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Fruit, Fiber, Bark, and Resin: Social Organization of a Maya Urban Center

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Summary. Quantitative analysis of 3579 trees recorded in the Classic Maya city of Cobá, Quintana Roo, Mexico, indicates a strong relation between the location and quantity of certain trees producing fruit, fiber, bark, and resin, high-status vaulted architecture, and their distance from the center of the site out toward the fringes. The relationships suggest agreement between the residence pattern of Cobá and Diego de Landa's 16th-century class-oriented description of Maya towns during pre-conquest times.

In notable contrast to the chroniclers who described the conquest of Highland Mexico, those who recorded the conquest of Yucatan only occasionally mentioned an inhabited city or town in anything but ordinary terms, especially when referring to its size or beauty. They did, however, leave us with numerous and fairly accurate descriptions of the 16th-century Maya people inhabiting northern Yucatan and the resplendent, virtually uninhabited, ruined cities encountered over the length and breadth of the peninsula. The sites of some of these ancient ruins were at times inhabited by the Spaniards who periodically quarried them and converted them into European-style cities. Although comparatively few Mayan ruins were so modified, many were mentioned or described by early writers who took the time and effort to record what they saw and heard for the ultimate benefit of peoples yet to be born. One of these writers was the well-known Bishop Diego de Landa, who put to paper much of what he learned about Maya culture. Among the gems that have come down to us is Landa's description of Maya social organization and a description of Maya towns before the conquest, including the distribution of some of their flora. Describing the settlement pattern of 16th-century Yucatec Maya towns, Landa stated:

> Their dwelling place was as follows:—in the middle of the town were their temples with beautiful plazas, and all around the temples stood the houses of the lords and the priests, and then [those of] the most important people. Thus came the houses of the richest and of those who were held in highest estimation nearest to these, and at the outskirts of the town were the houses of the lower class (*1*, p. 62).

The settlement pattern was organized in what can only be inferred to be a concentric residence pattern. Furthermore, Landa also stated that, if there were only a few wells, they were located near the houses of the lords and that *balche* trees, cotton, pepper, and maize were planted on the improved lands of these lords (*1*). These cultivated lands are assumed to have been located around the residences of the lords near the core area of the city.

The demonstration of the similarities between Yucatecan towns as described by Landa and the settlement configuration at Cobá, the Lowland Maya Classic city, has implications for an interpretation of the social stratification present during the Classic Period. Our research follows the work of Puleston (*2*) whose analysis of the presence of the *ramón* tree at Tikal, Guatemala, was an initial attempt to analyze the kitchen gardens of the ancient Maya urban populations. The research on the distribution of fruit, fiber, bark, and resin trees in the suburban zones of ancient Cobá, however, is an attempt to document the disparate distribution of economically important resources among the elite and commoner populations in the city. The existence of social stratification at Classic Maya settlements is one of the seminal problems with respect to the organization of the Classic Maya civilization.

Cobá, located 45 kilometers inland from Tulum, Quintana Roo, Mexico, is a Late Classic Maya site that has been extensively surveyed and mapped in order to determine its areal extent (*3–5*) and the relationship between the upper and lower classes resident at that center. The geographical location of Cobá suggests that it was probably the nexus for the exchange of products from a variety of ecological zones. Its flora contrasts sharply with that of the northwestern sector of the Yucatan peninsula and resembles that of the Petén tropical rain forest to the south. Cobá is endowed with great environmental potential; a series of freshwater lakes surrounded by moist, fertile, black calcareous soil characterize the zone. This represents a concatenation of strategic resources and provides an excellent area for human exploitation.

Architectural Survey and Analysis

As a result of the architectural survey, Folan (*4, 5*) argued that the settlement pattern at Cobá closely matched the pattern of 16th-century Yucatec Maya towns described by Landa (*1*). Analysis of the settlement pattern data collected during the Cobá Archaeological Mapping Project (1974 to 1976) allowed for the distinction to be drawn between two fundamental architectural types (*4*). These are (i) residential platforms supporting only high-status vaulted structures or vaulted and unvaulted struc-

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tures, representing the household compounds of the elite families (6), and (ii) platforms supporting only rectangular unvaulted and/or apsidal structures, representing the household compounds of the lower class or ancillary units associated with elite household compounds. Data were also collected on the distribution of trees valued for their fruit, fiber, bark, and resin by the ancient Maya, as well as the distribution of soil types in the northern area bounded by *sacbe* 3 and *sacbe* 27 (Fig. 1) (7).

