LATE PLEISTOCENE-EARLY HOLOCENE HISTORY OF CONIFEROUS WOODLANDS IN THE LUCERNE VALLEY REGION, MOHAVE DESERT, CALIFORNIA

Thomas Jackson King, Jr.[1]

Abstract.— The composition of four radiocarbon-dated, late Pleistocene woodrat middens is reported and analyzed. A date of 11,850 ±550 BP records the first reported macrofossil occurrence in this region of late Pleistocene *Pinus monophylla-Juniperus osteosperma* woodlands. A 7,800 ±350 BP date documents the most recent *J. osteosperma* woodlands in this presently coniferless desert area, while a date of 12,100 ±400 BP is the oldest record of juniper woodlands among the four middens. Other juniper and creosote bush desert flora radiocarbon dates along with six pollen profiles were obtained. The research suggests that as recently as 7,800 BP this part of the Mohave Desert was subject to a cooler, moister climate than at present, and that the aboriginal food resources of pinyon seeds and juniper berries were probably available to early prehistoric man in this area.

The research reported derives from an investigation into the woodland paleoenvironments of the Lucerne Valley region, San Bernardino County, California, in the western Mohave Desert (Fig. 1). The investigation utilizes radiocarbon-dated plant macrofossils from indurated woodrat middens to document a particular floral sequence at a specific location during a specific radiocarbon time frame.

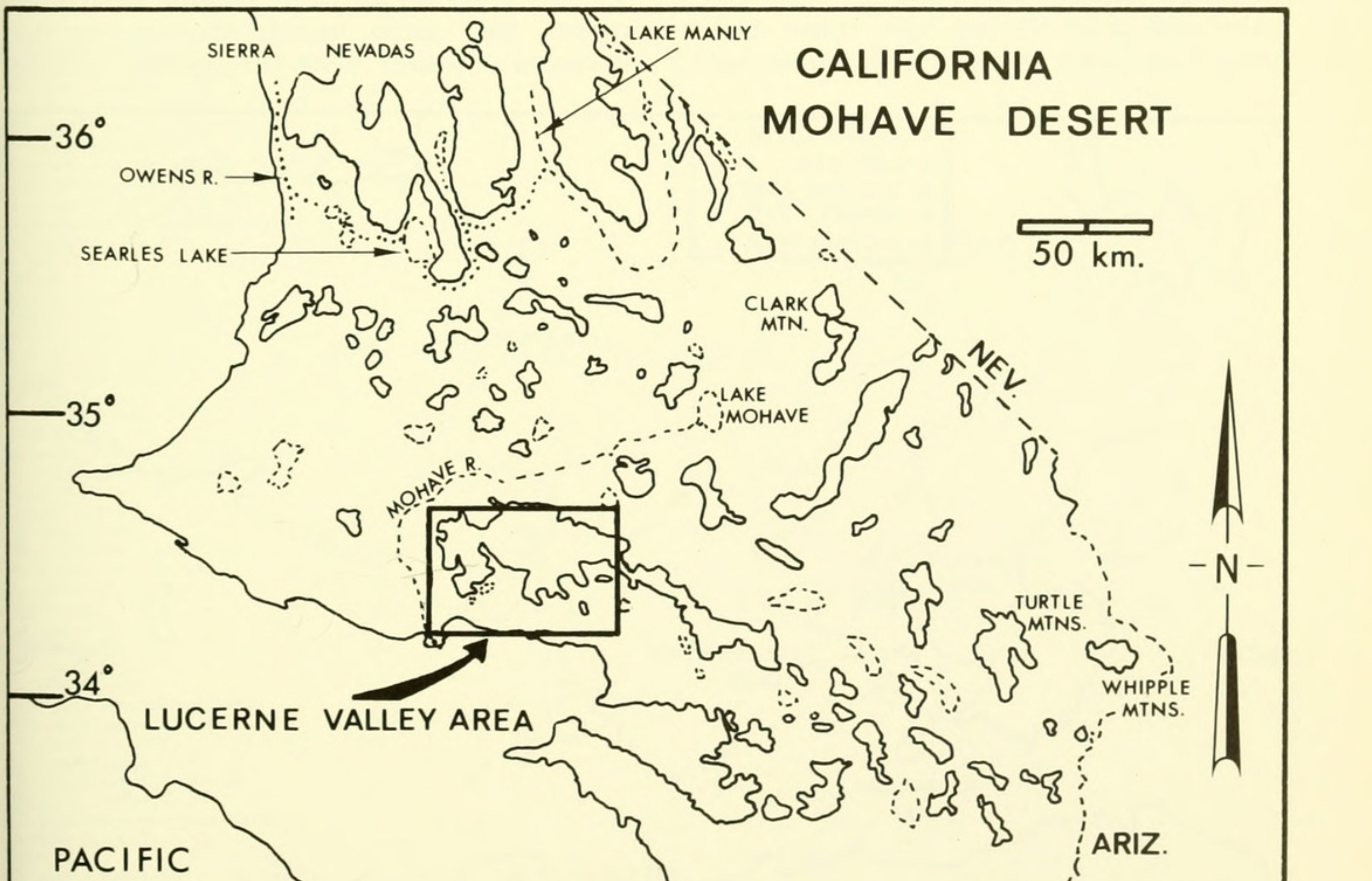

Fig. 1. The Lucerne Valley study area, shown enlarged in Figure 2, is depicted in relation to late Pleistocene Searles, Manly, and Mohave lakes and the late Pleistocene Mohave and Owens River courses. The higher elevations of the California Mohave Desert are shown in outline.

