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REPORT

Subsistence Procurement and Production after the Demise of Teotihuacan

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Abstract

Macro- and microbotanical remains recovered from post-Teotihuacan occupations in quarry tunnels east of the Sun Pyramid, Teotihuacan, contribute to understanding lifeways in the surrounding valley after the partial abandonment of the city. Plant remains associated with domestic and ritual contexts from the excavations directed by Linda Manzanilla (1993–1996) are relevant to subsistence questions, aspects of surrounding vegetation, landscape exploitation, and the possibility of less-intensive agricultural production during the Epiclassic and Early Postclassic occupations.

Resumen

Los restos macro y microbotánicos recuperados de ocupaciones post-teotihuacanas en túneles de extracción de *tezontle* al este de la Pirámide del Sol, Teotihuacán, contribuyen al conocimiento de formas de vida en el valle circundante después del abandono parcial de la ciudad, incluyendo aspectos de subsistencia, explotación del paisaje y prácticas agrícolas menos intensivas. Restos de plantas en contextos domésticos y rituales en las excavaciones dirigidas por Linda Manzanilla (1993-1996) son relevantes para temas de alimentación, así como la vegetación circundante en el momento de su ocupación, principalmente durante los períodos Epiclásico y Posclásico temprano.

Keywords: Epiclassic–Postclassic period; paleoethnobotany; Teotihuacan Valley

Palabras clave: Periodo Epiclásico–Posclásico; paleoetnobotánica; Valle de Teotihuacan

Significant changes in sociopolitical and economic organization following the collapse of the Teotihuacan state, beginning between the sixth and seventh centuries AD, are evident in archaeological materials and settlement patterns. The potential magnitude of this event and the subsequent ramifications within the valley are of considerable interest, although research tends to focus on the urban center or on basin-wide processes. Analyses of plant remains recovered from post-Teotihuacan occupations contribute to understanding lifeways in the surrounding valley after the partial abandonment of the city, particularly aspects of subsistence and landscape exploitation and the possibility of less-intensive agricultural production. Several decades of research on subsistence and the landscape highlight challenges likely faced by inhabitants of the region and how they adapted to shifting circumstances. The Teotihuacan Valley serves as a case study for long-term transformation, although this article focuses on an intermediate slice of time.

Table 1. Prehispanic Occupation and Associated Ceramic Phases in the Teotihuacan Valley.

Period	Approximate Calendar Dates	Ceramic Phase
	AD 1150–1500	Aztec I–III
Postclassic	AD 900–1150	Mazapa
Epiclassic	AD 600–900	Coyotlatelco
	AD 550–600	Metepec
	AD 350–550	Xolalpan
	AD 275–350	Late Tlamimilolpa
	AD 200–275	Early Tlamimilolpa
Classic	AD 150–200	Miccaotli
Late/Terminal	AD 1–150	Tzacualli
Formative	150–1 BC	Patlachique

Recovery of micro- and macrobotanical evidence associated with domestic and ritual contexts from the excavations of quarry tunnels east of the Sun Pyramid, which were directed by Linda Manzanilla between 1993 and 1996, contributes to our understanding of subsistence patterns and aspects of surrounding vegetation during the post-Teotihuacan occupations of the Epiclassic and Early Postclassic periods; evidence of Aztec occupation was also recovered. Additional research in the Teotihuacan Valley between 1992 and 2014 focused on geomorphic characterization, stratigraphic analyses, radiocarbon determinations of soils, and plant remains preserved in profiles in the surrounding landscape (McClung de Tapia et al. 2005). Evidence from both investigations enrich our understanding of human–environment interaction and associated legacies during this time frame. Although this article focuses on subsistence and indicators for plant use and its relevance for agricultural production, fluctuations in regional settlement patterns and landscape transformation evidenced by vegetation change, together with erosion/deposition events detected in stratigraphic sequences, provide context to understanding human adaptation to the Teotihuacan region after the demise of the Classic period urban center (McClung de Tapia et al. 2005; Sánchez Pérez et al. 2013; Stahlschmidt et al. 2019). Legacy is a relevant concept for understanding the intersection between politics and economics and their impact on past central Mexican landscapes (Morehart 2018). Our research over the years has focused largely on the use of subsistence resources and the impact of agricultural practices on the landscape's expansion, intensification, and eventual abandonment; however, other undertakings such as woodland exploitation are also relevant.

