time in the 17th century. Opinions differ, but not markedly, regarding how long it may have taken for certain changes to occur within the framework of this sequence, and the comments on the dates below sometimes reflect these variations in viewpoint. In the present state of knowledge, it is often possible to say whether a date agrees or disagrees with current archaeological evidence, but in case of disagreement it is rarely possible to state how great the discrepancy is: one can only say "too old" or "too recent."

One archaeological sample, Tx-74, from the Barton Springs Road site, is listed earlier under "Geologic and Paleontologic samples."

Smith Shelter series

Charcoal samples from Smith Rockshelter (41 TV 42) on Onion Creek S of Austin, Travis County, Texas (30° 12′ N Lat, 97° 43′ W Long). As reported by Suhm (1957), site has a stratified sequence of eleven layers divided into three major cultural periods. The earliest period (Layer I) is represented by a late manifestation of the Edwards Plateau Aspect, currently called Transitional Archaic; the middle and possibly longest period (upper part of Layer II through Layer X) is represented by the Austin Focus; the most recent period (Layer XI) is represented by the Toyah Focus. The samples dated here are relevant to the chronology of the late Edwards Plateau Aspect and the Austin Focus. Coll. 1954-55 and subm. by Dee Ann Suhm, Univ. of Texas, Austin.

Tx-21. Smith Shelter 7 **240 ± 140**
A.D. 1710

From Square N1-N2:B-C, 18 to 24 in. below surface. Layers IX-X, late Austin Focus.

Tx-22. Smith Shelter 8 **210 ± 70**
A.D. 1740

From Square N1-N2: B-C, 12 to 18 in. below surface. Layer X, associated with Eddy points. Late Austin Focus.

Tx-23. Smith Shelter 61 **705 ± 115**
A.D. 1245

From Square 0-N1:C-D, 72 to 91 in. below surface. Mostly in Layer I, partly in Layer II; Transitional Archaic. Sample was split and the two portions

were prepared and counted separately, and the results averaged. The individual ages were 680 ± 150 and 730 ± 170.

Tx-24. Smith Shelter A **585 ± 85**
A.D. 1365

From Square 1N-0:C-D, 54 to 60 in. below surface. Layer III, above the lowest Scallorn points. Early but not earliest Austin Focus.

Tx-25. Smith Shelter 51 **540 ± 140**
A.D. 1410

From Square N1-N2:A-B, 36 to 42 in. below surface. Layers VI-VII, middle Austin Focus.

Tx-26. Smith Shelter 54 **705 ± 95**
A.D. 1245

From Square N1-N2:A-B, 48 to 54 in. below surface. Layers III-IV, associated with a Scallorn point. Early middle Austin Focus. Sample was split and the two portions were prepared and counted separately, and the results averaged. The individual ages were 685 ± 85 and 725 ± 170.

Tx-27. Smith Shelter 23 **1180 ± 210**
A.D. 770

From Square 0-S1:D-E, 84 to 90 in. below surface. Layer I, Transitional Archaic.

Tx-28. Smith Shelter 24 **1165 ± 120**
A.D. 785

From Square 0-S1:D-E, 90 to 96 in. below surface. Layer I, Transitional Archaic.

Comment (D.A.S.): in terms of sequence, these dates agree reasonably well with the site stratigraphy. They also confirm the field interpretation of the sediments which was that the middle part of the section, about 60 to 30 in. below surface, accumulated more rapidly than the parts above and below. However, the dates are consistently 300 to 400 yr younger than would be expected from the lack of European trade material and from comparisons with dates obtained by the Socony-Mobil laboratory on six samples, with archaeological associations comparable to the present series, from the Kyle Site 130 m N of Smith Shelter (Jelks, 1962, p. 98; samples SM-495 through -499, -501; see also Tx-98 and Tx-99, this date list).

Kincaid Shelter series

Charcoal samples from the Kincaid Shelter (41 UV 2) at the edge of the Sabinal River valley, 3 mi N of Sabinal, Uvalde County, Texas (29° 22′ N Lat, 99° 28′ W Long). Samples are from top two zones, Zones 5 (lower) and 6 (higher). Zone 5 was the major zone in the site and contained artifacts of the Edwards Plateau Aspect, Archaic Stage. Zone 6 contained both Edwards Plateau and Central Texas Aspect artifacts, with a few historic White materials at the top. Coll. 1953 and subm. by T. N. Campbell, Univ. of Texas, Austin; *all comments* by T.N.C.

Tx-58. Kincaid 10 **545 ± 120**
A.D. 1405

Square E-F:8-9, 60 to 66 in. below datum. Sample from alluvial deposit

in front of the shelter, from the lower part of Zone 5. All diagnostic artifacts from lower Zone 5 in this excavation unit are Archaic in style. In level 60 to 66 in. only one artifact was recovered, a fragment of what appears to be an Abasolo point. Just below in the next 6 in. level, two Clear Fork gouges were found. *Comment*: the stratigraphy and cultural contents suggest that this date should be much earlier than that measured.

Tx-59. Kincaid 17 **5890 ± 200**
3940 B.C.

Square E-F:2-3, 32 to 48 in. below datum. This excavation unit was a test block inside the shelter, left by previous investigators. The artifacts from this lower part of Zone 5 were few and nondiagnostic, consisting of two side scrapers, a large scraper-graver, a crude gouge or chopper, a large biface fragment, and a cobble covered with red pigment. One side scraper was embedded in travertine formed from seepage of water down the wall to consolidate the base of Zone 5. The artifacts are considered to be Archaic. *Comment*: as the natural stratigraphy also indicates an early Archaic position in time, the date is considered reasonable.