[1]Department of Archaeology, University of California at Los Angeles, Los Angeles, California 90024. Present address: 3522 Douglass Avenue, Riverside, California 92507.

[2]Sunset Cove sample #1 and Lucerne Valley samples #2, 3, 4, 6, 12, and 15 were radiocarbon dated using miscellaneous twigs since no juniper was present and no single plant species provided enough mass for a single species C^{14} date.

The primary aims of this research are (1) to document woodland changes through time in the western Mohave Desert, (2) to utilize this data in suggesting climatic inferences for this region over the last 12,000 years, and (3) to evaluate the aboriginal subsistence strategy implications of the accumulated paleobotanical data.

Lucerne Valley and the surrounding Granite and Ord mountains lie in the intense winter precipitation rainshadow of the San Bernardino Mountains (Figs. 1, 2) (Wells and Berger 1967:1644-45). Present average annual precipitation on the valley floor is ca 12.5-15 cm and about 20 cm at higher elevations of the Granite and Ord mountains (Troxell and Hofmann 1954:14-15; Johnson, Vasek, and Yonkers 1974:8/4). Recently, snowfalls in the San Bernardino, Granite, and Ord mountains during the winter of 1973-74 produced runoff which resulted in a ca 45 cm ephemeral lake stand at Rabbit Dry Lake and a 15-30 cm lake stand at Lucerne Dry Lake, two playas with no outlet which serve as collecting sinks (Thompson 1929) (Fig. 2). The terrain of the area is one of deeply weathered quartz monzonite mountains surrounding an alluvium-filled basin (Thompson 1929: 616). Lucerne Valley is the northern end of a northwest to southeast trending trough.

The dominant vegetation of the area is *Larrea divaricata* (creosote bush) with stands of *Yucca brevifolia* (Joshua tree) and *Y. schidigera* from the valley floor at 914 meters to above 1372 m (Thompson 1929:610; Vasek, Johnson, and Brum 1974:4/4) (Table 1). Other common species are *Ambrosia dumosa* (white bursage), *Atriplex confertifolia* (shadscale), *Eriogonum fasciculatum* (woody buckwheat), *Ephedra californica* (Mormon tea), *Stipa speciosa*, *Salazaria mexicana* (bladder sage), and *Opuntia basilaris* (beavertail cactus) (Thompson 1929:47-51). Scattered stands of *Acacia greggii* (catclaw acacia) occur in upland washes, while *Prosopsis juliflora glandulosa* (mesquite) and some marsh grasses are occasionally found near the sparse springs

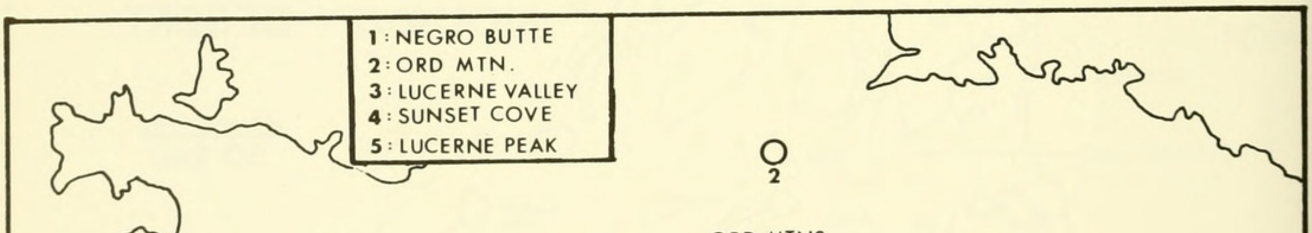

Fig. 2. Four woodrat middens studied by the author and one by Wells and Berger (1967), #1, are depicted in relation to the surrounding Granite, Ord, and San Bernardino mountains. The playa edges of Rabbit and Lucerne Dry lakes are shown. Two vegetation area transects conducted by Vasek, Johnson, and Brum (1974) are shown as *a* (1036 m) and *b* (883 m).