Epiclassic and Early Postclassic Settlement in the Teotihuacan Valley

Changes are apparent in the distribution of Coyotlatelco and Mazapa phase ceramics (Table 1) within the prehispanic city, based on George Cowgill's maps (2015), as well as beyond the limits of the Classic period urban center. A decrease in the number of settlements and their distribution within the subareas, as recognized by the Teotihuacan Valley Project, followed the demise of Teotihuacan´s hegemony and the subsequent Coyotlatelco and Mazapa phases (Gorenflo and Sanders 2007). These data emphasize, however, that neither the center nor the surrounding valley was totally abandoned at this time. Although their inhabitants are assumed to have continued to cultivate accessible lands within the surrounding alluvial plain, little is known about their subsistence procurement, production, and plant use during this period.

Inhabitants of the quarry tunnels occupied a unique setting: they lived in cave-like conditions that offered shelter but also had ritual significance (Manzanilla 2023:31–38; Manzanilla et al. 1996). However, these spaces are not caves in a strict geological sense but were created by the extraction of volcanic scoria (*tezontle*), which was used in the construction of the Classic period city. Archaeological evidence such as storage structures ("silos"), hearths, and interments, together with studies of plant and faunal remains and pollen, indicates a considerable range of domestic and ritual activities (McClung de Tapia, Martínez-Yrizar, et al. 2023). Taxa recovered from macrobotanical analyses were similar overall to the remains reported from previous excavations carried out in the Classic period urban center (González et al. 1993; McClung de Tapia 1987), Late Postclassic Otumba (McClung de Tapia and Aguilar Hernández 2001), and Cihuatecpan (Evans 1988). The tunnels' microenvironment favored preservation of charred and uncharred materials such as seeds in comparison with those found in extensive excavations and test pits elsewhere in the valley.

Macro- and microbotanical remains were recovered from quarry tunnels designated as Cueva de las Varillas and Cueva del Pirul (Figure 1). Both provided relatively intact occupation sequences with similar activity areas: circular bases of possible storage structures (referred to as "silos"), hearths, burials, ceramic concentrations, and other features consisting mainly of ceramic and lithic debris, ash, and contents of selected ceramic vessels. More than 1,680 sediment samples recovered during excavations provided macrobotanical evidence, including occasional in situ finds, pollen, and phytoliths (not considered in this analysis). Samples were analyzed in the Laboratorio de Paleoetnobotánica y Paleoambiente (LPP) of the Universidad Nacional Autónoma de México (UNAM) between 1994 and 1997 (Supplementary Text 1). This summary of plant remains is focused on results from activity areas identified as possible storage installations in the two tunnels pertaining to the Coyotlatelco and Mazapa phases and reused during the Aztec occupation, as confirmed by both ceramic materials and ^{14}C determinations (Beramendi-Orosco and González-Hernández 2023; Manzanilla et al. 1996).

