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LA JOLLA NATURAL RADIOCARBON MEASUREMENTS*

CARL L. HUBBS, GEORGE S. BIEN, and HANS E. SUESS

Scripps Institution of Oceanography, University of California, La Jolla

INTRODUCTION

The recently established low-level radiation laboratory of Scripps Institution of Oceanography has been measuring radiocarbon since August 1957. Through 1959 about 160 samples have been measured.

In the radiocarbon tests the La Jolla laboratory staff utilizes the technique, with acetylene as the counting gas, that was developed at the United States Geological Survey (Suess, 1953, 1954a, 1956, USGS I). Until March 1959 only one set of equipment was in service, with a counter somewhat smaller than either of the two used in Washington, having a sensitive volume of approximately 0.6 liter. Although several counters were constructed and tested, a background as low as that attained in Washington could not be achieved: the background ran about 2.8 counts/min as compared with 2.0 counts/min for each of the 1-liter counters in Washington.

In March 1959 an Oeschger-Houtermans counter, manufactured at the Physical Institute of the University of Bern, Switzerland, was installed. It operates with a background of less than 2.0 counts/min, decreasing with filling pressure, and a sensitive volume of 1.3 liters. The disadvantage of this counter is the large volume of counting gas required, for example, 3.2 l STP for a filling pressure of 850 mm. However, this counter proved to be more stable than the ordinary counters, and it can be operated at pressures as low as 440 mm, at which a background as low as 1.2 counts/min can be attained. Therefore, this counter proves to be superior also in the measurement of relatively small samples. Dates obtained with the Oeschger-Houtermans counter are designated by appending **(B.)**, for Bern, to the serial number of the count.

The installation of one or more additional counters is being considered, with the aim of increasing the annual output of tests.

Shell dates reported in this paper are calculated (as in USGS I) from 19th century wood as a reference standard, without correction for any supposed fractionation of isotopes. This procedure has been adopted because in general, within the errors of measurement, the activity of 19th century wood corresponds to that of modern shell, despite the differences in the equilibrium distribution of the isotopes as shown by C^{13} analyses.

For purposes of calibration and control, numerous tests, not treated in this report, have been run on bituminous coal, on standard oxalic acid, and on dated annual rings of 19th century wood. Numerous other measurements, which will be published elsewhere, have been made: (1) to analyze mixing processes and recent changes in the radioactivity of the sea and the atmosphere; (2) to test changes in the radioactivity of trees, various marine plants and animals, and food items; and (3) to estimate the age of water masses.

* Contributions from the Scripps Institution of Oceanography, New Series.

(Bien, Rakestraw, and Suess, in press). A report (Bien and Suess, 1959) has been published on the dating of various annual rings in 20th century wood. Except as just noted, all tests run by the La Jolla laboratory through 1959 are reported below.

In the dating program of the La Jolla laboratory, which has been pursued when the other research projects have afforded the opportunity, particular attention has been paid to the elucidation of past changes in the environment. Most of the samples that have been run were selected for their bearing on such problems, particularly in western North America, both in the coastal waters and in the arid lands of the Southwest. For example, past faunal associations, particularly when bolstered by O^{18} paleotemperature measurements, help in the elucidation of past oceanographic conditions. The environmental changes are being studied not only for their own significance but also for their bearing on the distribution and abundance of organisms, including man. In turn, the data on the organisms are being brought to bear on the environmental changes. The senior author is preparing reports along these lines, and has indicated in the sample accounts below some of the implications that he will discuss in these reports.

ACKNOWLEDGMENTS

The initial equipment, including the 17-ton iron shield, was provided through grants from the Office of Naval Research and the Atomic Energy Commission. A major share of support for the operation of the laboratory has been supplied by the Atomic Energy Commission, under contracts for the study of mixing processes in the sea and the atmosphere. Other support, which has made the laboratory available on a part-time basis for other tests, has stemmed from the California State Water Resources Board, for studies of climatic fluctuations in the California area, and from the National Science Foundation, by a grant to the senior author, for the collection and interpretation of material bearing on past changes in habitat and other ecological conditions, particularly in respect to the effect of these changes on human populations.

We are most grateful for the support received from various sources and to many individuals who have given encouragement and assistance. Paula Sandoval has served effectively as assistant in the laboratory. Laura C. Hubbs has devoted much time to the collecting and recording of data. Jacquelin N. Miller has served as assistant under the senior author's National Science Foundation grant. Robert N. C. Bowen is running O^{18} paleotemperature measurements.

CLASSIFIED SUBJECT INDEX

Many of the natural radiocarbon measurements run at the La Jolla laboratory, especially those reported herein, were selected because of their multiple bearing on various events and processes—geologic, oceanographic, zoogeographic, ecologic, climatologic, and archaeologic. The bearings we envision are listed for each entry in the date list, and the index permits ready reference to the serially listed entries.

I. GEOLOGIC INFERENCES:

1. Quaternary Changes in Sealevel:
   - Raised beaches, Australia and Golfo de California: LJ-128, 130-132
   - Buried deposits, Cape Cod: LJ-141, 142
   - Submarine shell, Texas and California: LJ-71, 95
   - Flooded cave, Florida: LJ-120

Middens sloping or inferred to have sloped to below present sealevel, southern California and Baja California: LJ-19, 20, 34, 37, 38, 78?, 83, 98 (and probably others)

2. Ancient Rise in Sealevel and Elimination of Minor Estuaries, Inferred Chiefly from Faunal Assemblages: LJ-3, 19, 31, 35, 36, 79, 109, 110
3. Quaternary History of Baja California Lagoons: LJ-12, 13, 21, 28, 30, 98
4. History of San Diego Bay, California: LJ-34, 37, 38, 103
5. Periods of Heavy Runoff, Alluviation, and Erosion (see also items I–3 and II–2):
   Basins of ancient lakes LeConte and Clark, California: LJ-7, 15-17, 99, 101, 102, 105, 106
   Coasts of southern California and northwestern Baja California: LJ-3, 19, 25, 27, 78, 83-85, 98
6. Long Continuity of Springs and Streams in Southern California and Northern Baja California: LJ-25, 26, 29, 31, 33-38, 75, 77, 84, 85, 98, 103, 136
7. Age of Last High Stage of Lake LeConte, California and Baja California: LJ-7, 15, 99, 101, 102, 105, 106
8. Age of Ancient Lake Clark, California: LJ-16, 17
9. History of Lake Lahontan and Its Fauna, in California: LJ-76
10. History of Rancho La Brea Tar Pits and Their Faunas, California: LJ-55, 89, 121
11. Rate of Soil Weathering (including clay infiltration and prismatic formation, induration with lime and formation of caliche, and reddening of soil, in southern California and Baja California): LJ-3, 5, 6, 17, 19, 20, 23, 25-27, 29, 31, 33-38, 75, 77-79, 83-85, 98, 103, 109, 110, 136
12. Successive Generations of Dunes, Southern California and Baja California: LJ-6, 16, 17, 20, 28, 30, 108
13. Rate of Sedimentation Due to Turbidity Currents, Northeastern Pacific Ocean: LJ-112
14. Pleistocene History of New England: LJ-141, 142
15. Extinction of Pleistocene Fauna: LJ-55, 121
16. Failure of Wood to Decompose on Ocean Floor, and Rate of Phosphatic Infiltration: LJ-82

II. OCEANOGRAPHIC, ZOOGEOGRAPHIC, ECOLOGIC, AND CLIMATOLOGIC INFERENCES:

1. Past Sea Temperatures and Faunal Changes:
   Southern California and northwestern Baja California: LJ-3, 5, 6, 19, 20, 23, 25-27, 29, 31, 33-38, 75, 79, 83-85, 96, 98, 108-110, 136
   Oregon: LJ-111
   Texas: LJ-71
2. Decreasing Rainfall:
   Desert, southeastern California (see items I–7 and I–8)
   Inferred from abundance of human population, etc., coasts of southern California and Baja California: LJ-3, 5, 6, 12, 13, 19-21, 25, 27, 28, 30, 34, 37, 38, 79, 96, 98, 109, 110, 136
   Inferred from changes in dune structure (northwestern Baja California coast, and southern California coast and desert): LJ-6, 12, 20, 28, 30, 108
3. Continuity of Climatic Pattern:
   Cool (upwelling) areas, southern California and northwestern Baja California: LJ-25, 27, 75, 83-85, 108, 111
   Temperate areas, same region: most other tests from coastal areas.
   Warm area, northwestern Baja California: LJ-20
   Subtropical areas, Baja California: LJ-13, 21, 26, 28-30, 96
4. Age of Sea-water Masses (from CO_2 Analyses): LJ-57-63, 66-69, 88, 90, 91, 93, 94, 123-127, 129, 137, 139, 140, 146, 147, 149-154, 157, 158 (tests to be reported elsewhere)

III. ARCHAEOLOGIC INFERENCES:

1. Data on Early Shellfish-gatherers (7400–4950 B.P., in southern California and northern Baja California): LJ-3, 6, 26, 27, 36, 77, 79, 107, 109, 110
2. Temporal Position of San Dieguitoan Culture, California: LJ-136
3. Man in Rancho La Brea Tar Pits, California: LJ-121 (see also LJ-55 and 89)
4. Data on Cultures Tentatively Appraised as Simple or Retrogressive (3900–<400 B.P., in southern California and northwestern Baja California): LJ-5, 19, 25, 31, 35, 78, 103
5. Data on Somewhat More Complex Cultures, Southern California and Oregon: LJ-34, 37, 38, 111
6. Date on Site in Lahontan Basin, California (2350 B.P.): LJ-76