Sites	Sunset Cove 972 m. 5,880± 250 #1		Lucerne Peak 1,097 m. 5,800± 250 #1		Ord Mountain 1,219 m. 11,850± 550 #1		Lucerne Valley 1,006 m. 3,650± 210 #2		3750 ±205 #3	3690 ±210 #4	4300 ±240 #6	11,100 ±420 #10	8300 ±780 #11	7820 ±570 #12	12,100 ±400 #13	7800 ±350 #14	1610 ±150 #15
Plants	Past	Now	Past	Now	Past	Now	Past	Now	Past	Past	Past	Past	Past	Past	Past	Past	Past
Juniperus osteosperma					**							**	**		**	**	
Pinus monophylla					+++												
Acacia greggii						++											
Allionia sp.											+						
Ambrosia dumosa				*		+	++			+++	+++					+	+
Amsinckia sp.							+		+	++	++	++					
A. tessellata ?		+		+				+					++	+			
Apiaceae											+						
Asteraceae																+	
Astragalus layneae												+++	++	*		+	
Atriplex confertifolia ?			+					*									
A. patula hastata ?			+														
Boraginaceae							+										
Brickellia sp.											+++						
B. arguta											++						
B. desertorum	+			*													
B. incana ?						*											
B. oblongifolia lini. ?											+++						
Bromus rubens				+		+											
Chenopodium californicum ?							+										
Chlorogalum sp. ?							++										
Chrysothamnus sp. (NVK)							++										
C. teretifolius			+	*		*		*									
Cirsium sp.															+		
C. mohavense						+						+++					
Compositae	+																
Cryptantha sp.												+			+		
Castilleja sp.												+++	++			+++	
Dalea sp.							++		++		+	+++			+		
D. fremontii ?																+	
D. mollis ?										*	+++						
Datura sp.																+	
Encelia frutescens			+++														
E. virginensis												**	**	**	**	**	
Ephedra sp.	+++	*	**	*	+++	*	+++	**	++	+++	+++			**	+	++	+++
Eriogonum sp.												++				+	
E. inflatum (NVK)							+										
E. fasciculatum		+				*		+									+
E. trichopes		+						+									
Equisetum sp. ?															++		
Erodium texanum			+														
Eschscholzia minutiflora			+++														
Ferocactus ancanthodes							+			+++							
Gutierrezia microcephala				+													
Haplopappus cooperii						**											
H. cuneatus						*											
Hilaria sp.	+																
Hymenoclea salsola						*											
Ipomopsis sp.						+											
Isomeris sp.																+	
Iva axillaris					*												
Larrea divaricata	+++	**	++	*		**	**	**	**	**	**						*
Leguminosae (NVK)									+								
Lessingia sp. ?	+																
Lepidium fremontii				+													
Lomatium sp.				+									+				
L. mohavense			+														
L. dasycarpum tomentosum																+	
Lupinus sp.			+														
Lycium cooperii ?													++				
Lygodesmia sp.						*											
Machaeranthea tortifolia						*								*			
Malvastrum exile (NVK)												++				+	
M. rotundifolium (NVK)							*			*	+++						++
Opuntia sp.	+++		+		++		+++		+++	*	*	*	+	+		+++	
O. basilaris	++																
O. bigelovii ?									+	+	+			+			
O. occidentalis ?											+						
O. ramosissima												+					
Oryzopsis hymenoides (NVK)										+							
Penstemon centranthifolius															+		
Phacelia sp. (NVK)			+							+				+++			
P. campanularia				+													
Phoradendron californicum						+											
Physalis crassifolia						+											
Plagiobothrys cusickii ? (NVK)													+				
Purshia glandulosa					**											+++	
Rosaeae							++			+++	+++						
Salazaria mexicana	+++			*		*		*									
Salvia ssp. *carnosa* ?												+					

TABLE 1. Present and past vegetation of the four midden sites is shown. The relative frequency of a plant's occurrence (as seed, achene, leaf, twig, fruit, etc.) in a sample is indicated by the following signs: rare (1-2 pieces), +; uncommon (3-5), ++; common (6-15), +++; very common (16-25), *; abundant (26+), **. Ancient plant species are identified under *Past* while present plants gathered from 30 m radially around each midden site are identified under *Now*. Midden names, elevations in meters, C^{14} dates, and sample numbers are given at the top of the table. Where a plant is listed ?, the genera choice is usually definite while the species choice is uncertain.

Table 1 (continued)

S. columbariae		+													
S. mohavensis		+	+			+									
Scrophularia californica												+++			++
Solinaceae								*	++		*	+++		+++	
Sparganium sp. ?				+											
Sphaeralcea sp.							+			+++			+		
S. ambigua					+						+				
Stipa sp.		++					+			++			+	+	
S. speciosa	+++					*									
Thamnosma montana						+++									
Thysanocarpus sp.										+					
T. curvipes														+	
Yucca sp.	+++				*	+	+++		+	*			+++		++
Y. brevifolia ?											+++				
Y. schidigera ?								++							
Y. whipplei			+												

and wells of the area (H. Johnson pers. comm. 1974). Table 2 lists recorded vegetation along two short transects in the study area as surveyed by Vasek, Johnson, and Brum (1974:4/28-29) (Fig. 2).

Woodrats and Middens

Woodrat midden analysis provides paleoenvironmental data through identification of the plant macrofossils preserved in the indurated, uriniferous middens. This technique has been applied to the California Mohave Desert by Wells and Berger (1967), Mehringer and Ferguson (1969), and Martin (1969). The desert woodrat, *Neotoma lepida* Thomas, occurs in the study area (Finley 1958:319; Goldman 1910:61). It commonly collects most of the plant species growing within a few hundred meters of its den, although juniper and sagebrush are frequently preferred food resources (Finley 1958:541; Stones and Hayward 1968:474; Cameron 1971:288). Finley (1958:334), in discussing Colorado woodrat ecology, has cautioned, "An individual woodrat sometimes forages over two or more very different plant communities or types of topography. Frequently the dens are in ecotones." More recently Cameron and Rainey (1972:256) found that *Neotoma lepida* preferred dwelling sites or dens were crevices and caverns in rock outcrops in the pinyon-juniper and Joshua tree woodland areas of the Joshua Tree National Monument, located 75 kms southeast of the study area.

Within the den are an outer mound composed of loosely packed sticks, stones, cactus spines, animal bones and dung, and an inner living space or nest of soft, fibrous plant materials built up behind the mound (Finley 1958:517). Van Devender and King (1971:240) have suggested that a fossil midden represents perch areas of the den where urine and fecal pellet deposition has cemented the accumulated plant materials into a hard, dense mass. Desiccation by hot, dry desert air apparently causes this hardening of the midden through quick release of volatile uric fractions as vapor. The whole midden deposit is often composed of several tunnels, levels or shelfs, nests, and food caches which, upon collapse or compaction, complicate any depositional stratigraphy (Van Devender 1973:8). Wells and Berger (1967:1640) suggest that most such deposits represent an accumulation of short duration. *Neotoma* middens are found throughout the semiarid and arid regions of North

Table 2. Vegetation recorded in two transects by Vasek, Johnson and Brum (1974).