Charred and uncharred seeds and other macrobotanical materials indicate cultivated food resources, including *Zea mays* (maize), *Phaseolus* sp. (beans), and *Opuntia* spp. (*nopal, tuna*). The macrobotanical and pollen taxa recovered from the tunnels are summarized in Table 2 and compared in Supplementary Table 1. The archaeological contexts, particularly the circular bases of storage structures (silos), reflect diverse activities corresponding to the three occupations. The silos were possibly used initially for grain storage during the Coyotlatelco and Mazapa phases and appear to have been reused as refuse deposits during the subsequent but less extensive Aztec occupation (Supplementary Table 2). Additional plant taxa preserved throughout the occupation sequence include *Portulaca oleracea* (purslane), *Jaltomata procumbens* (*jaltomate*), *Salvia* sp. (chia), *Amaranthus* sp. (amaranth), and *Chenopodium* sp. (chenopod), suggesting that edible plants were possibly gathered or cultivated in some cases. These taxa are opportunistic plants that adapt easily to disturbed conditions, as found in paths, field margins, or other clearings. Furthermore, amaranth and chenopods are present in the pollen samples in low numbers; they are designated as "cheno-ams" because these two taxa are generally indistinguishable in archaeological pollen (Figures 2–4).

In the Cueva de las Varillas during the Coyotlatelco phase, macrobotanical remains of maize, amaranth, purslane, chia, and beans were present in both silos and hearths but were absent in burials. Chenopods, however, were found in silos, hearths, and burials. During the subsequent Mazapa phase, maize, amaranth, chenopod, *tuna*, chía, and *jaltomate* were present in all three contexts, whereas beans were only recovered from silos and purslane was restricted to hearths and burials. During the Aztec occupation, only hearths provided relevant plant remains. Taxa in Aztec hearths included maize, amaranth, chenopods, chía, purslane, and *jaltomate*, although sunflower (*Helianthus* sp.) was recovered from a concentration of diverse materials corresponding to this occupation. Pollen evidence for maize and cheno-ams was recovered in silos, hearths, and burials during the Coyotlatelco and Mazapa phases, but only in hearths during the Aztec occupation (Supplementary Table 1).

In the Cueva del Pirul, macrobotanical remains of the aforementioned plant taxa were less plentiful, and their distributions differed somewhat from those in Cueva de Varillas. Only chenopods and maize were present in silos, hearths, and burials in Coyotlatelco contexts; amaranth was present in silos and burials, beans and purslane were present in silos, *tuna* and *jaltomate* were in hearths and burials, and chia was found in hearths. Sunflower was recovered from a concentration of ceramic debris as well. During the subsequent Mazapa occupation, amaranth, chenopod, and maize, together with *jaltomate* and purslane, were present in hearths and burials. Beans were present only in silos, and chía was associated with hearths during this phase. Maize, amaranth, and chenopods were recovered from hearths in this tunnel from the Aztec occupation.