7. Date on Occupation of Now-flooded Cave in Florida (10,000 B.P.): LJ-120
8. Date on Mayan Ruin, Yucatán: LJ-87
9. Dates on Sites with Flexed Burials (7370–3100 B.P., in southern California and northwestern Baja California): LJ-5, 36, 77, 79, 109, 110
10. Dates on Pottery:
    LeConte Basin, California (960–<200 B.P.): LJ-15-17, 106
    Northwestern Baja California coast (400 B.P.): LJ-33
11. Upper Limiting Date on Submarine Artifact, Southern California (520 B.P.): LJ-95
12. Date on Use of Atlatl, Southern California (4450 B.P.): LJ-121
13. Date on Pishkun (Bison Drive), Montana (550 B.P.): LJ-8
14. Evidence on Conditions Affecting Population Size:
    Especially favorable conditions in desert of southeastern California: LJ-7, 15, 16
    Especially favorable conditions along Pacific coast, Oregon to Golfo de California: LJ-5, 25, 26, 29, 31, 33, 77, 79, 96, 108-111
    Moderately favorable conditions along coasts of southern California and northwestern Baja California: LJ-19, 20, 23, 34, 35, 37, 38, 75, 78, 98, 103
    Conditions rather unfavorable along same coasts: LJ-6, 27, 37
15. Miscellaneous Data on Middens (other than III–2, 3, 6-8, 11-13):
    Oregon: LJ-111
    Southern California coast: LJ-3, 19, 25, 27, 31, 34-38, 77-79, 95, 103, 109, 110
    West coast, Baja California: LJ-5, 6, 20, 28, 33, 75, 83-85, 98, 107, 108
    Golfo de California: LJ-26, 29, 96, 100, 132
    Desert, southeastern California: LJ-7, 15-17, 26, 99, 101, 102, 105, 106

IV. TESTS BEARING ON THE RELIABILITY AND PRECISION OF THE DATES:

1. Orderly, Expected Sequences:
    Midden at Punta Minitas, Baja California Norte: LJ-5 (stratigraphically below W-26 and W-27)
    Two midden layers, Batiquitos Lagoon, California, separated by an unconformity: upper layer, LJ-31; lower layer, LJ-36
    Three occupation streaks, Chollas Creek, California: upper, LJ-37; middle, LJ-34; lower, LJ-38
    Scripps Estates Site I, La Jolla, California: upper level, LJ-110; intermediate level, LJ-79; lower level, LJ-109
    Midden, shore of Santa Rosa Island, California: LJ-27 (stratigraphically below L-257)
    Two occupation streaks, ancient lake LeConte, California: upper streak, LJ-106; lower streak, LJ-105 (other dates for camp sites around Lake LeConte form logical series)
    Rancho La Brea Tar Pits: buried tree, associated with extinct mammals, LJ-55; atlatl foreshaft, with indications of lesser antiquity, LJ-121
2. Agreement between Tests on Contemporary Shell and Charcoal (no corrections were made for C^{13} ratios):
    Occupation streak near La Jolla, California: shell, W-154, 600 ± 200; charcoal, W-155, 580 ± 200 (USGS II)
    Middle of thick midden at Punta Minitas, Baja California Norte: shell, W-26, 2540 ± 200; charcoal, W-27, 2500 ± 200 (USGS I)
    Occupation streak, Valle de Rosario, Baja California Norte: shell, LJ-84, 1060 ± 150; charcoal, LJ-85, 960 ± 150
3. Agreement between Tests on Different Molluscs (from raised beach, Australia): *Turbo* sp., LJ-128, 900 ± 150; *Patella* and *Fissurella*, LJ-130, 900 ± 150
4. Agreement between Datings by Different Laboratories:
    Rancho La Brea, California: LJ-55, 14,400 ± 300; cf. Y-354A, B and Y-355A, B, average 14,470 (Yale IV)
    Chichén-Itzá, Yucatán: LJ-87, 1140 ± 200; cf. Y-626, 1160 ± 60 (Yale IV) and Y-626 *bis*, 1010 ± 100 (Yale V)

SAMPLE DESCRIPTIONS*

LJ-3. Malaga Cove Site, California **6510 ± 200**

Clam shells (*Chione californiensis*) from point at N end of Malaga Cove, near Redondo Beach, Los Angeles County (33° 48′ 23″ N Lat, 118° 23′ 32″ W Long), California (from pl. 1, Woodring, Bramlette, and Kew, 1946). Coll. by C. L. Hubbs (sample 1955—XI: 24C); subm. 1957. From the next-to-lowermost soil horizon that contains evidence of human occupation, in the extensive site described by Walker (1951). This is apparently a B soil layer, ca. 2.5 m thick, of rather coarse brownish sand, with considerable clay, well indurated with lime, in places hard to dent, when dry, with a geologist's pick. *Comment*: this soil horizon seems to represent the nonmarine terrace-fill interpreted by Woodring, Bramlette, and Kew as Pleistocene, for it grades downward into the C layer that overlies the Miocene rock and underlies a blackish sand stratum at the base of the overlying dune formation; it also appears to correspond in part with Walker's "microlith"-containing "level 1", although, at the point where our sample was taken, the shells were scattered through a greater depth, rather than being densely congregated, in the uppermost 2 ft of the detritus formation, to form the "Shell Village" of Walker. A few midden shells and a few chips were found in the underlying C soil layer, which seems to correspond with what Walker interpreted as a sterile horizon. Date and circumstances indicate the early occupation of this coast by people with simple cultural traits, subsisting largely on shellfish, and further indicate the time involved in extensive soil weathering. The shell fauna points to temperatures at least as warm as, probably a little warmer than, the present. The circumstances further suggest: (1) physiographic changes, for most of the shells (predominantly *Chione*, with *Pecten circularis aequisulcatus* next in abundance) probably came from a nearby bay or lagoon that existed, presumably during lower and rising sealevels, where none now exists; (2) decreasing rainfall, as the region is now devoid of surface water. The *Chione californiensis* shells from here (and from a deeply buried layer in the cliff in the nearby Clifton section of Redondo Beach) seem unusually flat, suggesting some evolutionary change (J. L. Baily, Jr., personal communication).

LJ-5. Punta Minitas Site, Baja California **3100 ± 300**

Charcoal from level 8 (70 to 80 cm below surface) of coastal midden (31° 18′ 50″ N Lat, 116° 26′ 05″ W Long) (from HO Chart 1149, 1948), ca. midway between Punta Cabras and "Punta San Isidro" (as charted, "Punta Piedras Blancas" in local usage), Baja California Norte. Level 8 is ca. opposite the top of a flexed burial and is overlain by denser shell refuse, now exposed on the cliff face. Coll. by C. L. Hubbs and party (sample 1957—VI: 28A); subm. 1957. *Comment*: material from the overlying denser midden has been dated: W-26, 2540 ± 200, *Mytilus* shell; W-27, 2500 ± 200, charcoal (USGS I) (the depth of "3 to 4 ft" there reported was estimated from a higher point). As these earlier datings pertain to the middle of the deposit, which continues about 0.5 m below LJ-5, as the midden was probably

* Includes measurements of paleoecologic significance (physiography, oceanography, climatology, zoogeography, archaeology) only. Tests of strictly geochemical implication will be published later.

occupied for about a millenium, and as very similar, dense middens are semi-continuous for many miles along the coast, a prolonged and extensive occupation is suggested. Conditions were obviously favorable. As fresh water is now very scarce, it seems probable that rainfall was greater during the occupation. Mollusc fauna and the paleotemperature estimate reported for W-26 indicate temperatures somewhat warmer than those presently prevailing. Subsequent soil formation has been slow, for the downward penetration and accumulation of clay and lime has been slight.

LJ-6. Punta Cabras, Baja California—1 **5020 ± 200**

Mussel shells (*Mytilus californianus*) from 10 to 60 cm below top of consolidated reddish sand (representing a former generation of dunes), which is overlain by unconsolidated white sand; in cove on S side of Punta Cabras (31° 20′ 00″ N Lat, 116° 27′ 15″ W Long), Baja California Norte (from HO Chart 1149, 1948). Coll. by C. L. Hubbs (sample 1955—V: 7C); subm. 1957. Shells here represent a very sparse midden, and artifacts are almost wholly lacking. *Comment*: date and circumstances indicate an early occupation of this coast by a sparse population with a simple culture, living during a period drier than some subsequent period of erosion between the two periods of dune accumulation; and place an upper figure on the time involved in the consolidation and reddening of sand.

LJ-7. Fish Creek, San Diego County, California **1000 ± 200**

Charcoal from hearth site in angle of headwater forks of Fish Creek, arid Fish Creek Mountains, E part of San Diego County (32° 59′ N Lat, 116° 13′ W Long), California (from Carrizo Mountain Quadrangle, 1952). The hearths here contained numerous bones of fishes and of land vertebrates, including bighorn sheep. Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1954—XI: 27B); subm. 1957. *Comment*: date indicates a time when: (1) a rather large settlement of fishing and hunting people with relatively advanced culture existed; (2) rainfall was much greater, because the one nearby spring now existing would not have been adequate, and because the fish eaten and presumably caught here were the young of large fishes (humpback suckers and bonytails) that for spawning almost certainly had run up Fish Creek, which is now bone-dry; (3) Lake LeConte (Hubbs and Miller, 1948) existed, with an abounding human population around its shores, because such fish must have come from the lake. That the lake was then in existence is indicated by LJ-106.

LJ-8. Pishkun (bison drive), Montana **550 ± 200**

Charcoal and charred wood from single intact hearth about midway between Vaughn and Cascade, Cascade County, ca. 30 km SW of Great Falls, in T 19 N, R 1 E (ca. 47° 25′ N Lat, 111° 35′ W Long). The hearth was buried ca. 1.5 m, in close association with numerous bison bones and a considerable number of arrow points, at a "pishkun" site (where bison were stampeded over a cliff for a kill). The hearth was located near the bottom of the trench that was dug through the layer of bison bones. Coll. 1956 and subm. 1957 by T. J. Walker, Scripps Institution of Oceanography. *Comment*: the location was on the migratory route of the bison, the course of which was presumably de-

termined by the only favorable crossing of the Missouri River in this region. Previous attempts to obtain charcoal here for dating had failed because no hearths were found where the Indians are supposed to have camped above the cliff. The hearth site and associated remains are exhibited in the Museum of Plains Indians at Bowman, Montana. An effort is being made to preserve this site.