Transect a, 1036 m*
*Larrea divaricata***
Ambrosia dumosa
Hymenoclea salsola
Opuntia ramosissima
Yucca schidigera
Transect b, 883 m***
*Larrea divaricata***
Ambrosia dumosa
Acamptopappus sphaerocephalus
Atriplex polycarpa
Ephedra californica
Eriogonum fasciculatum
E. inflatum
Hilaria rigida
Krameria parvifolia
Lycium andersonii
Stephanomeria pauciflora
Salazaria mexicana

*Sample came from sloping wash area near East Ord Mountain.

***L. divaricata* was the most abundant species in each transect.

***Sample came from flats near Lucerne Dry Lake playa.

America (Wells and Berger 1967: 1640; Van Devender and King 1971:240).

Previous paleobotanical data for the Lucerne Valley area consist of one woodrat midden near Negro Butte (1070 m) containing abundant *Juniperus osteosperma*. This was bulk dated, and thus may be too young, at 9,140 ± 140BP by Wells and Berger (1967:1641-1642). They interpret this midden and others as indicating the presence of xerophilous juniper woodlands in the Mohave Desert down to 1067 m as recently as 9,000 BP and as suggesting a climate slightly more mesic than that presently existing in the midden area (Fig. 2).

Methods

Archaeological field excavation techniques were used in the excavation and extraction of radiocarbon and pollen samples. Plant macrofossils were recovered by soaking the sample in distilled water and straining through a 1.5 mm mesh hand stainer. After drying, juniper seeds and twigs or miscellaneous twigs were chosen for C^{14} dating. At least two boiling distilled water and boiling 2N HCl washes were applied to remove accumulated woodrat urine and foreign matter before sample combustion. The University of California at Riverside Radiocarbon Laboratory under the direction of Dr. R. E. Taylor provided all C^{14} dates.

The juniper macrofossils were identified by F. C. Vasek of the University of California at Riverside, Department of Biology, and the pinyon identification was provided by O. F. Clarke of the UCR Herbarium. Other plant identifications were provided or confirmed by O. F. Clarke and N. Van Kleech (NVK) of the California Department of Agriculture. The botanical nomenclature follows Munz (1974).

Results

All four woodrat middens are located in areas of granitic outcroppings in well-protected crevices or overhangs.

Sunset Cove

The north-facing Sunset Cove midden (972 m) was a physically large deposit. Sample #1 contained abundant *Ephedra* sp. (stems, seeds) and some *Larrea divaricata* (seeds, leaves, stems). In general, it reflects the present day plant species found near the midden (Table 1). Miscellaneous twigs[2] and an *Opuntia basilaris* pad provided a radiocarbon date of 5,880 ±250 BP (UCR-134).

Lucerne Peak

The east-facing Lucerne Peak midden (1097 m) sample #1 contained abundant *Ephedra* (seeds), some *Encelia frutescens* (seeds), and *Eschscholzia minutiflora* (seeds). It held little *Larrea divaricata* (seeds, branch?) in contrast to the present abundance of the species near the midden (Table 1). A single branch (*L. divaricata?*) gave a radiocarbon date of 5,800 ±250 BP (UCR-135).

Ord Mountain

The north-facing Ord Mountain midden (1219 m) sample #1 contained abundant remains of *Juniperus osteosperma* (seeds, twigs, wood) and *Purshia glandulosa* (seeds), while relatively fewer remains of *Pinus monophylla* (scales) were found (Table 1). Juniper seeds from the midden yielded a radiocarbon date of 11,850 ±550 BP (UCR-149).

Lucerne Valley

The south-facing Lucerne Valley midden (1006 m) was the most structurally complex of the middens (Fig. 3). Initial sampling of its exterior face (Level D, sample #15) revealed creosote bush desert plants and an apparently intrusive *J. osteosperma* twig. Trenching of the midden revealed at least three juniper-bearing layers in apparent stratigraphic superposition. Excavation and sampling for C^{14} dating of the interior and exterior layers was conducted in order to determine their temporal sequence.

Level A, sample #13, from the deeper juniper bearing layer, provided a 12,100 ±400 BP date (UCR-181) on juniper seeds and leafy twigs (Fig. 3). This is followed by Level B, #10, with an 11,100 ±420 BP date (UCR-187) on juniper seeds. Level C follows temporally with an 8,300 ±780 BP (UCR-186) date (#11) on juniper seeds and twigs with some gaseous fill; a 7,800 ±350 BP (UCR-249) date (#14) on juniper seeds, twigs, and wood; and a 7,820 ±570 BP (UCR-185)