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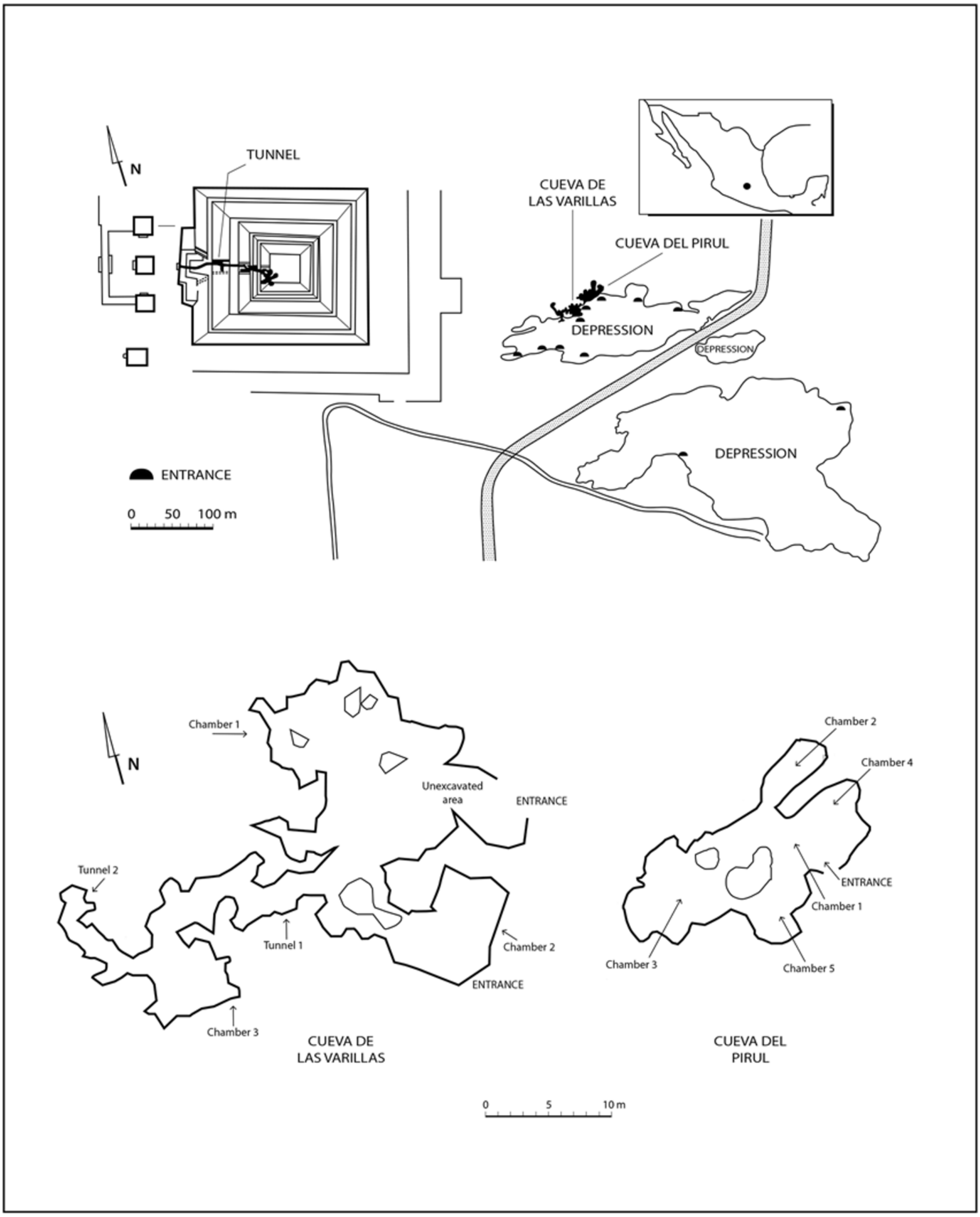

Figure 1. Location of quarry tunnels east of the of the Sun Pyramid, Teotihuacan.

There was considerably less pollen evidence in Cueva del Pirul than in Cueva de las Varillas. Cheno-ams were recovered in silos and burials corresponding to the Coyotlatelco occupation, but during the Mazapa phase were present in silos, hearths, and burials. Cheno-ams and maize pollen were present in hearths during the Aztec occupation as well.

In both Coyotlatelco and Mazapa phase contexts, three taxa were relatively common: *Zea mays* (maize), *Amaranthus* sp. (amaranth), and *Chenopodium* sp. (McClung de Tapia, Tapia-Recillas et al.

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Table 2. Plant Taxa Recovered from Cueva de las Varillas and Cueva del Pirul (S = Seeds, P = Pollen).