Tx-60. Kincaid 18 **305 ± 110**
A.D. 1645

Square C-D:8-9, 42 to 48 in. below datum. Sample from the alluvial deposit in front of the shelter and from the upper part of Zone 5. A fragment of a probable Bulverde point occurred in this level. Just above this level was a Castroville point, and just below (level 60 to 66 in.) were a Pedernales point and a Clear Fork gouge. A Frio point was at 114 to 120 in. *Comment*: as all cultural evidence indicates the Archaic, the date measured is too recent.

Tx-61. Kincaid 22 **<330**

Square C-D:7-8, 24 to 30 in. below datum. Sample, which comes from the alluvial deposit in front of the shelter, is from a level that includes the top of Zone 5 and the base of Zone 6. This particular level yielded one Perdiz point (found on screen—may have fallen from higher level) and one fragment of a Frio point. Actually the dominant artifacts in the levels above this one are Archaic (Bulverde, Pedernales, and Tortugas dart points), which suggests mixture of the deposit. *Comment*: date appears to be somewhat later than might be expected. It is consistent with Tx-60, but, as pointed out above, Tx-60 is too recent for the Archaic assemblage with which it is associated.

Tx-62. Kincaid 37 **305 ± 110**
A.D. 1645

Test Pit 2, 18 to 30 in. below datum, in terrace deposits just E of the opening of the shelter. No artifacts were in this level. In the level immediately above, a Scallorn arrowpoint was found. Below this level the artifacts were of Archaic types. *Comment*: date appears to be too late for a level that seems to be earlier than a Scallorn point. See also Tx-65, below.

Tx-63. Kincaid 38 **7900 ± 800**
5950 B.C.

Square C-D:1-2, 42 to 54 in. below datum. Sample from a test block at rear of shelter left by earlier investigators and subsequently damaged by un-

known excavators. Deposit was indurated so the remnant was carefully swept clean with a broom and excavated. Portion excavated is considered part of lower levels of Zone 5. This conclusion is supported by the recovery of the mid-section of a projectile point with Angostura outline. The lateral edges of the point are ground and the distal portion is alternately beveled. There were no other diagnostic artifacts. *Comment*: date appears reasonable.

Tx-64. Kincaid 49 **1310 ± 270**
A.D. 640

Test Pit 4, 48 to 54 in. below datum, in the alluvial deposit just E of the opening of the shelter. In the test unit, arrowpoints and pottery were found downward to the 30 in. level. Below that, one Young arrowpoint was found at 48 to 54 in., and from there on downward only Archaic styles of dart points occur (Pedernales, Castroville, and Kinney). *Comment*: date is acceptable.

Tx-65. Kincaid 68 **265 ± 135**
A.D. 1685

Test Pit 2, 78 to 84 in. below datum, in the alluvial deposit E of the opening of the shelter. Sample from a level correlated with the lower part of Zone 5 in front of the shelter. Arrowpoints appeared as low as 54 in. in this pit, but only dart points occurred below (one Abasolo point was identifiable). *Comment*: date is similar to Tx-62, which came from a level 4 ft higher in the same unit. Judging from this fact and from the evidence of the few artifacts found in this test pit, this sample should be much older than the date determined. Tx-6, 1120 ± 60 (Texas I), from 30 to 36 in. in this same unit, is a more reasonable date for its level in terms of current thinking.

Tx-66. Kincaid 71 **1125 ± 190**
A.D. 825

Square C-D:9-10, 78 to 96 in. below datum. From the alluvial deposit in front of the shelter. All artifacts below 12 in. here are Archaic in form. *Comment*: since Ensor and Frio points occurred as low as 90 to 96 in., this date is acceptable.

Tx-67. Kincaid 74 **1150 ± 140**
A.D. 800

Square E-F:8-9, 90 to 96 in. below datum. From Zone 5, in the alluvial deposit in front of the shelter. Artifacts from this level include one identifiable Refugio point. *Comment*: date is in proper sequence with Tx-58 (this date list) from the same excavation unit, and is reasonable. It is not in sequence with Tx-12, 1765 ± 145 (Texas I) from 66 to 72 in. in this excavation unit; but not enough information is available yet on absolute chronology to tell which might be nearer the actual age. Tx-17, 10,025 ± 185 (Texas I), snail shells from 84 to 90 in., is certainly too old.

Tx-68. Kincaid 84 **6020 ± 170**
4070 B.C.

From a test block left by previous excavators against the rear wall of the cave, in the base of Zone 5. No diagnostic artifacts were associated, only side scrapers, choppers, and ovate bifaces. *Comment*: date is reasonable in view of the stratigraphic position at the base of Zone 5 and immediately above Zone 4, which yielded extinct fauna.

Kyle Site series

Charcoal samples from the Kyle Rockshelter (41 HI 1), E edge of Brazos valley SW of Blum, Hill County, Texas (32° 02′ N Lat, 97° 25′ W Long). The site, reported by Jelks (1962), had six strata. Strata 1 (lowest) and 2 contained Austin Focus materials; Stratum 3 had approximately equal amounts of Austin and Toyah Focus materials; Stratum 4 was predominantly Toyah Focus; Stratum 5 was exclusively Toyah Focus; Stratum 6 was sterile. A series of samples from this site was previously dated by the Socony-Mobil laboratory (Jelks, 1962, p. 97-98 and see below) and the samples reported here were dated to add to the series as a further check. Coll. 1959-60 and subm. by E. B. Jelks, Texas Archeol. Salvage Project, Univ. of Texas, Austin.