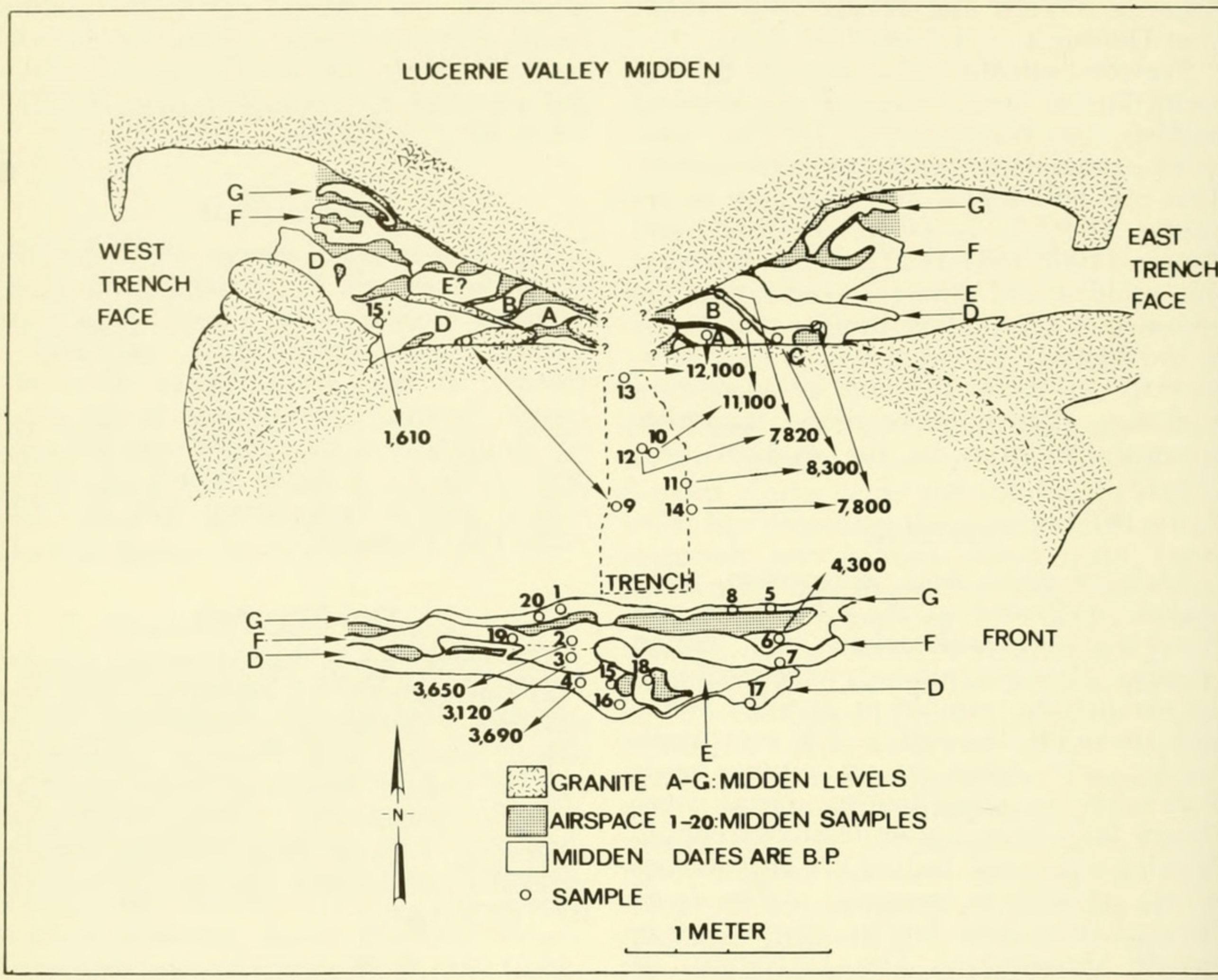

Fig. 3. The Lucerne Valley midden (1,006 m) strata and radiocarbon sample sites are shown with their associated radiocarbon dates; the error factors and laboratory numbers are given in the text. All apparent strata were labeled as levels A-G. Levels A-C are juniper-bearing strata, while levels D-G reflect essentially a creosote bush desert flora. Entrance to the rockshelter was through a horizontal opening next to the east and west faces. Excavation was focused upon the center of the midden and proceeded inward from levels G-D to level A. The trench is shown in an overhead view, while the trench faces are shown in an expanded horizontal format. The west trench face corresponds to the west side of the overhead trench view (dotted), while the east trench face corresponds to the east side of the overhead trench view. Sample #3 should read 3,750 BP.

date (#12) on miscellaneous twigs with some gaseous fill. The juniperless sample #12 from Level C is interpreted as being from a nest area of chaff and twigs within the overall juniper layer C.

The exterior Levels D through G of the midden do not appear to reflect the initial assumption of superposition of levels. Level G, #6, yielded a 4,300 ±240 BP (UCR-239) date on miscellaneous twigs, while Level D, #4, produced a 3,690 ±210 BP (UCR-237) date on miscellaneous twigs. Additional complications are expressed by two Level F dates; sample #3 yielded a 3,750 ±205 BP (UCR-236) date on miscellaneous twigs, while sample #2 provided a 3,650 ±210 BP (UCR-235) date on miscellaneous twigs. Sample #15, Level D, yielded a 1,610 ±150 BP (UCR-133) date on miscellaneous twigs and is regarded as an intrusive deposition of more recent material emplaced through reworking of the exterior face. Radiocarbon dating of samples #1 (G), #5 (G), #7 (F), #8 (G), and #9 (D) is in process (Fig. 3).

At present, it is assumed that the nonsequential dates of exterior Levels D through G of the midden are due to (1) redeposition and reworking of the exterior deposit, (2) an erratic or random level deposition and/or (3) shelving away of the lower rock face thus opening up space successively under Levels G, F, E, and D. It is also possible that in extracting miscellaneous twig samples #2 through #6 (Levels D-G) a veneer of recent or older material was unintentionally included. Such a disturbing factor is also possible for the juniper samples but unlikely in view of the rigorous selection and hand cleaning of the C^{14} samples. With these problems in mind, sample #14, Level C, was extracted as a check upon the sample #11 partial fill date of 8,300 BP for juniper and served to confirm the validity of this date. Table 3 summarizes the above radiocarbon dates.