AGAVACEAE P	EQUISITACEAE P	PINACEAE
Agave S	EUPHORBIACEAE S	*Abies* P
AMARANTHACEAE	*Acalypha* S	*Pinus* P
Amaranthus S	*Euphorbia* S	POLYGONACEAE
Chenopodium S	FABACEAE S, P	*Polygonum* S
Cheno-am S, P	*Phaseolus* S	*Rumex* S
ASTERACEAE P	*Trifolium* S	PORTULACACEAE
Ambrosia P	FAGACEAE	*Portulaca* S
Aster S	*Quercus* S, P	POTAMOGETONACEAE
Cirsium P	JUNCACEAE P	*Potamogeton* S
Eupatorium P	LAMIACEAE S	ROSACEAE S, P
Helianthus S	*Salvia* S	RUBIACEAE P
Madia S	LILIACEAE P	SALICACEAE
Senecio P	LYTHRACEAE P	*Salix* P
BETULACEAE P	MAGNOLIACEAE P	SOLANACEAE S cf.
Alnus P	MALVACEAE P, S	*Jaltomata* S
BIGNONIACEAE P	MOLLUGINACEAE	cf. *Physalis* S
BOMBACACEAE P	*Mollugo* S	*Solanum* S
BRASSICACEAE	NAJADACEAE	TYPHACEAE
Lepidum S	*Najas* S	*Typha* P
CACTACEAE S	ONAGRACEAE P	ULMACEAE P
Opuntia S, P	*Oenothera S*	VERBENACEAE P
CAROPHYLLACEAE S	OXALIDACEAE P	*Verbena* S
COMMELINACEAE S	PAPAVERACEAE	
CUPRESSACEAE	*Argemone* S	
Cupressus P	POACEAE S, P	
CYPERACEAE S, P	*Avena* P	
Cyperus S	*Eleusine* P	
Eleocharis S, P	*Eragrostis* S	
Schoenoplectus S	*Panicum* S	
	Setaria S	
	Zea mays S, P	

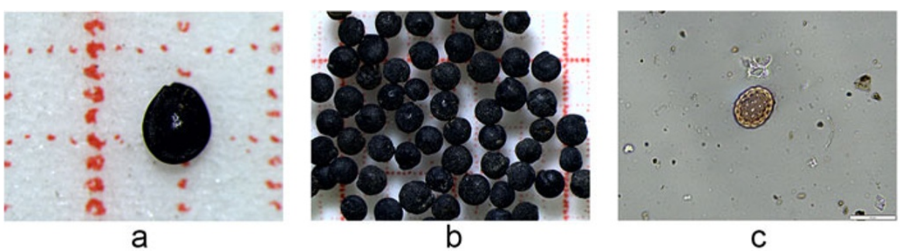

Figure 2. (a) *Amaranthus* sp. (4×) CV C2, N33- E96, layer 1j, Burial 3; (b) *Chenopodium* sp. (1×) CV C3, N33- E76, level R4, AA100; (c) cheno-am pollen (100×) CV C2, N344-E96, AA148. (Color online)

2023). Although found in both quarry tunnels, they were more numerous in Varillas, particularly during the Coyotlatelco occupation. For example, a storage installation in Chamber 3 of the Cueva de las Varillas, AA100, is one of several such structures in which large quantities of chenopods were recovered (Supplementary Figure 1; Supplementary Table 3). Maize was minimal in AA 99, west of AA 100, although chenopods were predominant in this context. In Cueva del Pirul, AA 161, a fragmented silo in Chamber 1, chenopods were similarly predominant together with cheno-am pollen; there was only a scarce presence of maize and amaranth (Supplementary Table 3). We interpret notable quantitative differences among plant taxa between the two tunnels as a product of preservation factors, human

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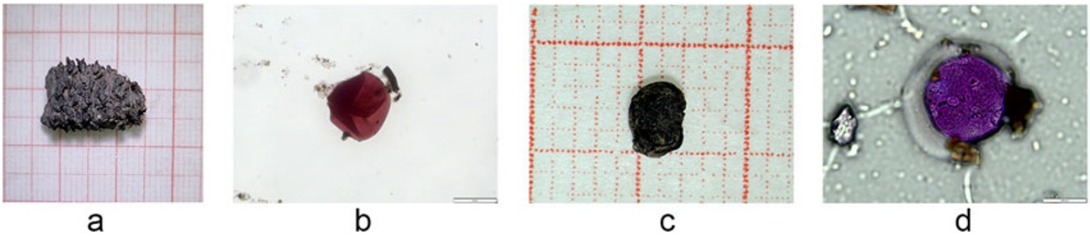