The two test areas selected for analysis were the northern zone and a southern area bounded by *sacbe* 8 and *sacbe* 15 (Fig. 1). These areas were most variable with respect to the distribution of vaulted and unvaulted structures within the zones. To facilitate the analysis, the northern test area was divided into seven discrete geographical units (A through G). Their geographical position and the distribution of architectural features in each unit is shown in Table 1. The residential platforms supporting high-status vaulted architecture as well as those without vaulted architecture were tallied. Since the areas of the seven units were unequal, adjusted frequencies (the number of platforms per standard square meter based on the area of unit A) were calculated (Table 1).

Domestic compounds with vaulted buildings clustered in the core area and the area adjacent to it. In the northern zone, the frequency of platforms with vaulted architecture was highest (11 per standard area) adjacent to the civic-ceremonial core, located from 250 to 750 m north of Lake Macanxoc. The frequency of vaulted architecture reflects the occupation by elite families and the sacred and secular uses of these quarters for the coordinated control of the urban population. The frequency of platforms with vaulted architecture decreased between 750 and 1750 m north of Lake Macanxoc (approximately eight platforms per standard area). This represents a reduction in the use of this zone by the elite, however slight. Beyond 1750 m, the number of residential platforms with vaulted architecture decreased notably; in other words, this peripheral zone of the city was one of low-status residences.