Pollen

Pollen samples from the sites of Sunset Cove #1, Lucerne Peak #1, Ord Mountain #1, and Lucerne Valley samples #4, #11, and #13 were processed by P. J. Mehringer of Washington State University, Pullman, Washington (Fig. 4). All samples contained windblown *Pinus*, *Juniperus* and *Quercus* pollen, but Compositae is dominant in all samples (P. J. Mehringer pers. comm. 1975). Several trends in relative pollen percentages can be discerned. *Pinus* and *Quercus* pollen both hit the highest levels from 12,100 to 11,850 BP, with low levels from 8,300 to 5,800 BP. Juniper pollen starts at a high level at 12,100 and generally decreases thereafter. *Sarcobatus* or greasewood pollen occurs only among the three juniper macrofossil samples from 12,100 to 8,300 BP while *Artemisia*, or sagebrush, pollen also hits high levels among the early juniper samples. Low *Artemisia* counts are recorded in more recent samples. Arid-type low-spine windblown Compositae generally increase through time while high-spine Compositae is low among early samples and high among recent samples. *Pinus*, *Juniperus*, *Quercus*, and *Sarcobatus* are not presently recorded in the study area.

Discussion

The rarity of conifer woodlands in the Granite and Ord mountains complicates an evaluation of the magnitude of vegetation change to be inferred from the middens (Wells and Berger 1967:1641). The only apparent modern remnant of juniper woodlands is a relict *J. californica* tree (ca 40 cm in diameter) at 1219 m in the Granite Mountains. This tree is associated with *Yucca brevifolia* and *Larrea divaricata*.

However, Vasek (1966:363) has studied the distributions of *J. occidentalis* ssp. *australis*, *J. osteosperma* and *J. californica* in the adjacent San Bernardino Mountains. He has suggested an altitudinal range of 2042 to 2743 m plus for *J. occidentalis* and *Pinus Jeffreyi*, a range of 1372 to 2074 m for *J. osteosperma* and *P. monophylla*, and a range down to ca 914 meters among the desert margin scrub for *J. californica* and *L. divaricata*. The Merriam Effect, or inverse relation between mountain mass and elevation of vegetation, has been largely discounted by Wells and Berger (1967:1644-45), who view local orographic factors and relative latitude as determinant climatic-vegetational factors in the Mohave Desert. However, T. R. Van Devender and G. Spaulding (pers. comm. 1975) feel that some degree of Merriam Effect was in effect in

Table 3. Radiocarbon dates from the Lucerne Valley region (tree-ring calibration of the dates has not been applied).

Midden	Sample number	Elevation	Years before present	Material	Laboratory number
Sunset Cove	1	972 m	5,880 ±250	Misc. twigs	UCR-134
Lucerne Peak	1	1097 m	5,800 ±250	*L. divaricata* ?	UCR-135
Ord Mountain	1	1219 m	11,850 ±550	*J. osteosperma*	UCR-149
Lucerne Valley	2	1006 m	3,650 ±210	Misc. twigs	UCR-235
"	3	"	3,750 ±205	"	UCR-236
"	4	"	3,690 ±210	"	UCR-237
"	6	"	4,300 ±240	"	UCR-239
"	10	"	11,100 ±420	*J. osteosperma*	UCR-187
"	11	"	8,300 ±780	"	UCR-186
"	12	"	7,820 ±570	Misc. twigs	UCR-185
"	13	"	12,100 ±400	*J. osteosperma*	UCR-181
"	14	"	7,800 ±350	"	UCR-249
"	15	"	1,610 ±150	Misc. twigs	UCR-133