Tx-98. Kyle 138 **560 ± 80**
A.D. 1390

From upper Stratum 5, late Toyah Focus; should be slightly more recent than SM-498, 400 ± 130 (cited in Jelks, 1962, p. 97, as sample C-5).

Tx-99. Kyle 116 **560 ± 80**
A.D. 1390

From lower Stratum 5, middle to late Toyah Focus; should be slightly earlier than SM-498 (cited above).

Tx-100. Kyle 127 **1900 ± 160**
A.D. 50

From upper Stratum 4, probably early to middle Toyah Focus; should fall between SM-501, 685 ± 165, and SM-495, 670 ± 150 (cited in Jelks, 1962, p. 97, as samples C-8 and C-1). *Comment* (E.B.J.): Tx-98 and Tx-99 agree well with the assignment to the Toyah Focus, and support the Socony-Mobile dates. Tx-100 is too early, perhaps by as much as 1000 yr, in terms of both archaeological evidence and other C^{14} dates.

Oblate Shelter series

Charcoal samples from the Oblate Rockshelter (41 CM 1) in the Canyon Reservoir on the Guadalupe River, Comal County, Texas (29° 55′ N Lat, 98° 17′ W Long). Tunnell (1962) reported that the site has three main zones: Zone I (lowest) is Middle Archaic with Pedernales, Bulverde, and other point types; Zone II is Late Archaic, with expanding stem points such as Ensor and Frio; Zone III is mixed Austin and Toyah foci.

Tx-29. Oblate 8 **155 ± 90**
A.D. 1795

Seven small samples from different parts of the site, but all from lower Zone III, were combined to make this sample large enough to be counted. Lower Zone III is mainly Austin Focus. Coll. 1959-60 by C. D. Tunnell; subm. by E. B. Jelks *Comment* (C.D.T.): since stratigraphic evidence from several central Texas sites shows that the Austin Focus preceded the Toyah Focus and both were prehistoric, this date is considered much too recent to represent the Austin Focus.

Tx-30. Oblate 271 **1970 ± 150**
20 B.C.

From Square N215-W105, 91.0 ft above site datum. Mixed Zones I and

II, late Middle Archaic or early Late Archaic. Coll. 1960 by C. D. Tunnell; subm. by E. B. Jelks. *Comment* (C.D.T.): date seems too recent, but this opinion is based more on impression than on evidence (see also comments on Tx-104, this date list).

Tx-103. Oblate 105X **3570 ± 650**
1620 B.C.

Very small sample from bottom of fire hearth, Square N235-W120, 85.5 to 85.0 ft above site datum, in Zone I, about 2½ ft below bottom of Zone II. A Pedernales point was found in this level and one in the level below; hence this level is interpreted as being Middle Archaic. Should be earlier than Tx-30, this date list. Coll. 1963 by Texas Archeol. Soc. summer field school; subm. by E. M. Davis. *Comment* (E.M.D.): even though the error is large because of small sample size, this date gives us a preliminary idea of the age of Pedernales points. The date, relative to other dates, is consistent with archaeological data.

Tx-104. Oblate 125X **2900 ± 180**
950 B.C.

From Square N205-W105, 94.0 to 93.5 ft above site datum. Interpretation of the stratigraphy here is not yet complete, but this is probably the lower part of Zone II, with a slight possibility that it is the top of Zone I. Nothing diagnostic in this level, but an expanding-stem point was found in the level above. Should be early Late Archaic or late Middle Archaic, roughly comparable in age to Tx-30, this date list. Coll. 1963 by Texas Archeol. Soc. summer field school; subm. by E. M. Davis. *Comment* (E.M.D.): significantly earlier than Tx-30. In terms of most current estimates of the rate of cultural change within the Middle and Late Archaic, Tx-104 is more likely than Tx-30 to be near the actual age, but these estimates are hypotheses which can be verified only by more C^{14} dating.

Penny Winkle series

Charcoal samples from Penny Winkle site (41 BL 23), on S bank of Stampede Creek 12 mi NW of Temple, Bell County, Texas (31° 15′ N Lat, 97° 27′ W Long). This is a buried alluvial terrace site in which the stratigraphy was complex and not sharply defined. In general, Toyah Focus materials occurred above those of the Austin Focus, both being in Zone 3; these materials, in turn, were above Edwards Plateau Aspect artifacts, which were in Zone 4. Coll. 1962 by J. D. Scurlock; subm. by E. B. Jelks and Dee Ann Suhm; comments by D.A.S.

Tx-70. Penny Winkle A **1040 ± 85**
A.D. 910

From test Square VV, 28 to 34 in. below surface. Lower Zone 3, Austin Focus. *Comment*: date agrees well with present ideas as to the age of the Austin Focus.

Tx-71. Penny Winkle B **290 ± 95**
A.D. 1660

From Square II, 1.0 to 1.5 ft below surface. Upper Zone 3, predominantly Toyah Focus. Sample made up of charcoal flecks scattered in the soil, and material looked unusually fresh; there was suspicion in the field that it might

represent recent carbonized roots. *Comment*: within early part of 1σ range, date could apply to Toyah Focus.