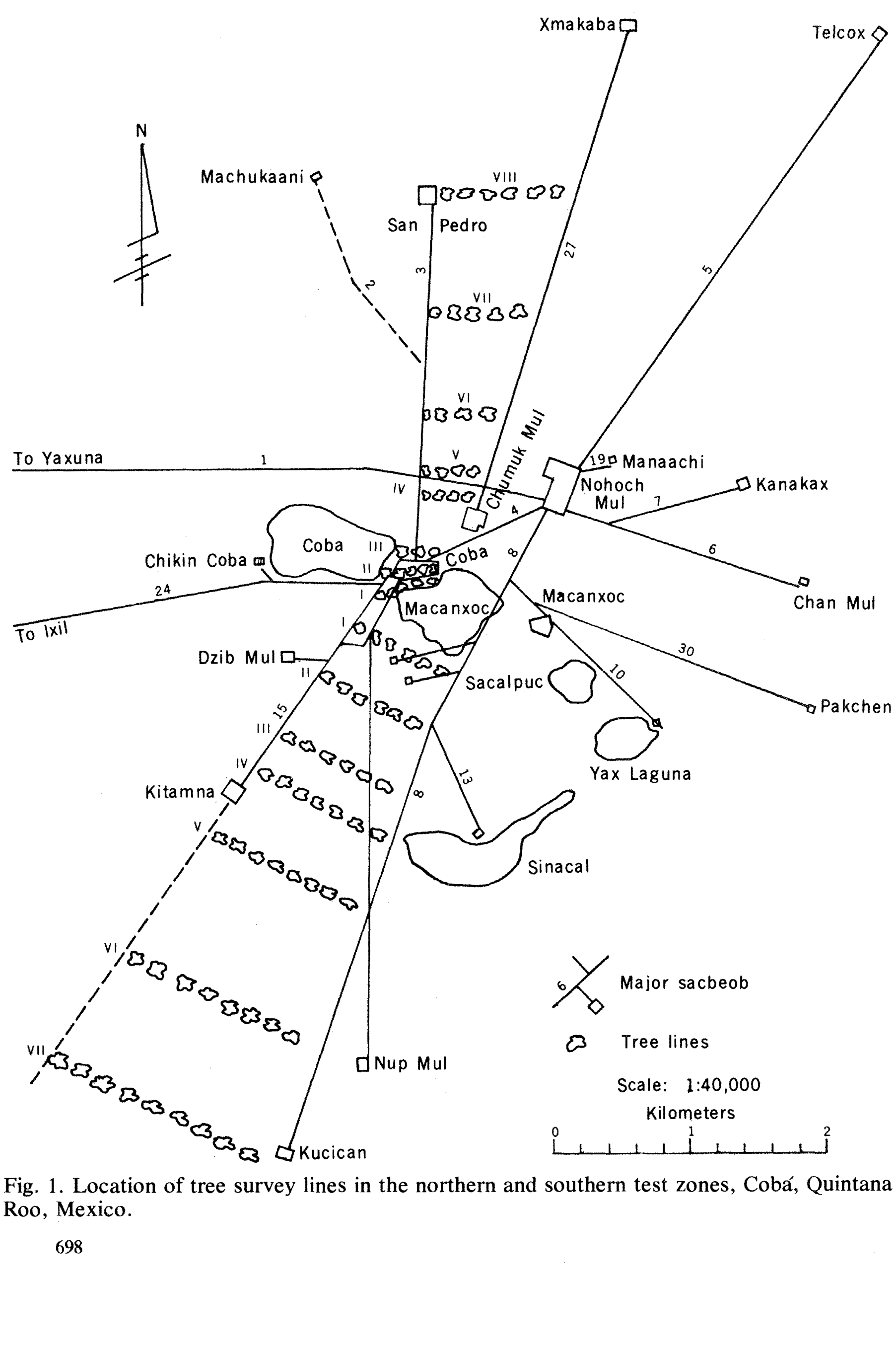

Fig. 1. Location of tree survey lines in the northern and southern test zones, Cobá, Quintana Roo, Mexico.

The residential architecture typical of the dwellings of the lower class—nonvaulted rectangular and apsidal rooms on platforms—was concentrated in the zone beyond the core and in the relatively lightly inhabited periphery of the urban center. The 26 platforms with only rectangular and/or apsidal superstructures found adjacent to the civic-ceremonial core represent either ancillary platforms associated with the households of the elite or the residential units of retainers. The highest frequency of platforms with only rectangular and/or apsidal superstructures occurred in the unit 750 to 1250 m north of Lake Macanxoc. Their incidence dropped only slightly in the two geographical units, from 1250 to 1750 m and from 1750 to 2250 m, respectively. These three units represent an inner suburban zone characterized by mixed upper- and lower-class housing. In the units from 2250 to 4100 m north of the lake, the relative frequency of lower-class housing was higher than that of elite occupation. However, this area shows an overall diminished occupation in the peripheral zone of the city. Altogether, three zones were defined: (i) a high-status elite zone adjacent to the civic-ceremonial core, (ii) an inner suburban zone of mixed elite-commoner buildings north of *sacbe* 1 and south of San Pedro, and (iii) an outer suburban zone of predominantly commoner households, north of San Pedro to the limits of the surveyed area at Xmakaba.

The same pattern was obtained for the southern test area, where 1163 structures were recorded. For the purpose of analysis, this zone is likewise divided into eight geographical units, H through O, the last the farthest from Lake Macanxoc to the south (Table 2). These units are also approximately 500 m wide, measured from north to south. Standard frequencies for platforms with high-status vaulted architecture were calculated, and the area of each group was standardized by dividing the area of unit H by that of each unit.

Vaulted architecture in the southern test area clustered near Lake Macanxoc, or the civic-ceremonial core, as it did in the northern test zone. The survey results demonstrate a more extensive elite occupation adjacent to the core in the residential zone in the southern than in the northern test area. The frequency of vaulted architecture in unit J in the south corresponds to that in units B and C in the north and demonstrates a decrease in elite occupation beyond the city's administrative and religious quarters. Occupation in units K through O corresponded to that of units D through G in the north, marking the outer suburban zone. In these units of both the southern and northern test areas, elite households were rare, in accordance with the model described by Landa for the 16th-century Maya towns.

Table 1. Distribution of platforms supporting architecture in the northern zone. The category "with vaulted" includes platforms with only vaulted structures or with vaulted structures and additional rectangular or apsidal structures. The category "without vaulted" comprises platforms with only rectangular and/or apsidal structures.

Geographical unit	Distance north of Lake Macanxoc (m)	Area (m^2)	With vaulted (frequency)		Without vaulted (frequency)	
			Raw	Adjusted	Raw	Adjusted
A	250 to 750	193,000	11	11	26	26
B	750 to 1250	257,000	11	8	45	34
C	1250 to 1750	315,250	13	8	39	30
D	1750 to 2250	380,500	9	5	54	27
E	2250 to 2800	493,900	8	3	48	19
F	2800 to 3350	580,250	4	1	22	7
G	3350 to 4100	668,690	2	1	38	11

Table 2. Distribution of platforms supporting vaulted architecture in the southern zone.

Geographical unit	Distance south of Lake Macanxoc (m)	Area (m^2)	Platforms supporting vaulted architecture	
			Raw frequency	Adjusted frequency
H	0 to 500	450,000	50	50
I	500 to 1000	500,000	36	32
J	1000 to 1500	580,000	12	9
K	1500 to 2000	650,000	3	2
L	2000 to 2500	595,000	3	2
M	2500 to 3000	505,000	1	1
N	3000 to 3500	380,000	1	1
O	3500 to 4180	333,200	1	1

Tree Distribution and Analysis

To be doubly certain of this fit, we decided to further test Landa's description of Maya towns by discovering if, at this late date, any of the descendants of the *balche* trees Landa said were located on the improved lands of the lords were still to be found in Cobá.