LJ-9. (See LJ-19)

LJ-12. Scammons Lagoon, Baja California Sur—1 1900 ± 300

A thick-shelled gastropod (identification lost) from *Donax* pavement of old shoreline, taken with other molluscs, volcanic metamorphic pebbles, and cobbles, exposed on between-dunes blowout flats, ca. 1 km back of present shore, on the peninsula between Scammons Lagoon (Laguna Ojo de Liebre) and Bahía Sebastián Vizcaíno (ca. 27° 58′ N Lat, 114° 16′ W Long), Baja California Sur (from air-photo compilation map by F. B Phleger). Coll. July 19, 1956 by R. R. Lankford, for F. B Phleger and G. C. Ewing, Scripps Institution of Oceanography; subm. 1957 by Phleger. *Comment*: according to the collectors, date bears on: (1) history of this large lagoon; (2) rapid seaward prograding of barrier island or peninsula; (3) greater rainfall, inferred to have been needed to supply the requisite sand from streams then flowing across the now notoriously arid Vizcaíno Desert. There are no archaeologic implications.

LJ-13. Scammons Lagoon, Baja California Sur—2 >25,000

Clam shell (a very large and thick example of *Periglypta multicostata*) found in place in the consolidated shell deposit of a fragment of an old lagoon barrier-island, on "South Brushy Island" of Scammons Lagoon (ca. 27° 44′ N Lat, 114° 14′ W Long), Baja California Sur (from same map, see LJ-12). Coll. and subm. 1957 by F. B Phleger and G. C. Ewing, Scripps Institution of Oceanography. *Comment*: according to the collectors, date bears on: (1) Pleistocene history of this lagoon; (2) probably greater former inflow of river water and sand; (3) persistence of the climatic pattern, for the molluscan assemblage is subtropical, as at present. There are no archaeologic implications.

LJ-15. Lake LeConte, Baja California Norte 300 ± 100

Charcoal from a shallow, sandy archaeologic site bordering ancient Lake LeConte, W of Mexicali, N of the Mexicali-Tijuana highway, ca. 2 mi S of California border (ca. 32° 36.8′ N Lat, 115° 41.3′ W Long), Baja California Norte. Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1955—X: 15A); subm. 1957. *Comment*: date indicates time when a dense population developed in response to the abundant supply of water and of fish and other food that existed during a late period in the last filling of Lake LeConte.

LJ-16. Clark Dry Lake, California—1 700 ± 150

Charcoal from extensive Indian site among the dunes on N side of playa of Clark Dry Lake, along the shore of ancient Lake Clark, San Diego County (33° 22.2′ N Lat, 116° 16.8′ W Long), California (from Clark Lake Quadrangle, 1941). Food remains in this habitation site and in other sites in the

basin include terrestrial vertebrates but no trace of fishes. Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1955—III: 5D); subm. 1957. *Comment*: date and circumstances indicate that this enclosed and now-arid basin (Hubbs and Miller, 1948) was probably occupied by an isolated lake, which, although almost certainly fishless, furnished water and attracted food adequate to support a considerable population.

LJ-17. Clark Dry Lake, California—2 **<200**

Charcoal from hearth in sandy soil near SE margin of playa of Clark Dry Lake (33° 19.7′ N Lat, 116° 15.8′ W Long), San Diego County, California (Clark Lake Quadrangle, 1941). Hearth was 4.4 m above the playa. Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1955—III: 5A); subm. 1957. *Comment*: date and circumstances indicate the continued habitation of this basin until very recent time and the support of a population without the fish supply on which the people around nearby Lake LeConte largely subsisted; and further indicate the probable, at least ephemeral, existence of Lake Clark within the last very few hundred yr. The appearance of the sandy soil and the fragmentation of the charcoal suggested greater antiquity but presumably were induced by frequent wetting.

LJ-19. Midden, Torrey Pines Park, California **3700 ± 200**

Mussel shell (*Mytilus californianus*) from occupation layers 2 to 3 m below the top of the low cliff margining N end of the high cliffs of Torrey Pines State Park, San Diego (32° 55′ 33″ N Lat, 117° 15′ 31″ W Long), California (from Air Photo Compilation T-5410, 1934). Charcoal (LJ-9) from the same collection proved insufficient for measurement. The now-buried land surfaces, on which the midden materials accumulated, slope inland at about 1:4 and were formed by talus derived from the high sandstone cliffs. Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1957—VI: 8A); subm. 1957. *Comment*: test suggests that the early shellfish-gatherers who occupied the coasts of southern California and northern Baja California between 7400 and 4950 B.P. (see LJ-3, 6, 26, 27, 36, 77, 79, 107, 109, and 110, this list), or other people with similar food habits and simple culture, persisted until about 3700 yr ago. The steep slope of the old land surface and the rapid truncation of the cliff suggest that the inhabited area continued westward to below present sealevel. A rising sealevel would be consistent with the continued existence of the open estuaries and the rocky foreshore from which the sea-food was presumably gathered (such habitats, which presumably existed during the times of the early shellfish-gatherers, are now nearly lacking in the vicinity). These inferences, along with others indicative of a wetter-than-present climate, will be elaborated by the senior author in other publications. Since the time of occupation and the accumulation of the overlying soil, soil weathering has involved considerable infiltration of clay and induration with lime.

LJ-20. Midden, Estero Beach, Baja California **1170 ± 200**

Pismo-clam shell (*Tivela stultorum*) from a single obvious clambake, enclosed in a former generation of hardened and yellowish dune sand, which is abruptly overlain by loose, whitish sand; at N end of the presumably Pleisto-

cene cliff, Estero Beach, S of Ensenada (31° 47.0′ N Lat, 116° 37.3′ W Long), Baja California Norte (from HO Chart 1149, 1958). Charcoal (LJ-24) from the same compact hearth proved insufficient for measurement. Coll. by C. L. Hubbs and G. E. Lindsay (sample 1956—V: 25B); subm. 1957. *Comment*: the uniformly small size of the clams indicates warm water (along the same general section of the coast large pismo clams seldom occur in water shallow enough for aboriginal gathering; O^{18} paleotemperature estimates from similar small pismo clam shells have indicated warm water—see reports on W-29, 330 ± 160, and W-31, 330 ± 160 (USGS I). Habitation in an area now devoid of fresh water suggests moister-than-present climate. The location of the hearth within reach of storm waves at high tides and the rapid backward retreat of the cliff suggest that the original area of habitation extended to below present sealevel (this inference is consistent with other evidence, as of LJ-19, 34, 37, 38, 83, 98, and probably LJ-78, this list, indicative of the continued, relative rise of sealevel in southern California and northern Baja California into late postglacial time). The data on LJ-20 indicate rapid soil weathering, perhaps accelerated here by salinization.

LJ-21. Black Warrior Lagoon, Baja California >37,000

Cockle shell (*Trachycardium panamense*) from an ancient and dense intertidal-flat shell assemblage on salina at head of Black Warrior Lagoon (Laguna Guerrero Negro), near the old airstrip of the salt works (ca. 28° 03′ N Lat, 114° 04′ W Long), Baja California Norte (from air-photo compilation map by F. B Phleger). Coll. 1956 by F. B Phleger and G. C. Ewing, Scripps Institution of Oceanography, subm. 1957. *Comment*: according to the collectors, the date bears on the Pleistocene history of this lagoon and on the development of the salt flats, with their saline deposits. There are no archaeologic implications. The molluscan species are subtropical, as at present.

LJ-23. North Coronado Island, Baja California <400

Charcoal from in situ hearths in a rather large camp or village site on high, sharp ridge of North Coronado Island (32° 17.9′ N Lat, 117° 17.8′ W Long), Baja California Norte (from recent relocation of islands by Scripps Institution of Oceanography). Crude pressure-flaked tools abounded in this site, with almost no evidence of higher culture. Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1956—V: 19A); subm. 1958. *Comment*: date and circumstances indicate: (1) long persistence of primitive culture, or a late retrogression, or periodic temporary occupations; (2) the age of associated fauna, which included sea otter; (3) despite the recency of the date, probably more rainfall and more brushy vegetation than now (to supply water needs, and fuel for the abundant fires).

LJ-24. (See LJ-20)

LJ-25. Midden, San Miguel Island, California 1750 ± 200

Charcoal from a large midden, deeply buried in cliff of Cuyler Harbor, San Miguel Island (34° 03′ 17″ N Lat, 120° 21′ 37″ W Long), California (from USC&GS Chart 5116, 1945). This a deep, rich, solid midden that is being eroded on the face of the sandy cliff. Coll. by C. L. Hubbs and party (sample 1954—IX: 16A); subm. 1957. *Comment*: the date tells when the

fauna indicated by the shells and bones lived and when, it is inferred, the flow of the adjacent spring was sufficiently greater than the present trickle to have provided an adequate supply of fresh water for the obviously large population. Here, as elsewhere along the coast, the freshwater supply was probably a major factor limiting the human populations; the midden remains indicate a bountiful supply of molluscs, fishes, birds, and sea mammals. Soil weathering since the accumulation of the midden has been rather slight, except where ocean spray often wets the lower part of the midden (here even the very recent soil is considerably hardened through salinization).