Tx-72. Penny Winkle C **1080 ± 110**
A.D. 870

From Square YY, 27 to 33 in. below surface, in a fire hearth, Feature 1, from a level including lower Zone 3 and upper Zone 4, with Austin Focus material and a few late Edwards Plateau artifacts. *Comment*: date satisfactory for Austin Focus.

Tx-75. Punkinseed A **920 ± 200**
A.D. 1030

Charcoal from Punkinseed Shelter (41 TV 48) on Lick Creek, a tributary of the Pedernales River about 27 mi W of Austin in western Travis County, Texas (30° 22′ N Lat, 98° 05′ W Long). Sample from Square 100, 0.5 to 1.0 ft below surface, associated with Scallorn points. Another portion of this same sample was previously dated as Tx-7, 2355 ± 185 (Texas I). Coll. 1961 and subm. by J. D. Scurlock, Univ. of Texas. *Comment* (E.M.D.): date fits present thinking; Tx-7 does not.

B. Amistad Reservoir, Texas

The following samples have been obtained in the course of archaeological salvage in the Amistad Reservoir area, on the Rio Grande and its tributaries in the vicinity of the mouth of the Pecos, in Val Verde County, Texas. This region is immediately southwest of central Texas (see above), and there is no sharp archaeological break between the two, but nevertheless the histories are distinct. The sequence of projectile point types which is assumed in the discussions of the samples is, briefly, as follows (Johnson, 1964): Lerma and Golondrina points (the latter being a variety of the Plainview type) are found in the late Paleo-Indian stage; in the Early Archaic are early barbed points and Pandale points, the latter type extending into the Middle Archaic in which contracting-stemmed points of the Langtry and Shumla types are characteristic; in the late Archaic expanding-stem or side-notched points are characteristic, in particular the Ensor type. Arrowpoints, especially the Perdiz type, appear in the Neo-American stage. The absolute chronology of this sequence is not yet known, and the evaluations of the dates given below are based primarily on comparisons with sequences in neighboring areas.

Unless otherwise stated, the samples were subm. by E. B. Jelks.

Centipede Cave series

Samples from Centipede Cave (41 VV 191) on the Rio Grande about 5½ mi NW of the mouth of the Pecos R. (29° 45′ N Lat, 101° 27′ W Long). Epstein (1963) reports 3 projectile-point zones in this site. The lower zone contains contracting-stem dart points, the intermediate zone has a mixture of contracting-stem and side-notched dart points, and the upper or most recent zone is characterized by side-notched dart points, arrowpoints, and wood and fiber artifacts of the Pecos River Focus. All the samples dated here came from a single column 2 ft square which was dug to a depth of 59½ in. Coll. 1959

and subm. by J. F. Epstein, Univ. of Texas, Austin; all comments by J.F.E. except where noted.

Tx-38. Centipede Cave 2 **830 ± 100**
A.D. 1120

Charcoal from 8 to 14 in. level, associated with Ensor and Frio dart points, arrowpoints of Perdiz, Cliffton, and Bonham types, and Pecos River Focus perishable artifacts. *Comment*: probably dates arrowpoint occupation of the upper zone as well as perishable artifacts.

Tx-39. Centipede Cave 5 **1840 ± 400**
A.D. 110

Charcoal from base of deposit (48 to 59½ in. level). Should date earliest occupation of cave. Associated with Langtry, Almagre, and Shumla dart points of lower zone. *Comment*: date much too recent. Nothing in the soil profile indicates why the date should be recent.

Tx-40. Centipede Cave 6 **3050 ± 120**
1000 B.C.

Snail shells from base of deposit (48 to 59½ in. level). See Tx-39. *Comment*: much too recent; see comment for Tx-39. (M.A.T.): The difference in dates between Tx-39 and Tx-40 does not conflict with the positive archaeological evidence that they are the same age, since it was shown by Rubin *et al.* (1963) that snail shells can give dates that are 1000 yr too old. The possibility of a counting error is thus precluded. Also there was definitely no sample mix-up either in the laboratory or in the field.

Tx-41. Centipede Cave 4 **6530 ± 620**
4580 B.C.

Charcoal from 36 to 48 in. level. Associated with contracting-stem points of Almagre, Langtry, and Shumla types. *Comment*: date acceptable and as predicted. May date the more recent contracting-stem points of the upper part of the lower zone.

Tx-42. Centipede Cave 3 **5080 ± 310**
3130 B.C.

Charcoal from 23½ in. depth. Associated with mixture of contracting-stem and side-notched dart points. Should be later than Tx-39, -40, -41, and earlier than Tx-38. *Comment*: acceptable. Slightly older than predicted.

Coontail Spin series

Samples from Coontail Spin site (41 VV 82), a rock shelter on the left bank of the Rio Grande about 5 mi NW of Comstock (29° 39′ N Lat, 101° 18′ W Long). This is a stratified site with a dart point sequence beginning with Lerma and ending with Ensor and other Late Archaic types. Coll. 1962 by J. P. Nunley; comments by J.P.N. and E.B.J.

Tx-76. Coontail Spin 297 **2300 ± 160**
350 B.C.

Charcoal from Area A, Square B-160, 5.5 ft below datum. Scattered through a zone containing both Ensor and Shumla points, with Ensor predominating. Should date early Ensor or late Shumla. *Comment*: date seems appropriate in terms of current knowledge.

Tx-77. Coontail Spin 301 **600 ± 190**
A.D. 1350

Charcoal from Area B, Square B-165, 4.5 ft below datum. Scattered in an area disturbed by a sotol pit and several burials. Associations were predominantly with late Archaic (Ensor) projectile points, but some Middle Archaic points also were present, and there was a possibility that post-Ensor materials might have intruded. *Comment*: date indicates very late Archaic.