We thought that they would be located in association with the residences and kitchen gardens of the elite and assumed that any trees that grew in and around these gardens before and during Hispanic times would, at least in part, reflect a 16th-century statement that large cities and towns in Yucatan were full of greenery with every town giving the appearance of a fruit orchard (*8*). We also assumed that those "very good trees" described by Landa as being planted by the Maya would have formed at least part of these orchards, but we held little hope of still being able to find descendants of the cotton, pepper, and maize mentioned by Landa as growing on the improved lands of the lords. On the basis of our assumptions, Puleston's findings at Tikal (*9*), and on-the-spot observations at Cobá, we hypothesized that, in addition to *balche* trees, other trees cultivated by the Maya in northern Yucatan would include *ramón* and several other fruit trees now growing in the Cobá area.

We further hypothesized that more of these trees would be found near the center of ancient Cobá around the dwellings of the lords and other landlords of high status, and that fewer and different species of trees would be associated with the dwellings of inhabitants of lower status living near the fringes of the urban area. We also assumed that certain indigenous trees now found within ancient Maya cities are descendants of those planted by the ancient Maya and that the present distribution and relative numbers of trees correspond generally to their original planned location and quantities. The distribution of historic lemon trees at Cobá lends credence to this assumption. These trees, planted in modern times close to the lake shores by *chicleros* (chicle gum collectors) and *milperos* (corn farmers), have retained their position over time. In other words, we set out to discover whether or not there exists a relation among certain types and numbers of trees, residential patterns, and distance from the central administrative district, thereby elucidating the social organization of the ancient city of Cobá.

Fifteen trees that produce either fruit, fiber, usable bark, or resin have been listed (*10*). Fruit producing trees are *chiceh* (*Chrysophyllum mexicana*); *chirichojom*; *cocoyol* (*Acrocomia mexicana*); *guayas* (*Cardiospermum corindum*); *kilim* (*Spondias purpurea*); *nance* (*Byrosonima crassifolia*); *ojo de venado*; *pich* (*Enterolobium cyclocarpum*); *ramón* (*Brosimum alicastrum*); *sacpa*; *zapote* (*Achras zapota*), and *subul* (*Sideroxylon gaumeri*). A fiber-producing tree is *piim* (*Ceiba aesculifolia*); a bark-producing tree, *balche* (*Lonchocarpus longistylus*); and resin-producing trees are *pom* (*Protium copal*) and *zapote* (*Achras zapota*). This list was based on the folk categories of May and Caamal (*11*), and although most of these trees have been further identified (*12, 13*), the identity of one or two of the fruit trees may be a bit doubtful owing to local differences in nomenclature.

The survey was carried out over an area approximately 9 kilometers from north to south, bisected near its center by Lake Macanxoc and the Cobá group B (Fig. 1). Because the northern and southern test zones were of unequal area, an additional tree line was run in the south. Two lines were run in the civic-ceremonial zone north of Lake Macanxoc, six lines were run between the *sacbeob* to the north and seven lines were run between the *sacbeob* leading to Kitamna and Kucican to the south, for a total of 15 lines. The designated trees on each line were identified and counted (Tables 3 and 4).

A total of 3579 trees were recorded. We matched the tree survey lines to the geographical units already described, thereby delimiting the civic-ceremonial core zone and adjacent high-status residential zone, an inner suburban zone, and an outer suburban zone. The linear measurement of each tree survey line was used to derive the number of tree species per 1000 m per geographical unit. A χ^2 test was applied to these adjusted frequencies to test for nonrandom distribution of economically and ceremonially important tree species. Fruit, fiber, bark, and resin-producing trees were nonrandomly distributed ($\chi^2 = 56.6$, d.f. $= 9, P < .001$). Of all the trees listed above, 82 percent were located between 750 m north and 1000 m south of Lake Macanxoc. On the basis of the distribution of vaulted high-status architecture, we assumed that this area housed the priests, lords, and the most important people of Cobá. Most of the trees surveyed had previously been classified as cultivated or semicultivated, with *ramón*, *guayas*, and *balche* leading the list (*13*). The occurrence and frequency of these ceremonially or economically important trees diminished in the lightly inhabited limits of the survey area, indicating a direct relation between status and certain species and quantities of trees. The lords and priests of Cobá, along with the most important people, residing in the civic-ceremonial core controlled more fruit- (79 percent), bark- (96 percent), and resin-producing (72 percent) trees than other peoples at Cobá. (They controlled 52 percent of the fiber-producing trees.) Thus, they held almost absolute control over the trees used to produce ceremonial drinks such as *balche* and over the incense-producing *pom* tree.