LJ-26. Bahía de los Angeles, Baja California—1 6100 ± 200

Clam shell (*Glycymeris* cf. *maculata*) from dense, almost coquina-like midden deposit, near surface, beside a rather large spring on bajada at foot of the hills behind village of Bahía de los Angeles, Golfo de California (28° 56.4′ N Lat, 113° 34.8′ W Long), Baja California Norte (from HO Chart 0620, 1943). Coll. by C. L. and L. C. Hubbs (sample 1954—II: 17A); subm. 1958. *Comment*: test indicates the occupation of this area on the Gulf of California coast within the period (from ca. 7500 to 5000 B.P. or later) when shellfish-gatherers abounded along the coasts of southern California and northwestern Baja California (see LJ-3, 6, 27, 36, 77, 79, 107, 109, and 110, this list). It seems probable that the vicinity of the springs has been more or less continuously occupied for at least six millenia, as the middens are virtually continuous through several meters about the springs, and evidences of occupation abound in the general region, which is otherwise almost devoid of fresh water, and apparently has long been dry. Sample LJ-29 (this list), yields a date of 2500 ± 300; the occupation of the area continued until historic time (Father Kino mentioned encountering a large *ranchería* on the bay); the more recent middens along the shore contain much pottery. Throughout the long period of occupation the fauna, as repreesnted by midden shells, has remained subtropical, as it is now. The interval of 6000 yr seems rather short for the production of the coquina-like deposit, but the process was presumably accelerated by the action of the spring water.

LJ-27. Midden, Santa Rosa Island, California 7400 ± 200

One red-abalone shell (*Haliotis rufescens*) from 4.6 m below lip of sea-cliff ca. 6.5 km E of Arlington Canyon (between that canyon and "Deer Gulch"), Santa Rosa Island (34° 00′ 20″ N Lat, 119° 10′ 22″ W Long), California (from USC&GS Chart 5116, 1945). Coll. by C. L. Hubbs with P. C. Orr, G. F. Carter, and W. S. Broecker (sample 1955—IX: 11C); subm. 1958. *Comment*: this isolated shell was taken, in the same midden, stratigraphically below the level of the red-abalone shell dated 6820 ± 150 (L-257, Lamont III). Red-abalone shell from a nearby site has been dated 7070 ± 250 (L-290D, Lamont IV). The two Lamont dates have been listed by Orr (1956, p. 5-6). An older midden deposit of red-abalone shells was exposed in an inaccessible part of the midden complex from which this sample was obtained, but still lower (6.0 m below lip of cliff). Date and circumstances indicate, as will be elaborated in a later publication: (1) occupation of island coast by early (initial?) shellfish-gatherers at least 7500 and probably 8000 yr ago, during the latter part of the

period of post-Sangamon terrace-fill; (2) rather cold sea temperatures that brought the red abalones within harvesting reach; (3) freshwater supply probably more abundant than at present. The soil has reddened considerably and is moderately infiltrated with clay and indurated with lime.

LJ-28. Dune midden, Baja California Sur—1 **1000 ± 250**

Charcoal from blowout in low dunes near Colina Coyote, on sand strip separating ocean from expansion of lagoon midway between Bahía Santa María and Boca Soledad, N of Bahía Magdalena (25° 10′ 53″ N Lat, 112° 10′ 53″ W Long), Baja California Sur (from HO Chart 1493, 1945). Sample accompanied an abundance of shells of warm-water molluscs. Coll. by F. B Phleger and G. C. Ewing, Scripps Institution of Oceanography (sample 1958—I: 30B); subm. 1958. *Comment*: test was run for Drs. Phleger and Ewing because of its bearing on their studies, to be published elsewhere, of the history of the coastal lagoons of western Mexico; a particular point was to obtain a limiting date for the formation of the barrier sand strip, which they believe was formed when stream inflow greater than at present contributed an adequate supply of sand. The abundant middens in the general vicinity of Colina Coyote suggest that at the time of occupation (see LJ-30, this list) more fresh water and wood fuel were available than at present. The warm-water molluscs in these middens suggest that the present warm regime was established in this region when cold conditions prevailed farther north in Baja California (see LJ-75, 83-85, and 108, this list).

LJ-29. Bahía de los Angeles, Baja California—2 **2500 ± 300**

Charcoal from ca. 0.8 to 1.3 m below surface of exposed, noncoquinized midden, 1.5 m deep, at rim of upper spring at Bahía de los Angeles, Golfo de California (28° 56.4′ N Lat, 113° 34.8′ W Long), Baja California Norte. Coll. by F. B Phleger and G. C. Ewing, Scripps Institution of Oceanography (sample 1957—XII: 31A); subm. 1958. *Comment*: as will be shown in a later publication, date bears on: (1) the prolonged habitation about these permanent springs; (2) continuity of subtropical fauna; (3) time involved in soil weathering.

LJ-30. Dune midden, Baja California Sur—2 **600 ± 150**

Charcoal from low midden halfway between Colina Coyote and larger dune midden (25° 01′ 35″ N Lat, 112° 10′ 50″ W Long), Baja California Sur (from HO Chart 1493, 1945); close to LJ-28. Coll. by F. B Phleger and G. C. Ewing, Scripps Institution of Oceanography (sample 1958—I: 30A); subm. 1958. *Comment*: implications are the same as for LJ-28.

LJ-31. Batiquitos Lagoon, California—1 **3900 ± 200**

Clam shell (*Chione californiensis*) from upper midden level beside marsh on S shore of Batiquitos Lagoon, at W side of westernmost canyon on S side (33° 05′ 01″ N Lat, 117° 17′ 52″ W Long), California (from Air-Photo Compilation T-5411, 1954). Coll. by C. L. Hubbs (sample 1956—X: 27B); subm. 1958. *Comment*: the upper, dark, loose superficial midden, rich in shells and crude artifacts, rests unconformably on a more consolidated stratum contain-

ing much older midden shell dated 7300 ± 200 (LJ-36, this list). These dates and preliminary study of the artifacts and shells suggest: (1) long continuation at this site, as elsewhere along the coast, of a simple shellfish-gathering culture; (2) continued existence here, during the same time, of a salt-water estuary, probably during a long period of rise in sealevel; (3) probable long continuity, in the adjacent marsh, of surface or subsurface fresh water, which was probably responsible for the long-continued human population.

LJ-32. (See LJ-35)

LJ-33. Rancho Cuevas, Baja California Norte **400 ± 200**

Charcoal from layer 2 (second dm) below surface, at E end of a rather deep midden deposit in large rock shelter located on Rancho Cuevas, between Rosarita Beach and Punta Descanso, ca. 100 m upstream from low coastal terrace, in third canyon S of basaltic hill known as "Aquajito" (ca. 32° 17.0′ N Lat, 117° 02.0′ W Long), Baja California Norte (from HO Chart 1149, 1948). Coll. by C. L. Hubbs and party (sample 1958—II: 8A); subm. 1958. *Comment*: this is the first date from a potentially important site, in which excavations are being continued. The sample pertains to a late but prehistoric culture with pottery; paleoecologic inferences are expected. The present small water holes in the adjacent canyon bottom probably represent a continuum with a least as adequate surface water in the past. The soil shows little weathering.

LJ-34. Chollas Creek, California—1 **1450 ± 200**

Pismo-clam shell (*Tivela stultorum*) from below high-tide level, in middle of three occupation streaks exposed in bank, here low, of Chollas Creek (a tributary of San Diego Bay), immediately below National Avenue, San Diego (32° 41′ 44″ N Lat, 117° 07′ 17″ W Long), California (from Air Photo Compilation T-5372, 1933). Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1957—I: 12D); subm. 1957. *Comment*: all these occupation streaks, which extend for a considerable distance along the creek, slope to below high-tide level. Dates and positions of the three occupation streaks (see LJ-37 and LJ-38, this list) indicate: (1) rise in sealevel during the past millenium (perhaps as a continuation of a long-established trend)—an idea that seems plausible to us; or (2) subsidence of the land, such as may have been the continuation of the down-faulting of a Mission Bay-San Diego Bay trench; or (3) westward tilting of the strata. The species composition of the molluscs in LJ-34 and LJ-37 (950 ± 200) do not suggest that the temperatures here were colder than at present, during a period when the coastal waters of northwestern Baja California were cold (see LJ-83, 84, 85, and 108, this list). The extensive occupation indicated by the abundant shells in each of the layers suggests that the freshwater supply may have exceeded that of the spring still extant nearby. Abundance of pismo clams in the three occupation layers suggests that the mouth of the creek may have been near the ocean beach (where this clam lives), rather than on the inner side of a broad bay. Artifacts taken from the creek bank indicate culture more advanced than the La Jollan.

LJ-35. Batiquitos Lagoon, California—2 **3500 ± 200**

Clam shell (*Chione californiensis*) from midden in bottom of talus along road beside S shore of Batiquitos Lagoon, San Diego County, across marsh from (E of) location of LJ-31 and LJ-36 (33° 05′ 03″ N Lat, 117° 17′ 44″ W Long), California (from Air Photo Compilation T-5411, 1954). Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1956—X: 27C); subm. 1958. Charcoal (LJ-32) from the same spot proved inadequate for measurement. *Comment*: midden apparently pertains to about the same period of occupation as LJ-31 (3900 ± 200, this list), and, although little in the way of artifacts was seen here, the culture represented was probably similar. Similar physiographic inferences may be drawn.

LJ-36. Batiquitos Lagoon, California—3 **7300 ± 200**

Clam shell (*Chione californiensis*) from the lower of two soil horizons, below that of LJ-31, Batiquitos Lagoon (33° 05′ 01″ N Lat, 117° 17′ 52″ W Long), California (from Air Photo Compilation T-5411, 1954). Coll. by C. L. Hubbs (sample 1957—I: 5B); subm. 1958. Taken about 1 m down in yellowish sand, indurated with lime, overlain unconformably by loose, dark midden soil (LJ-31). There are very few artifacts in the lower layer, but an imperfect human skeleton was found in the same soil horizon (at a slightly higher level). *Comment*: date is conformable with several others along the coasts of southern California and northern Baja California that pertain to the early shellfish-gatherers (see LJ-3, 6, 26, 27, 77, 79, 107, 109, and 110, this list). It bears on inferred Holocene rise in sealevel and on past estuarine condition in the lagoon, which is now silted up and incapable of supporting the molluscs that existed here between three and eight millenia ago; it bears also on the probable temporal continuity of surface or subsurface water in the adjacent marsh (many long-inhabited sites are near springs or other supplies of fresh water).