Tx-78. Coontail Spin 310A **4430 ± 140**
2480 B.C.

Tx-79. Coontail Spin 310B **3950 ± 120**
2000 B.C.

Tx-78 and Tx-79 are two posts of Feature 1, possibly a wind screen, in Area A. Feature dates either from the late occurrence of Shumla points at the site, or from the earliest occurrence of Ensor points, uncertainty being due to inability in the field to tell exactly from what level the posts were driven into the ground. *Comment*: dates seem too old for Ensor points; hence Feature 1 probably dates from Shumla period.

Tx-80. Coontail Spin 258 **10,300 ± 400**
8350 B.C.

Charcoal from Area A, Square E-20, 12 ft below datum. Earliest occupation of site, just below Lerma points. No direct association with diagnostic artifacts. *Comment*: seems appropriate for general Lerma period, in view of a date of 9270 ± 500 from Lerma occupation in the Sierra de Tamaulipas, Mexico (M-499, Michigan II), and dates of 8200 ± 450 and 8540 ± 450 for immediately post-Lerma occupation in SW Tamaulipas (M-498, M-500, Michigan II; for discussion of these dates see MacNeish, 1958, p. 194).

Tx-81. Coontail Spin 62 **1270 ± 110**
A.D. 680

Unburned grass bundle from Area A, Square E-10, upper Zone "C". Associated primarily with Ensor points, and should constitute a firm Ensor date. *Comment*: date is appropriate for Ensor.

Bonfire Shelter series

Samples from Bonfire Shelter (41 VV 218) near Langtry (29° 48′ N Lat, 101° 33′ W Long). Initial testing in this site showed an unusual layer of heavily burned bones which might have resulted from disposal of cattle within the present century. However, there were signs of aboriginal occupation above the bone layer, and a Montell point was in the layer. Tx-46 and Tx-47, below, were dated to see whether the bones were recent or not, and hence whether further investigation was merited. Subsequently, full-scale excavation was undertaken, and was under way at the time this list went to press. Tx-106 derives from the early stages of this latter work.

Tx-46. Bonfire Shelter A **2310 ± 210**
360 B.C.

Bone fragments from bone layer in preliminary test pit. These pieces were so heavily burned that little but the inorganic shell was left. Coll. 1962 by Jelks, Duffield, and Nunley. *Comment*: these bones were simply acid washed.

The C obtained by burning the sample amounted to 0.7% of the weight of the untreated bones. An acid dissolving of a large amount of bones from the same area of the shelter and subsequent burning showed that the sample had less than 0.06% organic C. The bones were probably originally burned in a very hot fire. This date should be less reliable than Tx-47.

Tx-47. Bonfire Shelter 6 **2810 ± 110**
860 B.C.

Bone fragments from Test Excavation IV, Zone D (bone layer). They had a blackish color and appeared to be charred. Coll. 1962 by Mark Parsons. *Comment*: these bones were dissolved in HCl and the solution taken to dryness. The burning of the resulting solid material showed they contained 0.6% organic C. This date considered more reliable than Tx-46. *Comment on Tx-46 and Tx-47* (E.B.J.): both of these dates are reasonable in terms of current thinking regarding the possible age of Montell points.

Tx-106. Bonfire Shelter B **2780 ± 110**
830 B.C.

Charcoal from Square N98-W40, ca. 0.5 to 1.0 ft deep, in upper bone layer. This is composite sample made up of charcoal flecks collected from the same bone layer as Tx-46 and Tx-47, but from a different part of the site. Coll. 1963 by Tunnell and Dibble; subm. by C. D. Tunnell, Texas Memorial Mus., Univ. of Texas, Austin. *Comment* (C.D.T.): identity of age with Tx-47 agrees with stratigraphic evidence, and is reasonable for Montell point type.

Tx-82. Black Cave **5900 ± 200**
3950 B.C.

Charcoal embedded in a travertine deposit against the back wall of Black Cave, a cave remnant in Pressa Canyon (29° 39′ N Lat, 101° 18′ W Long). This was oldest deposit in the cave. The material was submitted to find out whether the presence of the charcoal in travertine signified occupation of the cave in relatively early times. Coll. 1962 by J. P. Nunley. *Comment* (E.B.J.): evidently the travertine does not signify great antiquity.

C. Caddoan Area

The following samples pertain to the chronology of the Caddoan archaeological area in adjoining parts of Texas, Oklahoma, Arkansas, and Louisiana. Early Caddoan sites are grouped in the Gibson Aspect, and late Caddoan sites in the Fulton Aspect which extends into the historic period. There have long been two schools of thought concerning the length of the Caddoan sequence, one school favoring a short chronology in which the Gibson Aspect begins around A.D. 1200, and the other school favoring a longer time span beginning around A.D. 800 or earlier. Both schools have based their beliefs on cross-ties with sequences in neighboring areas. C^{14} dating is now beginning to influence the picture, although not decisively as yet, since not many samples have yet been run from a variety of Gibson Aspect Caddoan sites (a summary of Caddoan dates is given by Campbell, 1961).

Mounds Plantation series, Louisiana

Logs from Mounds Plantation site (16 CD 12), Caddo Parish, NW Louisiana, about 11 mi N of Shreveport (32° 38′ N Lat, 92° 46′ W Long).