The survey also demonstrated that the people who resided in the inner suburban zone possessed almost all of the tree types that grew in the core area of the city inhabited by the lords and priests. They had fewer trees, however, and those included few of the ceremonially oriented trees such as *balche* (only 4 percent) and *pom* (9 percent). Families living on the outskirts of Cobá had few fruit trees (only 11 percent) and an insignificant number of fiber or bark trees. Of the resin-producing trees, they had only *zapote* (18 percent).

This distribution would indicate that persons with higher status, besides controlling most of the trees in general, also controlled those associated with ceremony. That they also controlled the fiber-producing *piim* tree may mean that they also controlled the important cloth industry for which Yucatan was known during the 16th and 17th centuries.

The ancient Maya modified virtually their entire urban area at Cobá by planting trees and by a series of earth-moving activities. These land modifications undertaken by the Classic Period residents included (i) intensive quarrying for *sascab* (soft limestone), (ii) hydraulic systems around the lake zones that probably included irrigation and piscicultural activities, (iii) road building, (iv) construction of walkways, boundary markers, houselot walls, and soil retention walls, (v) kitchen gardens, (vi) construction of large platforms, and (vii) raised fields.

A soil survey was conducted north of Lake Macanxoc to San Pedro in the area bounded by *sacbe* 3 and *sacbe* 27. A systematic sample was taken at 60-m intervals where possible along the east-west survey lines. The folk categories, black soil (*ek lu'um*) or red soil (*chac lu'um*), were recorded for each sample. Black soil is locally preferred to the less fertile red soil. We wanted to ascertain whether the clustering of ceremonially and economically important trees near the center of the city was due to the presence of moist, fertile black soil in that area. The χ^2 value (52.83) was larger than that expected by chance (18.456), and the null hypothesis of no difference between the distribution of black and red soil was rejected at the .001 level. The black soil, comprising 80 percent of all soil samples taken in the northern zone, is predominant. Furthermore, that the zone inhabited in the north by lords and priests has only black soil presents the possibility that the presence of black soil may account for the association between the important trees and elite architecture. But virtually none of the ceremonially important trees such as *balche* and *pom* are found in the intermediate lower-class residential zone and the peripheries of the urban center, where black soil is also predominant. The relation between the trees and elite residential compounds suggests access to and control of these resources by nobles and those most esteemed by them (*1*).

Table 3. Distribution of trees in the northern zone.

Tree	Tree survey lines											
	I	II	Sub-total	III	IV	Sub-total	V	VI	Sub-total	VII	VIII	Sub-total
Balche	0	60	60	50	75	125	15	1	16	0	0	0
Guayas	60	40	100	5	60	65	5	17	22	10	10	20
Pich	3	16	19	37	15	52	10	50	60	10	0	10
Ramón	190	155	345	10	75	85	10	10	20	10	10	20
Ojo de venado	0	13	13	0	0	0	0	0	0	0	0	0
Chiri-chojom	0	30	30	2	45	47	15	0	15	0	0	0
Kilim	0	0	0	19	15	34	15	2	17	0	0	0
Sacpa	0	10	10	0	0	0	0	0	0	5	10	15
Piim	0	0	0	3	5	8	10	5	15	2	5	7
Cocoyol	0	4	4	20	15	35	5	2	7	0	0	0
Pom	0	23	23	4	5	9	0	0	0	0	0	0
Zapote	15	7	22	0	16	16	5	0	5	5	15	20
Subul	0	2	2	4	2	6	2	2	4	5	5	10
Chiceh	0	0	0	45	10	55	5	5	10	5	10	15
Nance	0	0	0	1	25	26	0	0	0	0	0	0
Limón	0	65	65	32	0	32	0	0	0	0	0	0

Table 4. Distribution of trees in the southern zone.