LJ-37. Chollas Creek, California—2 **950 ± 200**

Pismo-clam shell (*Tivela stultorum*) from uppermost of three occupation streaks exposed in low bank of Chollas Creek, immediately below National Avenue, San Diego (32° 41′ 43″ N Lat, 117° 07′ 19″ W Long), California (from Air Photo Compilation T-5372, 1933). Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1957—I: 12A); subm. 1958. From about 1 to 2 m above high-tide level, but the occupation streak slopes to below that level. Sample taken a few meters downstream from LJ-34. *Comment*: see LJ-34 (this list).

LJ-38. Chollas Creek, California—3 **2100 ± 200**

Pismo-clam shell (*Tivela stultorum*) taken between tidal limits from lowermost of three occupation levels exposed in low bank of Chollas Creek, San Diego, ca. 50 m downstream from LJ-37 (32° 41′ 43″ N Lat, 117° 07′ 19″ W Long), California. Coll. by C. L. Hubbs, B. E. McCown, and party (sample 1957—I: 12B); subm. 1958. *Comment*: inferences are similar to those for LJ-34 (this list), except that the inclusion of *Laevicardium elatum* in this layer suggests that temperatures were probably a little higher than at present.

LJ-55. La Brea Tar Pits, California—1 **14,400 ± 300**

Wood from tree trunk discovered in situ in Pit 3 of Rancho La Brea tar pits (34° 03′ 45″ N Lat, 118° 21′ 25″ W Long), California. Coll. 1913 by L. E. Wyman, Los Angeles County Museum; subm. 1958 for that museum by Hildegarde Howard, who wrote: "This tree was rooted in the sloping bank of the pit (possibly an old gully) at a depth of 12 feet from the surface; the tip of the topmost branch (broken or burned off) was first encountered at a depth of 4 feet; total height of tree as preserved was 8 feet. Bones of typical Pleistocene animals were packed about the tree." Before the wood was analyzed, the tar was removed and run separately (LJ-89). *Comment*: date obtained by the La Jolla laboratory is in almost perfect agreement with four dates (13,890 to 15,390, averaging 14,470) soon afterward announced by the Yale laboratory, for samples (Y-354A, B and Y-355A, B) from the same trunk (Yale IV). Yale, referring to the trunk, noted that "Douglas (1952) cited two unpublished CalTech dates, 16,250 ± 2000 and 16,400 ± 2000, for wood subm. by Chester Stock." The Rancho La Brea datings, which have been discussed by Howard (1960), show that much of the extinct Pleistocene fauna continued into the last millenia of that period. A rather high proportion of the rich bird fauna from Pit 3, as well as of the mammal fauna, is extinct (Howard and Miller, 1939). No definite indications of human occupation have been discovered in Pit 3, but artifacts have been found in other pits (see LJ-121, this list).

LJ-71. Oyster reef, off coast of Texas **2700 ± 100**

Oyster shell (*Crassostrea rhizophorae*) from API Station J468, dredged on continental shelf off Padre Island, at depth of 39 fathoms (26° 46.0′ N Lat, 96° 42.0′ W Long), (from USC&GS Chart 1117, 1956). Coll. June 8, 1956 by R. H. Parker, Scripps Institution of Oceanography; subm. 1958 by J. R. Curray and R. H. Parker. *Comment*: sample submitted for the bearing that the date may have on estimates of changes in sealevel. This species of oyster lives on mangroves, very near sealevel, in tropical waters and is therefore considered to be an excellent indicator of sealevel at a time when surface waters were considerably lower than at present in the same region. The age was predicted at ca. 13,000 yr because of depth of the collection (Curray, 1959, 1960), but such a date would be inconsistent with the inferred temperature. Was there a recession of the sea, or an elevation of the land, about 2700 yr ago, or may the shell have been washed outward? The data of Shepard and Moore (1955) render the first two possibilities unlikely, and also tend to rule out crustal downwarping in this region during the last 10,000 yr.

LJ-75. Near Punta Clara, Baja California **1150 ± 150**

Charcoal from a single hearth at lip of cliff on most prominent point between Punta Clara and Punta China, near (S of) mouth of Arroyo Santo Tomás (31° 31′ 34″ N Lat, 116° 39′ 36″ W Long), Baja California Norte (from HO Chart 1044, 1949). Coll. by C. L. Hubbs and G. F. Carter (sample 1954—V: 7D); subm. 1958. The hearth was in somewhat hardened and reddened soil, barely overlying strongly reddened sand. *Comment*: this is the first dating based on charcoal from the abundant subsurface middens in an area

where C^{14} and O^{18} analyses of midden shells, bolstering faunal evidence, have indicated a cold period for the NW coast of Baja California from ca. 1600 to ca. 600 yr ago, a period when the climate in the Arctic is reported to have been mild. Other dates on this episode in California are C-659, 889 ± 100 (Chicago III); LJ-83, 1600 ± 150, LJ-84, 1060 ± 150, LJ-85, 960 ± 150, and LJ-108, 1580 ± 100, this list. The date bears on archaeology and on the rate of soil weathering, as well as on paleoclimatology.

LJ-76. Karlo Site, northern California **2350 ± 150**

Charcoal recovered during excavation of the Karlo site (4-Las-7), near Susanville, Lassen County (40° 33′ 45″ N Lat, 120° 19′ 30″ W Long), California (from Karlo Quadrangle, 1954). Coll. 1955 by F. A. Riddell; subm. 1958 by R. F. Heizer, University of California, Berkeley. Sample (#119/323) came from Square 40/21 (same lens as Sq. 40/22), ca. 0.6 to 0.9 m below surface. *Comment*: charcoal contained many rootlets, which were removed as far as possible. The culture disclosed by the excavations here has been interpreted by Riddell (1956, in press) as belonging to the Lovelock Culture, which has been described, with datings between 2000 B.C and A.D. 1000, by Loud and Harrington (1929), Heizer and Krieger (1956), and Grosscup (1958). Heizer comments: "The LJ-76 date falls within the expected time range of the Lovelock Culture as known from a number of other radiocarbon dates, and is of interest in indicating the western extension of the Great Basin culture of Medithermal age." The date bears also on the past fauna of a part of the Lahontan basin, including the fish fauna being studied by W. I. Follett of the California Academy of Sciences.

LJ-77. Zuma Creek Site, California **4950 ± 200**

Black-abalone shell (*Haliotis cracherodii*) from Zuma Creek site, Los Angeles County (LAn–174 of the University of California Archaeological Survey), which lies on the 100-ft (30-m) terrace just above the beach, (ca. 34° 00.1′ N Lat, 119° 49.0′ W Long), California (from USC&GS Chart 5205, 1915.) The shell (174–16) dated came from Pit 6 of the UCLA excavation, at depth of 0.3 to 0.6 m. Coll. spring 1957 by Robert Ascher; subm. 1958 by C. W. Meighan, University of California, Los Angeles. *Comment*: this finding provides another date for the early milling-stone material of the southern California coast, which is associated with an abundance of shellfish, generally crude artifacts, and no pottery (Peck, 1955; Ascher, 1959). The fauna, as reported by Peck, is not much different from that of today (Peck's listing of *Mytilus edulus* (sic) is probably in error).

LJ-78. Near Malibu Beach, California **3460 ± 200**

Mussel shell (*Mytilus californianus*) from the lowest exposed midden streak, buried ca. 4.8 m, in road-cut cliff along Pacific Highway, opposite house no. 20732 (34° 02′ 16″ N Lat, 118° 37′ 31″ W Long), California (from Malibu Beach Quadrangle, 1951). Coll. by C. L. Hubbs (sample 1958—XII: 11A); subm. 1958. According to C. W. Meighan this sample was taken at Site Lan–190 of the University of California Archaeological Survey. *Comment*: Meighan suspects that some of the midden material may have been derived by

intermittent slippage, or by inwash of occupation debris, from above, but it appeared during collecting that the midden had accumulated in place on an old land-surface. Several occupation streaks above suggest repeated population on the successive land-surfaces as these were temporarily stabilized. The overlying alluvial fill strongly suggests greater rainfall than now, during and for some time following the dated occupation.

LJ-79. Scripps Estates Site I, California—1 **6700 ± 150**

Mussel shell (*Mytilus californianus*) associated with Burial 7, near mid-depth of shallow midden near the ocean edge of Linda Vista Terrace, on S rim of Sumner Canyon, at 2504 Ellentown Road, La Jolla (32° 52′ 22″ N Lat, 117° 14′ 54″ W Long), California (from Air Photo Compilation T-5375, 1933, and La Jolla Quadrangle, 1933). Coll. by C. L. Hubbs, J. R. Moriarty, and George Shumway (sample 1958—XII: 13A); subm. 1959. *Comment*: a preliminary account of this ancient, La Jollan site (SDi–525 in the records of the University of California Archaeological Survey; SDMM–9–W of the San Diego Museum of Man) has been published by Moriarty, Shumway, and Warren (1959); the investigations are being continued by these authors and Hubbs. The early date stands in agreement with several other dates for sites in southern California and northern Baja California with similar assemblages of stone tools (other such sites are herein reported as LJ-3, 6, 26, 27, 36, 77, 107, 109, and 110). The molluscan assemblage in LJ-79 suggests water (and air) temperatures probably a little warmer than those prevailing at present, and mass spectrometric O^{18} determinations (by R. N. C. Bowen of Scripps Institution of Oceanography) now yield confirmatory temperature estimates of 21.3° C for *Mytilus californianus* and 20.6° for *Pseudochama exogyra*. As will be detailed in subsequent reports, the fauna and various other data indicate that the site was occupied during a low but rising sealevel. The abundant population that appears to have existed at this site for more than 2000 yr (see also LJ-109, 7370 ± 100, LJ-110, 5460 ± 100) appears to have been too large to have been supported by such limited rain as falls currently. This and other considerations point toward a more humid climate.