Formed a frame above part of Burial Pit 5, submound level, Mound B, associated with Alto-Gahagan artifact types of the Gibson Aspect (Webb and McKinney, 1963). Coll. 1961 by Ralph McKinney and subm. by C. H. Webb, Shreveport, La.

Tx-55. Mounds Plantation Log 1 **860 ± 120** **A.D. 1090**

Tx-56. Mounds Plantation Log 6 **475 ± 110** **A.D. 1475**

Comment (E.M.D.): although the dates overlap within 2σ statistics, they are different enough so that it will take more dating to determine the age of the site satisfactorily.

Tx-57. Spiro site, Oklahoma **530 ± 105** **A.D. 1420**

Wood from timber removed from central tomb in Craig mound, Spiro site, Le Flore County, Oklahoma (35° 15′ N Lat, 94° 20′ W Long). This is a classic site of the Gibson Aspect. Sample is from the same lot, but not necessarily the same log, previously dated as Tx-4, 1144 ± 165 (Texas I); but see comments at end of introduction to present list. Coll. about 1935 by F. E. Clements; subm. by R. E. Bell, Univ. of Oklahoma, Norman. *Comment* (E.M.D.): date is in significant agreement with most of those previously determined for the Spiro site (see summary of Spiro and Spiro-related dates in Texas I, sample Tx-4; and dates determined more recently in Michigan VIII, samples M-815, -858, -859, -860). Samples relating directly or indirectly to Spiro have varied considerably in C^{14} age, but those from the Spiro site itself indicate a post-A.D. 1200 date for the tomb in the Craig mound, and thus lend support to the short chronology for the Caddoan sequence.

Tx-105. Davis site 5888, Texas **1120 ± 90** **A.D. 830**

Charred corn screenings and charcoal from Davis site (41 CE 19), on Neches R SW of Alto, Cherokee County, Texas (31° 35′ N Lat, 95° 10′ W Long). From floor of cache pit in Feature 31, under mound. Should date Phase 1 of Alto Focus occupation of site (Newell and Krieger, 1949). Sample is from the same lot as that dated by Libby as C-153, 1553 ± 175 (Chicago II), and is from a different lot but from the same house, and hence should be the same age, as M-1186, 655 ± 75 (Michigan VIII; Griffin and Yarnell, 1963, discuss the Chicago and Michigan dates). A. D. Krieger sent the Davis Site corn to V. Jones of the Univ. of Michigan Ethnobotanical Lab. Jones treated the identifiable material with preservative, retaining untreated the screenings and siftings, of which part of cat. no. 5888 (Ethnobotanical Lab. No. 3497) was sent to Libby who obtained the C-153 date, and the remainder was returned to Krieger in 1953. Part of this remainder was used in obtaining the present date Tx-105. Coll. 1940-41 by H. P. Newell; subm. by E. M. Davis, Univ. of Texas, Austin. *Comment* (E.M.D.): date, falling between the previous two, is in line with the longer chronology favored by Caddoan archeologists. However, the significant discrepancy between it and the other two dates makes it clear that more samples from this key site must be dated if possible. We do not yet have a consistent pattern of C^{14} dates for the Alto Focus.

Tx-83. Dalton Mound, no. 173, Texas **480 ± 110**
A.D. 1470

Charcoal from Dalton Mound (41 UR 11), NE of Ore City, Upshur County, Texas (32° 50′ N Lat, 94° 42′ W Long). The mound covered remains of two ceremonial structures which had been used and then burned, one after the other. Charcoal is from remains of the later structure. Associated artifacts were those of the "Whelan Complex," early Titus Focus, Fulton Aspect. The Whelan Complex was followed by the classic Titus Focus in which a number of significant changes took place in pottery types, and mound-building was abandoned. Still later, European trade goods appeared, probably in the 17th or early 18th century. It is not known how long it took for these changes to take place. Coll. 1958 and subm. by E. M. Davis. *Comment* (E.M.D.): the earlier part of the time span indicated seems feasible for the site.

Tx-84. Harroun Site, Mound D, Texas **490 ± 100**
A.D. 1460

Charcoal from Mound D, Harroun Site (41 UR 10), NE of Ore City, Upshur County, Texas (32° 50′ N Lat, 94° 41′ W Long). Coordinates of sample within site, N97.1/W102.4, elev. 97.76. Site has been reported by Jelks and Tunnell (1959). Mound D covered remains of a burned structure and charcoal was from a beam above the house floor. Associated artifacts were those of the early Titus Focus (Whelan Complex), and the date should be similar to Tx-83 from the Dalton Mound. Coll. 1958 and subm. by E. B. Jelks. *Comment* (E.M.D.): same date as Tx-83. Strengthens the case for this dating of the Whelan Complex.

D. Utah

Danger Cave series

Sample from Level I of Danger Cave (41 TO 13), near Wendover, Tooele County, western Utah (40° 45′ N Lat, 114° 00′ W Long). Level contains evidences of early Desert Culture occupation (Jennings, 1957). Coll. 1951 and subm. by J. D. Jennings, Univ. of Utah, Salt Lake City, as further check on C^{14} dates from the same level previously determined by other laboratories (Jennings, 1957, p. 93-98, and references below). All samples were expected to be between 10,000 and 11,000 yr old.

Tx-85. Danger Cave 694 **10,600 ± 200**
8650 B.C.

Twigs from Feature 108, a fireplace in a thin layer of trash lying on the surface of the lower sand component. A very limited amount of charcoal also found in this fireplace has been dated as M-202, 10,270 ± 650 (Michigan I).