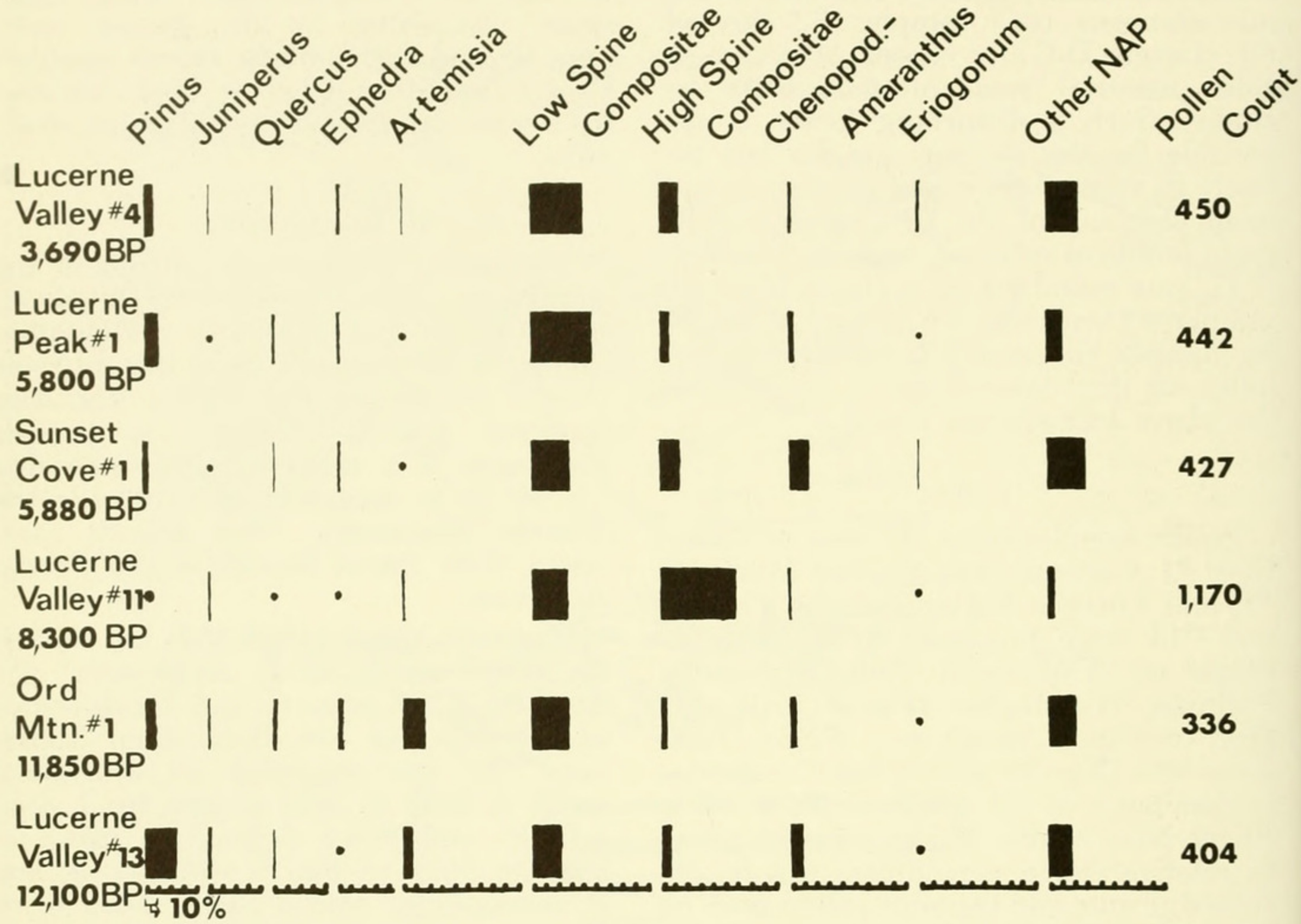

Fig. 4. Pollen profiles from four middens in the Lucerne Valley region, California.

the study area and that the juniper middens record a slightly greater vegetational depression than is here proposed.

Comparison of Wells and Berger's (1967) bulk-dated *J. osteosperma* midden at Negro Butte to Vasek's local conifer woodland elevation correlations suggests a 300 m depression of *J. osteosperma* occurred at 9,140 BP (Berger, Ferguson, and Libby 1965:367). The Lucerne Valley midden juniper samples #10, #11, #13, and #14 similarly suggest that a 365 m depression of *J. osteosperma* and almost 7 km lateral range displacement occurred from ca 12,100 to 7,800 BP in the study area. The Ord Mountain midden conifer date of 11,850 ±550 BP, when compared to Vasek's study, suggests that a smaller depression (150 m) of *P. monophylla-J. osteosperma* woodlands occurred at this time along with a lateral range displacement of ca 32 km (Wells and Berger 1967:1641).

The occurrence of pinyon in the Ord Mountains at 1219 m at ca 11,850 BP is additional confirmation of pinyon woodlands' presence in the area prior to the end of the Wisconsin glaciation. Such an occurrence is supported by the Searles Lake pollen data of Roosma (1958:716) and has been proposed by Martin (1964:74), Martin and Mehringer (1965:439), and Mehringer (1967:180), based on pollen records. The only other macrofossil records of pinyon in a presently coniferless area of the California Mohave Desert are those documented by Wells and Berger (1967:1642, 1644) at 19,500 ±380 BP and 13,900 ±200 BP for the Turtle Mountains (Fig. 1). However, pinyon has recently been collected in a midden dated at 8,910 ±380 BP (A-1580 on *Juniperus* seeds and twigs) at a record low elevation of 555 m in the Whipple Mountains of southeastern California (T. R. Van Devender pers. comm. 1975). This and the above records thus document a widespread late Pleistocene pinyon-juniper community in the Mohave Desert. In addition, the local occurrence of pinyon far below the 1918 m summit of Ord Mountain peak also suggests that a small stand of montane woodland may have been present near the peak similar to Mehringer and Ferguson's documentation of late Pleistocene montane woodlands at Clark Mountain (Fig. 1).

The Sunset Cove midden of 5,880 BP and the Lucerne Peak midden sample of 5,800 BP, containing creosote bush desert flora (Table 1), indicate coniferous woodlands in the area had retreated upward past 1097 m by ca 5,800 BP; whether juniper woodlands survived at higher elevations in the study area during or after this period is uncertain. However, *J. californica* may have persisted at or above ca 1219 m until recent times if it is assumed the relict juniper tree earlier mentioned is the last survivor of an earlier juniper presence. This species could also be a recent invader unrelated to middle Holocene conifer fluctuations. Whatever the case, it is suggested that upward recession of *J. osteosperma* continued after 7,800 and 5,800 BP, perhaps until recent times. This view is supported by LaMarche's (1973:632,655) documentation of upward bristlecone pine (*P. longaeva*) treeline advances during the Altithermal in the White Mountains north of Searles Lake. Lastly, the Sunset Cove and Lucerne Peak midden data partially support Antevs's (1952:26) concept of a hot, dry Altithermal from ca 7,500 to 4,000 BP for elevations below 1097 m in the study area.

Lucerne Valley samples #2 through #6 and #15 document essentially a creosote bush desert flora, suggesting warm, dry climatic conditions, from ca 4,300 to 1,610 BP at and below 1006 m in the study area (Table 1). However, an exact replica of present-day plant species is not presented by these samples, and slightly less arid conditions may be suggested for the midden area at this time by the presence of more mesic plant species such as *Oryzopsis hymenoides*. LaMarche's (1973:632) data actually argues for cooler and wetter conditions for ca 3,500 to 2,500 BP in the northern Mohave Desert.