LJ-82. Wood from ocean bottom off Mexico **>28,000**

Wood (log of some dicotyledon), mineralized by phosphatic infiltration, dredged (TO–58–2, D–7) from a 510-m terrace in the Gulf of Tehuantepec, Mexico, near the edge of the Middle American Trench (from 14° 25′ N Lat, 93° 05′ W Long, to 14° 27′ N Lat, 93° 11′ W Long) (from HO Chart 0932, 1956). Coll. November 20, 1958 by R. H. Parker on Scripps Institution of Oceanography Research Ship *Horizon*; subm. 1959 by G. O. S. Arrhenius and R. H. Parker. *Comment*: the wood that abounded on the bottom showed no trace of decomposition. Its exposed portion had become strongly phosphatized, but the part buried in clay had remained essentially unaltered. The overlying waters have an exceedingly low content of dissolved oxygen: between 0 and 0.1 ml/l. G. E. Jones, microbiologist at Scripps Institution of Oceanography, has been unable to cultivate bacteria from the center of this wood, nor any wood-decomposing organisms from the more superficial parts. The radiocarbon determination was made on the organic wood component of the sample.

A report on this discovery, giving consideration to the mechanisms involved in the fossilization, has been prepared by Goldberg and Parker (1960).

LJ-83. Near Punta Baja, Baja California **1600 ± 150**

Mussel shell (*Mytilus californianus*) from cobbly valley-fill truncated by the sea, ca. 2 mi E of Punta Baja (29° 57.3′ N Lat, 115° 46.6′ W Long), Baja California Norte (from HO Chart 1044, 1949). Coll. by C. L. Hubbs and Nobuo Egami (sample 1958—V: 3B); subm. 1958. The midden shells (and a trace of artifacts) were mixed with cobbles, gravel, and sand. *Comment*: material had apparently been deposited at a lower relative sealevel and presumably during a period of heavier rainfall and more intense alluviation. The shells apparently were washed from middens up the canyon (where middens still abound) and therefore may have considerably antedated the valley-fill. Recently the valley-fill has been entrenched to near present sealevel. Inclusion of some *Cryptochiton* valves indicates that the cold period (see LJ-75, this list) had already begun. A confirmatory paleotemperature estimate of 13.6° C was obtained by R. N. C. Bowen, Scripps Institution, through an O^{18} determination on shells of *Mytilus californianus* in this collection. Soil weathering has proceeded to a moderate degree.

LJ-84. Valle de Rosario, Baja California—1 **1060 ± 150**

Mussel shell (*Mytilus californianus*) from occupation streak buried in the sand-and-silt valley-fill of Arroyo Rosario, 2.4 km above mouth (30° 03.3′ N Lat, 115° 45.7′ W Long), Baja California Norte (from HO Chart 1149, 1948). Coll. by C. L. Hubbs and Nobuo Egami (sample 1958—V: 4B); subm. 1958. The continuous midden streak, representing an old land-surface, is buried ca. 150 cm below the present surface and ca. 4.5 m above present floodplain of river; it is exposed in the road cut. *Comment*: some *Cryptochiton* valves place this deposit in the cold period mentioned under LJ-83. The valley, here several mi wide, was probably aggraded when rainfall was greater and sealevel lower. The date exceeds that for charcoal from the same site (LJ-85) by 100 yr. No correction was made for the apparent age of modern shell.

LJ-85. Valle de Rosario, Baja California—2 **960 ± 150**

Charcoal from the same collection as LJ-84. *Comment*: date is close to that obtained from carbonate carbon.

LJ-87. "The Nunnery," Chichén, Itzá, Yucatán **1140 ± 200**

Wood from the ruin known as "The Nunnery," at Chichén-Itzá (ca. 20° 41′ N Lat, 88° 34′ W Long), Yucatán, pertaining archaeologically, we understand, to the Classical Mayan Period A.D. 700 to 1000. Coll. by Theodore Shedlovsky, Rockefeller Institute, who reports: "It was given to me by my guide who detached it as a loosely hanging fragment from what had probably been a substantial beam in the original structure but was no longer supporting any load." By request of the La Jolla Laboratory, the sample was subm. by Julian Shedlovsky in 1959. *Comment*: the agreement of the date with the archaeologic estimate is gratifyingly close. There is also close agreement with the date by the Yale laboratory from Chichén Itzá: Y-626, 1160 ± 60 (Yale IV) and Y-626*bis*, 1010 ± 100 (Yale V).

LJ-89. La Brea Tar Pits, California—2 **>28,000**

Tar extracted from cavity in trunk of wood run as LJ-55 (this list), Rancho La Brea tar pits (34° 03′ 45″ N Lat, 118° 21′ 25″ W Long), California. *Comment*: run to test whether the tar that impregnated this sample was essentially "dead", since recent tests are said to indicate that some tars may be much younger than previously thought. The count was only slightly above the background.

LJ-95. Submarine artifact, California **520 ± 150**

Oyster shell (*Ostrea lurida*) attached on inside of a gigantic stone bowl found outside the surf, at La Jolla (32° 51′ 15″ N Lat, 117° 15′ 38″ W Long), California (from Air Photo Compilation T-5375, 1933). Coll. by Gary Wickham, Ralph Dam, and Robert Atkinson, La Jolla (sample 1958—IX: 21A); subm. 1959. The bowl was buried in the sand so that only the rim was exposed, but shifting sand may have exposed it more fully in the past. *Comment*: analysis was obtained to give a minimum date for the abundant submarine artifacts in this region (Tuthill and Allanson, 1955). Large numbers of artifacts of relatively recent cultures, mostly smaller bowls, found on the seafloor in southern California, have posed exciting problems. It seems most plausible to attribute their occurrence to a relatively recent rise in sealevel, resulting in a rapid erosion of the shore. As such a heavy object as the bowl here treated, weighing 61 kg, probably would not have shifted greatly in position, it may have stayed near where it was left on shore by man, and the oyster shells on it may not be much younger than the time of its submergence.

LJ-96. Midden, San Felipe, Baja California—1 **1370 ± 200**

Clam shell (*Chione californiensis*) from extensive superficial midden on beach ridge, at edge of coastal terrace, just above and W of air strip occupying a stranded lagoon, close to the San Felipe village well, Golfo de California (31° 01′ N Lat, 114° 51′ W Long), Baja California Norte. Coll. by C. L. Hubbs, F. P. Shepard, and party (sample 1955—XII: 29A); subm. 1959. *Comment*: dates the former dense population, indicated by the abundance of surface middens, in a now-dry coastal area, and dates the greater-than-present precipitation that is inferred to have afforded an adequate water supply.

LJ-98. Estero de Punta Banda, Baja California **1820 ± 200**

Charcoal, mostly from a burned log, in midden buried 1.5 to 4.6 m in alluvial-clay slope along S shore of Estero de Punta Banda (31° 42.3′ N Lat, 116° 38.5′ W Long), Baja California Norte (from insert on HO Chart 1149, 1948). Coll. by C. L. Hubbs and W. J. North (sample 1957—V: 26A); subm. 1959. *Comment*: the character of the alluvial deposits and the evidences of human occupation indicate that the slope, with its midden shells, fire areas, etc., probably accumulated on the shore of the estuary during a period of greater-than-present rainfall, when sealevel was somewhat lower than now. The site is along an active fault with warm springs, which have probably had a long history, and have presumably supplied fresh water for the widespread habitations in this region.

LJ-99. Lake LeConte, California—1 **760 ± 100**

Charcoal from near W shore of ancient Lake LeConte, in recess 1.8 km WSW from Travertine Rock, Imperial County, in south-central part of sec. 6. T 9 S, R 9 E (33° 24.9′ N Lat, 116° 04.4′ W Long), California (from Oasis Quadrangle, 1956). Coll. by G. M. Stanley, Fresno State College, and C. L. Hubbs (sample 1958—IV: 20B); subm. 1959. Taken from a canyon draining toward the NW, between 10.76 and 10.91 m above sealevel, and 0.37 m below surface of foreshore slope of small southward-built gravel spit (altitude 13.38 m), 6 m E, which marks the high shoreline of the last main stage of Lake LeConte (Hubbs and Miller, 1948, p. 103-112. The charcoal, mostly of tules, permeates a layer of lake silt, 7.6 cm thick, that overlies beach gravel, and in turn is covered by sand and gravel. The silt is the thinner and upper of two silt layers, each of which is interbedded between, and is separated by, layers of beach gravel. *Comment*: the silt was formed during the second of three cycles of inundation (due, presumably, to fluctuating lake level) that are indicated in the gully section that exposes the charcoal. The site was occupied well before the termination of the last high stage of Lake LeConte. (Most of these detailed data were kindly supplied by Stanley.)

LJ-100. Midden, San Felipe, Baja California—2 **200 ± 100**

Charcoal from a single hearth in the beach-ridge midden recorded under LJ-96 (this list), San Felipe (31° 01′ N Lat, 114° 51′ W Long), Baja California Norte. Coll. 1955 by C. L. Hubbs, F. P. Shepard, and party; subm. 1959. Only 3.9 g of clean charcoal was secured from the 11.2-g sample. *Comment*: sample dated to confirm the date obtained from shell (LJ-96, this list), but it now appears that the fire was intrusive, and much more recent (very late prehistoric or modern).

LJ-101. Lake LeConte, California—2 **1580 ± 200**

Charcoal from beachline 3.0 km SW×W from Valerie Jean, in NW¼ sec. 24 (close to north–south center line), T 7 S, R 7 E, Riverside County (33° 33.1′ N Lat, 116° 12.4′ W Long), California (from Valerie Quadrangle, 1956). Coll. by G. M. Stanley and C. L. Hubbs (sample 1958—IV: 20C); subm. 1959. In thin silt seams at 10.7 m altitude, where highest beach stand was at 13.4 to 13.7 m (data from Stanley); overlying well-cemented pebbly sand and underlying sand with foreset laminae; ca. 45 cm below top of a broad silt-flat. *Comment*: the silt-flat formed behind a sand-bar on the shore of the last high stage of Lake LeConte, but earlier than the period of greatest population with much pottery. This is the oldest date so far obtained for Lake LeConte.