Tx-86. Danger Cave 695 **8970 ± 150**
7020 B.C.

Charred rat dung and twigs collected by sifting sands (Feature 108/109) immediately adjacent to and under fireplace, Feature 108. Dung charred by heat from the fireplace. Should be approx. the same age as Tx-85. Other dates from the sands under the fireplace are M-204, slightly charred sheep dung, 10,270 ± 650 (Michigan I) and C-610, uncharred wood, 11,151 ± 570 (Chicago II).

Tx-87. Danger Cave 735 **10,150 ± 170**
8200 B.C.

Charcoal and vegetal material from same stratigraphic position as Tx-85, but scattered over a more extensive area; should be same age.

Tx-88. Danger Cave 730 **9050 ± 180**
7100 B.C.

Sheep dung sifted from lower part of Sand 2 (Feature 19), immediately overlying the fireplace, Feature 108. Should be slightly younger than Tx-85. 86, and 87. This material came approx. 20 ft from the dung dated as C-609, 11,453 ± 600 (Chicago II) and should be equivalent to it in age. However, the date of C-609 was older than that of samples from deeper positions (M-204 and C-610; see Tx-86, above). Also from the same stratigraphic position are M-118, sheep dung, 11,000 ± 700, and M-119, twigs and leaves, 10,400 ± 700 (Michigan I).

Tx-89. Danger Cave 731 **9740 ± 210**
7790 B.C.

Twigs and sticks associated with the sheep dung of Tx-88; should be same age.

Comment on Danger Cave Dates (J.D.J.): Tx-86 is closest to our preconceptions. (E.M.D.): Texas dates run younger than the others, but within 2σ statistics (and often within 1σ) there is substantial overlap among most of the dates. As a general statement, 9,000 to 11,500 B.P. seems to cover most of the interval involved.

E. Mexico

La Candelaria Cave

Textile material and associated human bone fragments from La Candelaria Cave, Las Delicias basin, near San Pedro de las Colonias in southwestern Coahuila, Mexico (approx. 25° 01′ N Lat, 102° 46′ W Long). The cave contained an extremely rich mortuary deposit, very important for the archeology of Arid America, but without stratigraphy. Materials recovered as funerary offerings show some similarities with cultural elements of the Pecos and Big Bend Cave-Dwellers and similar developments of the Arid Southwest. On typological grounds it was concluded that the cave was used during the last four or five centuries before the Spanish colonization of the area, and in any case not previous to A.D. 1000 (Aveleyra *et al.*, 1956). Coll. 1953 by Aveleyra and others; subm. by the late P. Martínez del Río, Inst. Nac. de Anthropol. e Historia, Mexico, D.F.

Tx-50. Candelaria cloth **745 ± 110**
A.D. 1205

Tx-51. Candelaria bone **745 ± 95**
A.D. 1205

The bone sample was freed of inorganic carbonates by dissolving in HCl and was found to contain 9% organic C, the highest percentage for bone that we have seen. *Comment* (Luis Aveleyra A. de Anda): C^{14} date checks very well with the previous conclusion as to the age of the deposit.

El Jaral series

Samples from El Jaral site, municipio of Rioverde, south-central San Luís Potosí, Mexico (21° 54′ N Lat, 100° 03′ W Long). Both specimens are from Mound 14, Pit 1, Level 5, 292-301 cm below the top of the mound. Associated cultural materials are Huastec, representing the transition between late Classic and early Postclassic. The area of this site (Troike, 1962) represents the westernmost known expansion of the Huastec culture, and the samples should help to date this expansion. These are also the first dates obtained for any Huastec material. Coll. 1957 and subm. by R. C. and N. P. Troike, Univ. of Texas, Austin.

Tx-101. El Jaral charcoal **1680 ± 90**
A.D. 270

Tx-102. El Jaral burned corncob **1160 ± 100**
A.D. 790

Comment (N.P.T.): In terms of current knowledge of the change from Classic to Postclassic in Mesoamerica, Tx-101 is at least 400 yr too early for the Rioverde area, whereas Tx-102 is entirely appropriate and helps validate the cultural assignment. The early date of Tx-101 suggests that the charcoal was part of the mound fill, and a recheck of the excavation records indicates that this may have been the case.

E. Dominican Republic

Tx-53. La Isabela **800 ± 390**
A.D. 1150

Charcoal from top zone (0.25 to 0.50 m level) of a mound with aboriginal pottery, at site of La Isabela, founded by Columbus in 1493 on his second voyage, on N coast of Dominican Republic (19° 54′ N Lat, 71° 06′ W Long). Zone should represent the culture of the Indians whom Columbus met, but it is not known how long they had lived there. Charcoal sample was quite small; hence the size of the quoted error. Coll. 1963 by Cruxent, Chanlate, and Ortega; subm. by J. M. Cruxent, Inst. Venezolano de Inv. Cient., Caracas. *Comment* (J.M.C.): date confirms the belief that the Indians who lived at this site were those whom Columbus met.

Tx-54. Mordan **4140 ± 130**
2190 B.C.

Charcoal from top level (0.75 to 1.0 m) of Mordan site in province of Azua, Dominican Republic (18° 22′ N Lat, 71° 06′ W Long). Zone is non-ceramic, and this is the first date on a Meso-Indian complex in the Dominican Republic. Coll. 1963 by Cruxent, Chanlate, and Ortega; subm. by J. M. Cruxent. *Comment* (J.M.C.): date seems correct.