Figure 3. (a) *Zea mays* cob fragment. CV C2, N332-E96, layer 1h, AA98, Burial 13; (b) *Zea mays* pollen (40×), CP C5, N397-E117, AA204; (c) *Opuntia* sp. (1×) CV C2, N332-334-E93, layer 1a-1b, AA77b; (d) *Opuntia* sp. pollen (100×) CV C3 N330-31-E75, AA99. (Color online)

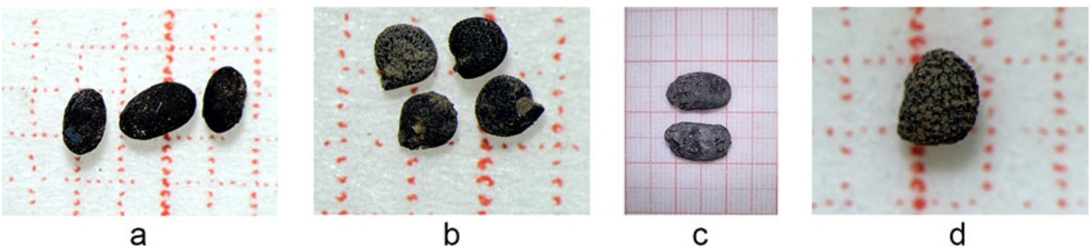

Figure 4. (a) *Salvia* sp. (2×) CV C2, N332-E95, layer 1g, AA90; (b) *Portulaca* sp. (3.2×), CV C2, N333-34 E93, layer 1a-1b, AA77b; (c) *Phaseolus* sp. CP C1, N357-E116, layer 2a, AA157, 3-Dimensional Register 3700; (d) *Jaltomata* sp., (3.2×) CP C1, N358-E124, layer 1s/Earth floor 10. (Color online)

and faunal disturbance regimes, preparation and consumption habits, and variable seed production in different taxa; however, the abundance of chenopods led us to hypothesize their intensive use.

Considerable disparity among the frequencies of different plant taxa in both silos and other contexts represents a limiting factor to comparing them (Supplementary Table 3). As a result, we grouped taxa recovered from the silos according to their provenience: Cueva de las Varillas (CV) and Cueva del Pirul (CP). A two-sample Kolmogorov-Smirnov test (Shennan 1997) was carried out, and results from both tunnels were evaluated at significance levels of 0.05 and 0.001 (Table 3). The observed difference between the two samples is greater than the minimum required to reject a null hypothesis that the samples are drawn from the same distribution (Supplementary Figure 2).

A morphological analysis of both complete and fragmented chenopod achenes indicates that the specimens generally correspond to nondomesticated plants (*Chenopodium berlandieri*), which perhaps were cultivated, although foraging is not excluded. High counts of charred and uncharred achenes in diverse contexts, particularly in silos, favor their possible cultivation. However, the margins of these achenes are generally biconvex or slightly rounded rather than truncated, a sign that they were not yet fully domesticated. Although both amaranth and chenopod greens provide a nutritive vegetal resource, the storage of achenes suggests that they were possibly ground and used as flour in *atoles* or other preparations, although the consumption of leaves and immature inflorescences is also probable.

Post-Teotihuacan Agricultural Production in the Teotihuacan Valley

Soil profiles studied in different sectors of the valley between 1992 and 2014 suggest a characteristic buried black soil horizon, broadly distributed in different geomorphological positions in the Teotihuacan region and either overlain by up to several meters of redeposited sediments or exposed on eroded surfaces of Cerro Gordo and the Patlachique Range (González Arqueros 2014; McClung et al. 2005; Sánchez-Pérez et al. 2013; Stahlschmidt et al. 2019). Although the contribution of erosive events to the formation of the modern landscape has been apparent for decades, the widespread distribution of the black soil suggests prior availability of more fertile soil resources in the region than usually considered.