The pollen data generally document a shift from relatively high arboreal pollen counts during 12,100 to 11,850 BP to low counts during 8,300 to 5,800 BP. After 5,800 BP arboreal pollen increases. Great Basin sagebrush, or *Artemisia*, also shows high levels from 12,100 to 8,300 BP. In general, the pollen record parallels the macrofossil record in recording a shift from a xerophilous arboreal vegetation community to a classic Mohave Desert vegetation community. The relative resurgence of *Pinus* and *Quercus* after 5,800 BP may, however, reflect the onset of a less arid climate in the study area. Since all the arboreal pollen discussed is the wind-dispersed type, it is uncertain whether the pollen record after 5,800 BP documents a local or regional presence of pinyon, juniper and oak. The dominance of arid-type Compositae in all samples suggests that a xerophilous vegetation community was present for most of the last 12,000 years in the study area.

Summary and Conclusions

Four woodrat middens were excavated and radiocarbon dated in an effort to detect late Pleistocene records of juniper or pinyon-juniper woodlands in the western Mohave Desert of California. A radiocarbon date of 11,850 ±550 BP was obtained for pinyon and juniper at 1219 m. Dates of 12,100 ±400 BP, 11,100 ±420 BP, 8,300 ±780 BP and 7,800 ±350 BP were obtained for juniper alone at 1006 m; a 7,820 ±570 BP date without juniper is associated with this conifer sequence. Dates of 5,880 ±250 BP, 5,800 ±250 BP, 4,300 ±240 BP, 3,690 ±210 BP, 3,650 ±210 BP, 3,750 ±240 BP and 1,610 ±150 BP were obtained on miscellaneous twigs at elevations of 972, 1097 and 1006 m (Fig. 3, Table 3). A 365 m depression for *J. osteosperma* woodland between 12,100 and 7,800 BP is suggested for the study area.

It is concluded that extensive stands of *P. monophylla-J. osteosperma* woodlands existed in the western California Mohave Desert, in areas of presently intense rainshadows, as recently as ca 11,850 BP. Xerophilous *J. osteosperma* woodlands apparently persisted as late as 7,800 BP; *J. californica* woodlands may have persisted at higher elevations until recent times. Comparison of the Ord Mountain paleobotanical record with that for pinyon-juniper woodlands in the Turtle Mountains (Wells and Berger 1967: 1644) and for juniper woodlands in the Rampart Cave, Arizona, area (Phillips and Van Devender 1974:118; unpublished dates) suggests that both the eastern and western regions of the Mohave Desert may have shared similar climatic aspects from ca 19,500 to 8,500-9,000 BP.

The lacustral data of Smith (1968), Ore and Warren (1971), and Hooke (1972) suggest that high winter precipitation is the probable cause of late Pleistocene lake stands at Searles Lake, Lake Mohave, and Lake Manly (Gale 1914: 256, 320; Mehringer ms.:4) (Fig. 1). This higher winter precipitation probably persisted as late as ca 10,500 BP for the upper Owens River drainage system and to ca 7,500 BP for the Mohave River source area in the San Bernardino Mountains (Smith 1968:298-299; Ore and Warren 1971:2561-62; Hooke 1972:2073; Antevs 1952:24; Thompson 1929:565). Thus the presence of pinyon-juniper and juniper in Lucerne Valley from ca 12,100 to 7,800 BP, at the same time as high winter precipitation was probably occurring to the north and to the southwest of the study area, suggests the study area was subject to a cooler, moister climate than that now in existence. A shift toward a warm, moist regime may have begun toward the end of this period. However, the presence of essentially creosote bush desert flora below 1097 m from ca 5,800 to 1,610 (and present) in Lucerne Valley suggests that a strong shift in precipitation, climate, and vegetation occurred between 7,800 and 5,800 BP, and may have continued through to recent times. Table 4 summarizes these inferences.

Lastly, the ethnographic studies of Steward (1933:241; 1938:20, 80), Strong (1929:38), Barrows (1900:61-63), and Bean and Saubel (1972:19-21) have documented the importance of pine seed and juniper berry gathering among late prehistoric and historic aboriginal populations of the Great Basin and Southern California. The radiocarbon documentation of such resources for presently coniferless areas of the Mohave Desert suggests the possibility that native Americans may have utilized subsistence and resource exploitation strategies focusing upon juniper berry and pinyon seed gathering and processing long before the onset of the southern California Milling Stone Horizon at ca 7,000 BP (Wallace 1955:219-221; Heizer 1964: 123). An indication of this potential trend is Jennings' (1957:209, 212; 1964:154, 156) finding of milling stones used in pickleweed processing at a ca 9,000 to 11,000 BP level of Danger Cave, while Mehringer (ms.:19) has suggested late Pleistocene pinyon range contractions "could have had a significant effect upon prehistoric man." In addition, Harper and Alder (1970:220-221) have identified culturally utilized juniper at Hogup Cave at ca 8,800-3,200 BP and pinyon at ca 3,200—2,600 BP (Aikens 1970:28-29). Specific radiocarbon documentation of such plant resources for the Great Basin and western United States has been provided by the data of Wells and Jorgenson (1964), Wells and Berger (1967), Wells (1965, 1966, 1969), Mehringer and Ferguson (1969), Van Devender and King (1971), Leskinen (1970), Van Devender (1973), and Phillips and Van Devender (1974).

Table 4. Suggested vegetational and climatic change in Lucerne Valley region over the last 12,000 years.

Time-YBP	Vegetation	Climate*
12,100		
to	Pinyon-juniper	Cooler, moister
11,850		
to	Juniper, *J. osteosperma*	Cooler, moister
7,800		
	?	?
5,800		
to	Creosote bush desert flora, possibly *J. californica*	Warm, dry
1,610		
	?	?
Present	Creosote bush desert flora	Hot, arid

* Inferred past climates are compared to the present hot and arid climate of the study area. Sampling error may have excluded other climatic events.

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