LJ-102. Lake LeConte, California—3 **220 ± 100**

Charred tules from eastern beachline in Imperial County, ca. 0.6 km NW of Siphon 18 on Coachella Canal, in SW¼ sec. 7, T 9 S, R 13 E (33° 24.1′ N Lat, 115° 39.5′ W Long), California (from Frink NW Quadrangle, 1956). Coll. by C. L. Hubbs and B. E. McCown (sample 1956—XII: 29C); subm. 1959. *Comment*: a sample from one of the extensive tule fires of the shoreline,

which appear to have been set in game-drives around the margin of Lake LeConte toward the end of the last stage. The fire baked the underlying clay.

LJ-103. Midden, Sweetwater River, California **760 ± 100**

Charcoal, metamorphosed into almost coal-like hardness and brittleness, from terrace at ca. 13.7 m altitude on S side of Sweetwater River, along the S line of C Street between National Avenue and Date Street, Chula Vista, San Diego County (32° 38′ 49″ N Lat, 117° 05′ 38″ W Long), California (from Air Photo Compilation T-5372, 1933). Coll. by C. L. Hubbs and L. C. Hubbs (sample 1959—IV: 19A); subm. 1959. Accompanying the charcoal are many crudely flaked artifacts. *Comment*: the crudeness of the artifacts, the modification of the charcoal, and the lime induration and the yellowish-to-reddish coloration of the soil in which the artifacts lay, combined to give an impression of very considerable antiquity, but the relatively young date merely shows how recent are some of the crude artifacts that predominate in some Californian sites and how rapid the inferred soil-forming processes can be. Incidentally, this soil grades downward, conformably, in Hubbs' opinion, into the river gravels in which Carter (1952, and 1957, p. 356) found broken cobbles that provided "the major source of data for the initial claim for interglacial man in the San Diego area." No confirmation of this interpretation could be gleaned from the field work of 1959.

LJ-105. Lake LeConte, California—4 **1440 ± 100**

Charcoal from a thin occupation level at 2.0 m depth in an extensive silt deposit behind a bar along E shore of ancient Lake LeConte, Imperial County, in a draw ca. 0.4 km below Siphon 15 of Coachella Canal, in sec. 26, T 9 S, R 13 E (33° 21.7′ N Lat, 115° 35.0′ W Long), California (from Frink Quadrangle, 1940). Coll. by C. L. Hubbs, with B. E. McCown and party of the Archaeological Survey Association of Southern California (sample 1956—XII: 31C); subm. 1959. In a rather continuous and thin occupation streak, with some fish bones, lying ca. 30 cm above a sandy level containing Lake LeConte shells. At a total depth of 3.2 m there was another occupation streak on an older land-surface (with insufficient charcoal for a test). *Comment*: the collectors arrived at the following interpretations: More than 1500 yr ago a lagoon formed behind the barrier-bar on the E shore of Lake LeConte; gradually silt filled this lagoon; when the land surface dried it was widely occupied by man; after further aggradation, a higher land-surface was inhabited ca. 1440 yr ago (LJ-105); then another 2 m of silt accumulated over that land-surface, to form a third surface, which was occupied (see LJ-15, 300 ± 100, and LJ-102, 220 ± 100, this list) by the dense population that developed toward the end of the last high stage of Lake LeConte.

LJ-106. (B.) Lake LeConte, California—5 **960 ± 100**

Charcoal from essentially the same locality as LJ-105, in an adjacent draw. Coll. by same party (sample 1956—XII: 31B); subm. 1959. The very definite habitation streak was 2.5 to 20 cm thick and was buried about 1.7 m. A small potsherd and some fish bone occurred with the charcoal. Very near, at the same level, a large part of a pot was taken by the collectors. *Comment*:

this and other collections show that the earlier inhabitants of the shoreline of the last high stage of Lake LeConte had pottery, though not in the abundance indicated for the terminal period of the lake's existence. This intermediate date confirms the existence of the lake 1000 yr ago, as hypothesized under LJ-7 (this list) and enhances the probability that the lake persisted from at least 1600 B.P. until about 300 B.P.

LJ-107. (B.) Punta Cabras, Baja California—2 6400 ± 200

Rock-scallop shell (*Hinnites multirugosus*) from surface midden near cliff edge at tip of Punta Cabras (31° 20.1′ N Lat, 116° 27.7′ W Long), Baja California (from HO Chart 1149, 1948). Coll. by C. L. Hubbs (sample 1952—VI: 8A); subm. 1959. *Comment*: date provides another indication that the early shellfish-gatherers occupied the NW coast of Baja California. LJ-6 provided a date of 5020 ± 200 for a site 1 km E.

LJ-108. Hearth, Punta Clara, Baja California Norte 1580 ± 100

Black-abalone shell (*Haliotis cracherodii*) from a single definite hearth on the face of the dunes at Punta Clara (first point S of the mouth of Arroyo Santo Tomás) (31° 51′ 54″ N Lat, 116° 39′ 48″ W Long), Baja California Norte (from HO Chart 1044, 1918). The hearth contained many shells, a whale vertebra, some charcoal, etc. Coll. by C. L. Hubbs and party from Great Basin Conference (sample 1955—IX: 3D); subm. 1959. *Comment*: this date is the oldest in the Santo Tomás region for the *Cryptochiton*-bearing middens of a cold period that continued until less than 1000 yr ago. With the date of 1600 ± 150 for LJ-83, it may approach the beginning of this period. This was the first definite hearth located in the shell- and artifact-rich dune area of Punta Clara.

LJ-109. (B.) Scripps Estates Site I, California—2 7370 ± 100

Mussel shell (*Mytilus californianus*), encased in almost cement-like caliche, from the bottom of the shell-rich layer of the site, on Lot 24, Scripps Estates Associates, at ca. 107 m altitude (32° 52′ 18″ N Lat, 117° 14′ 55″ W Long), California (from Air Photo Compilation T-5375, 1933, and La Jolla Quadrangle, 1933). Coll. 1954-1957 by C. L. Hubbs; subm. 1959. *Comment*: this sample (1) dates the lower level of main occupation of this significant site, higher levels of which are dated by LJ-79, 6700 ± 150, and LJ-110, 5460 ± 100 (this list), but the initial habitation by a smaller population is still older, though undated; (2) gives a maximal estimate of the time required (under the local conditions) for the production of an extensive caliche lime-pan; (3) bears on the time of the inferred rise in sealevel and the hypothesized greater-than-present precipitation, and on the time when sea temperatures had become as warm as or warmer than now, as discussed under LJ-79, this list.

LJ-110. (B.) Scripps Estates Site I, California—3 5460 ± 100

Mussel shell (*Mytilus californianus*) from dark, friable A-horizon, superficial soil of site I, Scripps Estates Associates (32° 52′ 18″ N Lat, 117° 14′ 55″ W Long), California (from Air Photo Compilation T-5375, 1933, and La Jolla Quadrangle, 1933). Coll. 1954-1957 by C. L. Hubbs; subm. 1959. *Comment*:

sample dates the upper limit of the probably more than two millenia of occupation and (as discussed under LJ-79) bears on the rate of soil weathering and on past oceanographic and climatic conditions.

LJ-111. (B.) Midden, Cape Arago, Oregon 1500 ± 100

Charcoal from the upper 2 dm of one of the middens excavated by C. L. Hubbs and party (sample 1957—VII: 10A); subm. 1959. This midden lies at the island end of the footbridge leading to Cape Arago Light, at the E end of the crest of a residual ridge (43° 20′ 27″ N Lat, 124° 22′ 23″ W Long), Oregon (from USC&GS Chart 5984, 1957). *Comment*: date fixes the upper limit of the occupation of this particular midden site; inferred changes in ecologic conditions and in culture will be detailed in a later report.

LJ-112. Mukluk Piston Core B21P >40,000

Carbonate ooze (coccoliths and Foraminifera) from piston core taken 1957 by R. J. Hurley in the NE Pacific Ocean, on the Mukluk Expedition of Scripps Institution of Oceanography (52° 32′ N Lat, 141° 44′ W Long); subm. 1959. According to the collector, the core consists of 8.7 m of carbonate ooze interbedded with blue-green mud and with sand layers; the sample was from 42 to 49 cm from top of core and represents the uppermost carbonate-ooze layer; due to disturbances of the bottom materials in the piston coring, the layers in the core cannot be exactly equated with those in an adjacent, shorter gravity core, in which the uppermost 10 cm, consisting primarily of pelagic sediments, overlies sediments of turbidity-current origin that do not extend deep enough to have included the topmost carbonate-ooze layer. *Comment*: a finite radiocarbon date would have confirmed the hypothesis of rapid accumulation of turbidity-current deposits, but, in view of the uncertainties as to the actual depth of the carbonate ooze in the bottom, and in view of the probable variations in the rate of such sedimentation, the test does not negate the hypothesis.

LJ-120. (B.) Flooded cave, Florida 10,000 ± 200

Strongly charred log taken in close association with human bones and artifacts, buried in sediment on the floor of a now-flooded cave surrounding the opening of Warm Mineral Springs, 11.6 m under water (27° 02′ 30″ N Lat, 82° 15′ 30″ W Long), Florida (from pl.l, Ferguson, Lingham, Love, and Vernon, 1947). Coll. and subm. 1959 by Eugenie Clark, Director, Cape Haze Marine Laboratory. The burned log was uncovered from ca. 2 m of cave deposit, 1.83 m back from the outermost stalactites of the overhanging cave roof. Human bones were found within a few mm of the log. Ca. 6 m from the log there was removed, from the middle of three sedimentary layers, a dolichocephalic human skull containing supposed brain tissue but showing no cellular structure in microscopic sections. *Comment*: a preliminary account of this notable find has been prepared by Clark (ms).