Table 3. Cumulative Frequencies for Macrobotanical Taxa from Cueva de las Varillas (CV) and Cueva del Pirul (CP) Used in the Kolmogorov-Smirnov Two-Sample Test.

	CV	CP	Total	
Chenopodium sp.	8,642	212	8,854	
Amaranthus sp.	56	10	66	
Zea mays	66	5	71	
Others	50	70	120	
Total	8,814	297		
Percentage	0.98048559	0.71380471		
	0.00635353	0.03367003		
	0.00748809	0.01683502		
	0.00567279	0.23569024		
	Cumulative %			
	CV	**CP**	**Observed Difference**	**%**
Chenopodium sp.	0.98048559	0.71380471	0.26668088	26.6
Amaranthus sp.	0.98683912	0.74747475	0.23936437	23.9
Zea mays	0.99432721	0.76430976	0.23001744	23.0
Others	1	1	0	
Multiplication Factor $c(\alpha)$	**Significance Level**	**Minimum Difference** $c(\alpha)\sqrt{\frac{n_1+n_2}{n_1\times n_2}}$		
1.36	0.05	0.08023377		
1.95	0.001	0.11504106		

Plant remains from several archaeological excavations—particularly specimens from Cueva de las Varillas and Cueva del Pirul—suggest a mixed subsistence base that was partially dependent on gathering possibly noncultivated taxa such as amaranth and chenopods, together with maize and other cultigens. The favorable preservation of remains in these tunnels provides a unique opportunity to develop new hypotheses concerning procurement and productive subsistence practices and their organization in post-Teotihuacan communities. Future studies should incorporate the following analytical techniques: systematic phytolith and starch grain analyses of residues in ceramic vessels and dental calculus, the establishment of baseline reference collections of starch, and the application of advanced techniques of phytolith analysis and interpretation.

From a regional perspective, erosion and sedimentation suggest an unknown number of Epiclassic and Early Postclassic sites that are not visible on the surface of the alluvial plain, rendering previous population estimates unverifiable. Extension of the black soil in prehispanic times (Sánchez-Pérez et al. 2013) and its hypothesized agricultural potential compel a reassessment of the productivity of the region's subareas. Evidence for prehispanic inhabitants' use of a range of locally available subsistence resources, the distribution of potential agricultural lands, and considerable landscape modifications suggests the need to review past interpretations. Favorable preservation of plant remains in the quarry tunnels east of the Sun Pyramid expands the panorama of post-Teotihuacan subsistence, contributing to the legacy of traditional Mesoamerican foodways and landscape management through procurement, as well as the production of plant resources.

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Data Availability Statement. All plant remains and related documentation are curated in the Laboratorio de Paleoetnobotánica y Paleoambiente, Universidad Nacional Autónoma de México, and are available on request for consultation and further study.

Competing Interests. The authors declare none.

Supplementary Material. The supplementary material for this article can be found at https://doi.org/10.1017/laq.2025.13.

Supplementary Table 1. Comparison of plant families and genera present in features of Cueva de las Varillas and Cueva del Pirul, Teotihuacan, by ceramic phase. Coyotlatelco, Mazapa, and Aztec occupations. **M**, Macrobotanical remains; **P**, Pollen.

Supplementary Table 2. Selected storage structures (silos) in Cueva de la Varillas (CV) and Cueva del Pirul (CP), Teotihuacan.

Supplementary Table 3. Frequencies of macrobotanical remains recovered from selected silos in CV and CP.

Supplementary Figure 1. Coyotlatelco phase silo in Cueva de las Varillas (Activity Area 100); photograph reproduced with authorization of Linda R. Manzanilla.

Supplementary Figure 2. Graphic representation of Kolmogorov-Smirnov two-sample test results on distributions of macrobotanical remains from Cueva de las Varillas and Cueva del Pirul illustrating the result in which the observed difference between the two samples is greater than the minimum required to reject a null hypothesis that the samples are drawn from the same distribution.

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