Tree	Tree survey lines									
	I	II	III	Sub-total	IV	Sub-total	V	VI	VII	Sub-total
Balche	110	45	0	155	0	0	0	0	0	0
Guayas	230	50	60	340	45	45	20	15	15	50
Pich	30	15	10	55	2	2	0	5	0	5
Ramón	560	110	50	720	50	50	15	25	25	65
Ojo de venado	0	0	0	0	0	0	0	0	0	0
Chiri-chojom	25	10	0	35	0	0	0	0	0	0
Kilim	10	0	0	10	0	0	0	0	0	0
Sacpa	0	0	0	0	5	5	3	7	3	13
Piim	10	20	10	40	10	10	5	8	0	13
Cocoyol	10	0	0	10	0	0	0	0	0	0
Pom	15	35	5	55	4	4	5	0	0	5
Zapote	60	35	25	120	20	20	15	15	10	40
Subul	15	15	15	45	10	10	10	4	5	19
Chiceh	0	5	0	5	8	8	4	10	5	19
Nance	0	0	0	0	0	0	0	0	0	0
Limón	10	0	0	10	0	0	0	0	0	0

Conclusions

Recent quantitative analysis of 3579 trees recorded in the urban center of Cobá indicates that certain trees are most often located toward the center of the site. Certain architectural features followed the same pattern. The relation suggests agreement between the residential pattern of Cobá and Diego de Landa's 16th-century class-oriented description of Maya towns before the conquest.

This survey conducted at Cobá established the settlement pattern of continuous architectural remains radiating out in all directions surrounding the administrative and religious core. Spatial analysis of the distribution of vaulted and unvaulted architecture supported Folan's (*4*) hypothesis that the city was generally organized in concentric rings with the elite residing near the center of the city and the lower classes living in the surrounding zones. The existence of garden cities during the post-Hispanic period (*1*) seems to be a reflection of a pattern already established by the Late Classic. Furthermore, the distribution of economically and ceremonially important trees in the zones controlled by the elite at Cobá establishes the control over these resources by the lords and priests of Cobá during the Late Classic.

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Development of Vegetation and Climate in the Southwestern United States

Thomas R. Van Devender and W. Geoffrey Spaulding

In the past 15 years, analysis of packrat (*Neotoma* spp.) middens has provided several hundred radiocarbon-dated fossil plant assemblages from now arid and semiarid regions in the southwestern United States (Fig. 1). Packrats thoroughly sampled the vegetation on rocky slopes within 100 meters of the dry, protected shelters where middens are built and preserved. Many of the hundreds of plants in the fossil middens have been identified to species, allowing their distributions and autecologies to be used in paleoclimatic reconstructions. Fossil middens allow detailed paleoecological reconstructions of past communities in areas with few other sources of perishable organic materials. On the basis of the packrat midden record, we describe here the vegetational changes and inferred climates during the past 22,000 years in the warm deserts of the southwestern United States.

Vegetation Chronology

Late Wisconsinan (22,000 to 11,000 years B.P.). Packrat middens dating from the late Wisconsinan glacial maximum, 22,000 to 17,000 years B.P. (radiocarbon years before present), to about 11,000 years B.P. document the occurrence of pinyon-juniper woodlands at middle elevations of 1525 to 550 m in areas now occupied by desertscrub communities. Time series of midden assemblages from single sites or several sites in a small area show few important changes in composition, suggesting that the pinyon-juniper woodlands were relatively stable throughout this 11,000-year period.

The species of pinyon in the midden samples are Colorado pinyon (*Pinus edulis* Engelm.) and Mexican pinyon (*P. cembroides* Zucc. var. *remota* Little) in the Chihuahuan Desert and border pinyon (*P. cembroides* var. *bicolor* Little) and single-needle pinyon (*P. monophylla* Torr. & Frém.) in the Sonoran and Mohave deserts (Fig. 2). Middens recording this pinyon-juniper woodland extend from Ord Mountain, San Bernardino County (*1*), and Robber's Roost, Kern County (*2*), California, on the western side of the Mohave Desert (116°W), to the Guadalupe Mountains, Culberson County (*3*), and Maravillas Canyon, Brewster County (*4*), Texas (103°W). In the present Chihuahuan Desert, pinyon-juniper midden records extend from the Big Bend to the Guadalupe Mountains in Texas, and to Bishop's Cap, Doña Ana County, New Mexico (29° to 32°N) (*5*). In Arizona, pinyon-juniper middens have been found from Montezuma's Head, Ajo Mountains, Pima County, to Desert Almond Canyon and Peach Springs Wash, Grand Canyon, Mohave County (32° to 36°N) (*6*). The midden sample from Kern County at 35°35′N is the northernmost late Wisconsinan pinyon-juniper midden in California (*1, 2, 7,*

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