REFERENCES

Date lists:

Chicago II	Libby, 1951
Chicago IV	Libby, 1954
Michigan I	Crane, 1956
Michigan II	Crane and Griffin, 1958
Michigan VIII	Crane and Griffin, 1963
Texas I	Stipp *et al.*, 1962

Anders, R. B., 1957, Ground-water geology of Wilson County, Texas: Texas Water Comm., Bull. 5710.

Anders, R. B., and Baker, E. T., Jr., 1961, Ground-water geology of Live Oak County, Texas: Texas Water Comm., Bull. 6105.

Aveleyra Arroyo de Anda, Luis, Maldonaldo-Koerdell, Manuel, and Martínez del Río, Pablo, 1956, Cueva de la Candelaria: Mexico, Inst. Nac. Antropol. e Historia. Mem., no. 5.

Broecker, W. S., and Farrand, W. R., 1963, Radiocarbon age of the Two Creeks Forest Bed, Wisconsin: Geol. Soc. Am. Bull., v. 74, p. 795-802.

Campbell, T. N., 1961, Caddoan radiocarbon dates: Texas Archeol. Soc. Bull., v. 31, p. 145-151.

Crane, H. R., 1956, University of Michigan radiocarbon dates I: Science, v. 124, p. 664-672.

Crane, H. R., and Griffin, J. B., 1958, University of Michigan radiocarbon dates II: Science, v. 127, p. 1098-1105.

———— 1963, University of Michigan radiocarbon dates VIII: Radiocarbon, v. 5, p. 228-253.

Epstein, J. F., 1963, Centipede and Damp Caves: Texas Archeol. Soc. Bull., v. 33, p. 1-129.

Godwin, H., 1962, Half-life of radiocarbon: Nature, v. 195, p. 984.

Griffin, J. B., and Yarnell, R. A., 1963, A new radiocarbon date on corn from the Davis site, Cherokee County, Texas: Am. Antiquity, v. 28, p. 396-397.

Jelks, Edward B., 1962, The Kyle Site: Dept. of Anthropol., Univ. of Texas, Archaeol. Series, no. 5.

Jelks, Edward B., and Tunnell, Curtis D., 1959, The Harroun Site: Dept. of Anthropol., Univ. of Texas, Archaeol. Series, no. 2.

Jennings, Jesse D., 1957, Danger Cave: Soc. Am. Archaeol. Mem., no. 14.

Johnson, LeRoy, Jr., 1964, The Devil's Mouth Site: Dept. of Anthropol., Univ. of Texas, Archaeol. Series, no. 6.

Kendrick, G. W., 1960, The fossil Mollusca of the Peppermint Grove Limestone, Swan River district of Western Australia: Western Australia Naturalist, v. 7, no. 3, p. 53-66.

Léger, C., and Tamers, M. A., 1963, The counting of naturally occurring radiocarbon in the form of benzene in a liquid scintillation counter: Int. Jour. Applied Radiation and Isotopes, v. 14, p. 65-70.

Libby, W. F., 1951, Radiocarbon dates, II: Science, v. 114, p. 291-296.

———— 1954, Chicago radiocarbon dates IV: Science, v. 119, p. 135-140.

MacNeish, Richard S., 1958, Preliminary archaeological investigations in the Sierra de Tamaulipas, Mexico: Trans. Am. Philos. Soc., v. 48, pt. 6.

Newell, H. P., and Krieger, Alex D., 1949, The George C. Davis Site, Cherokee County, Texas: Soc. Am. Archaeol. Mem., no. 5.

Noakes, J. E., Isbell, A. F., Stipp, J. J., and Hood, D. W., 1963, Benzene synthesis by low temperature catalysis for radiocarbon dating: Geochim. et Cosmochim. Acta, v. 27, p. 797-804.

Patton, Thomas Hudson, 1963, Fossil vertebrates from Miller's Cave, Llano County, Texas: Texas Memorial Mus., Bull. 7.

Rubin, Meyer, Likins, Robert C., and Berry, Elmer G., 1963, On the validity of radiocarbon dates from snail shells: Jour. Geol., v. 71, p. 84-89.

Stipp, J. J., Davis, E. Mott, Noakes, John E., and Hoover, Tom E., 1962, University of Texas radiocarbon dates I: Radiocarbon, v. 4, p. 43-50.

Suhm, Dee Ann, 1957, Excavations at the Smith rockshelter, Travis County, Texas: Texas Jour. Sci., v. 9, p. 26-58.

Tamers, M. A., Stipp, J. J., and Collier, J., 1961, High sensitivity detection of naturally occurring radiocarbon: Chemistry of the counting sample: Geochim. et Cosmochim. Acta, v. 24, p. 266-276.

Troike, Nancy P., 1962, Archeological reconnaissance in the drainage of the Rio Verde, San Luis Potosi, Mexico: Texas Archeol. Soc. Bull., v. 32, p. 47-55.

Tunnell, Curtis D., 1962, Oblate: A rockshelter site, *in* Johnson, LeRoy, Jr., Suhm, Dee Ann, and Tunnell, Curtis D., Salvage archeology of Canyon Reservoir: Texas Memorial Mus. Bull. 5, p. 77-116.

Webb, Clarence H., and McKinney, Ralph R., 1963, An unusual pottery vessel from Mounds Plantation site, Caddo Parish, Louisiana: Arkansas Archeol. Soc. Bull., v. 4, no. 5, p. 1-9.