LJ-121. (B.) La Brea Tar Pits, California—3 4450 ± 200

Wooden atlatl foreshaft (Los Angeles County Museum no. 385), one of the few artifacts known from the Rancho La Brea tar pits (34° 03′ 45″ N Lat,

118° 21′ 25″ W Long), California. Coll. 1915 by L. E. Wyman, Los Angeles County Museum; subm. 1959 by Hildegarde Howard of the same institution. The test was made of the butt end of the specimen, which was illustrated by Woodward (1937, pl. 18 (*a*)). This specimen, and others described by Woodward, came from Pit 61–67, and bears data "Pit 67, caved wall, SE." Field notes state that several artifacts were found in an area embracing grid sections F, G, H, and I from 8 to 18 ft in Pit 67 and into Pit 61 (pits 61 and 67 were found upon excavation to be continuous). Marine shells were also found where pits 61 and 67 joined. *Comment*: according to Howard (1960), various circumstances suggest a younger age for the evidences of man in the Rancho La Brea tar pits than for the in situ tree trunk (LJ-55, this list). The problem was earlier discussed by Howard and Miller (1939).

LJ-128. (B.) Shell, Long Reef, Australia—1 900 ± 150

A large shell of a presumably intertidal mollusc, *Turbo* sp., from 3.65 m above mean tide, on a "raised beach" at Long Reef, on the coast between Deewhy and Callaroy, near Sydney (ca. 33° 44.6′ S Lat, 151° 19.4′ E Long), Australia (from HO Chart 1904, 1942). Coll. 1959 by H. R. Wanless, University of Illinois, Urbana; subm. 1959 by F. P. Shepard, Scripps Institution of Oceanography. *Comment*: sample was dated to test the evidence for a postglacial high sea-stand, for which perhaps the least assailable evidence seems to stem from Australia. Some authorities, such as Shepard and Suess (1956) and Curray (1959, 1960), believe that the preponderance of evidence argues against such a high stand. Others, particularly Fairbridge (1958), disagree. Possibilities in need of consideration, in this and in similar tests, are whether there has been uplift of the land and whether the shell deposits are really natural. The uniform altitude and broad areal extent of the shell deposit, and the lithified nature of some of the matrix, indicate that the deposit probably represents a "raised beach", but the date and height do not correspond closely with any of the eustatic stages postulated by Fairbridge. Tectonic movement(s) may have been involved.

LJ-130. (B.) Shell, Long Reef, Australia—2 900 ± 150

Shell (intertidal limpets, *Patella* sp. and *Fissurella* sp.) from the same collection as LJ-128, Long Reef, near Sydney (ca. 33° 44.6′ S Lat, 151° 19.4′ E Long), Australia (from HO Chart 1904, 1942). Coll. 1959 by H. R. Wanless, University of Illinois, Urbana; subm. 1959 by F. P. Shepard, Scripps Institution of Oceanography. *Comment*: the reasons for this measurement, and the inferences, are the same as for LJ-128.

LJ-131. (B.) Isla Ceralbo, Golfo de California >42,000

Shell of a single large gastropod (*Strombus galeatus*), from more or less cemented stratum 0.4 to 2.5 m thick, in the lower, marine part of the terrace-fill, just W of the S point of Isla Ceralbo, off Baja California Sur (24° 08.8′ N Lat, 109° 47.1′ W Long) (from HO Chart 1664, 1956). Coll. March 28, 1959, and described by Chao-Siang Wang, National Taiwan University, on a Vermilion Sea Expedition of the Scripps Institution of Oceanography; subm. 1959 by F. P. Shepard. The collector reported the following altitudes: top of

terrace-fill [at cliff?], 10 m; fossil bed, 1.5 to 4 m; buried wave-cut platform, 1.5 m. *Comment*: sample was run in an effort to date when, in this unstable region, the fossil bed was at or below sealevel. The date indicates a deposit earlier than late Wisconsin, certainly not Recent. The shell, unlike that of LJ-132, was clearly altered by fossilization.

LJ-132. (B.) Punta Pescadero, Baja California 1700 ± 150

Shell of a single large gastropod (*Strombus galeatus*) from terrace along Golfo de California, at Punta Pescadero (23° 47.6′ N Lat, 109° 42.0′ W Long), Baja California Sur (from HO Chart 1664, 1956). Coll. 1959 by Chao-Siang Wang, National Taiwan University, on a Vermilion Sea Expedition of the Scripps Institution (sample 1959—III: 28A); subm. 1959 by F. P. Shepard. The collector recorded, presumably from the cliff face, the altitude of the terrace [top] as 8 m; the thickness of what he took to be a fossil bed as 0.2 to 0.3 m; the height of the buried wave-cut platform as 6 m; and the thickness of the superficial alluvial fill as ca. 2 m. *Comment*: the late date indicates an unexpected very recent uplift; or, less probably, a recent high eustatic sealevel; or, as now seems almost certain, that the deposit, contrary to the collector's view, is a midden. He reported that the species of molluscs in this deposit are the same as those in the deposit dated by LJ-131, but the two other shells submitted (one each of *Chamma buddiana* and *Muricanthus nigritus*) were not represented in the sample from Isla Ceralbo. All three specimens at hand from Punta Pescadero give the impression of being recent midden shells.

LJ-136. (B.) San Dieguitoan site, California 4720 ± 160

Shell (*Chione californiensis*) from the San Dieguitoan site (SDMM–W–198), extensively studied by M. J. Rogers, San Diego Museum of Man, in the San Dieguito River valley, 12.5 km inland, just above a volcanic dike, in SW¼ sec. 13, T 13 S, R 3 W (33° 02′ 33″ N Lat, 117° 09′ 10″ W Long), California (from Rancho Santa Fe Quadrangle, 1949). This is Site SDi–149 of the University of California Archaeological Survey. Coll. August 1938 and subm. 1959 by M. J. Rogers. *Comment*: the collector reports that *Chione* and *Pecten circularis aequisulcatus* made up about 98% of the shells, which were found in very limited number here (shells are ordinarily lacking in San Dieguitoan, as contrasted with La Jollan, sites). Included also were a few pieces of the warm-water cockle *Laevicardium elatum*, and a few other fragments, possibly of abalone (*Haliotis*). Shells were in a sandy layer, Rogers' Stratum M′, that he interprets as part of an ancient sand-bar. This sandy layer, he states, was in a residual hummock on the floodplain of a now-intermittent stream below a concrete-like layer and, before erosion, was under ca. 5 m of valley-fill. Within the sand Rogers found shells only in the upper part, in contact with the "concrete" and just below [the cemented layer may have prevented the solution of the shells]. From the same sand layer Rogers took artifacts (amulets, notched points, etc.), regarded by him as characteristic of what he has termed San Dieguito III. Rogers originally (1929) indicated that the "Scraper-Maker Culture", which he named San Dieguito in 1939, may have developed from that of the "Shell-Midden People" (which he later called

La Jollan). After much field work Rogers (1945) reversed the sequence, and theorized that the San Diequitoan people were replaced by the retrogressive La Jollans, who, in turn, graded into the relatively recent Yumans. This sequence has been accepted by Meighan (1959). The evidence for this view, which has not been shared by the senior author of this report, is (1) the stratigraphic relation, at several places, including site SDMM–W–198, of cultural material identified as San Dieguitoan below "La Jollan", and (2) the similarity of the San Dieguitoan stone artifacts to those of other Western sites that appear on artifactual or dated grounds to have preceded the La Jollan. The problem needs further elucidation, especially because stratigraphic relations in reworked floodplain deposits like those at SDMM–W–198 are suspect, and because migrations, cultural deterioration, and independent developments and acquisitions may often affect the apparent cultural sequence. The extent of valley alluviation at this site suggests greater stream flow in the past; the repeated or prolonged occupation of the site may well have resulted from the long persistence of the stream here (prior to the current drought, some surface water persisted perennially here).

LJ-141. (B.) Drilled well, Cape Cod >42,000

LJ-142. (B.) >42,000

Charcoal from Holdens Well 86, at edge of Holdens Pond, near tip of Cape Cod (42° 03′ 19″ N Lat, 70° 16′ 03″ W Long), Massachusetts (from North Truro Quadrangle, 1948). Coll. September 1959 by J. M. Zeigler, Woods Hole Oceanographic Institution, Massachusetts; subm. 1959 by him through F. P. Shepard. LJ-141 was listed as having come from the charcoal layer at depth 26.0 m; LJ-142, from the mixed layer of charcoal and oxidized clay at 27.0 m. Zeigler reports that this well is being drilled to determine whether or not the four glacial formations, if present, are separated by marine deposits. The well, a 3-in. cased hole, has been handled very carefully; the entire operation has been by staff members. There is no possible way that the charcoal in this sample could have come from elsewhere. The bottom of Holdens Pond is at 1.5 m altitude; the uppermost material is interpreted as fluvio-glacial sands and gravels of Wisconsin age, from the surface; at 6.1 m an oxidized zone tops a layer of clay, probably Gardiners Clay, the age of which is given as Sangamon; this clay extends to 10.8 m and overlies ca. 15.5 m of fine, gray, angular sand, devoid of marine fossils. Below this sand, at ca. 26.2 m depth, is a layer of charcoal, overlying a mixture of charcoal and oxidized clay. *Comment*: Zeigler remarked that "the date of this charcoal could very well be the most important date in New England of this century because: 1. There are no known pre-Wisconsin glacial deposits in New England. 2. The Gardiners Clay is widespread but the correlation is uncertain. Thus no matter what age the carbon gives, it will be very important, whether a pre-Wisconsin age or a stadial age." It is obvious that the charcoal is at the latest early Wisconsin. The date does not further fix the age of either the charcoal or the clay.

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