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## Ethnohistoric Records of Hunter-Gatherer Diet of the Texas/ Mexico Borderlands: Implications for Staple Foods of the Lower Pecos Canyonlands During the Holocene

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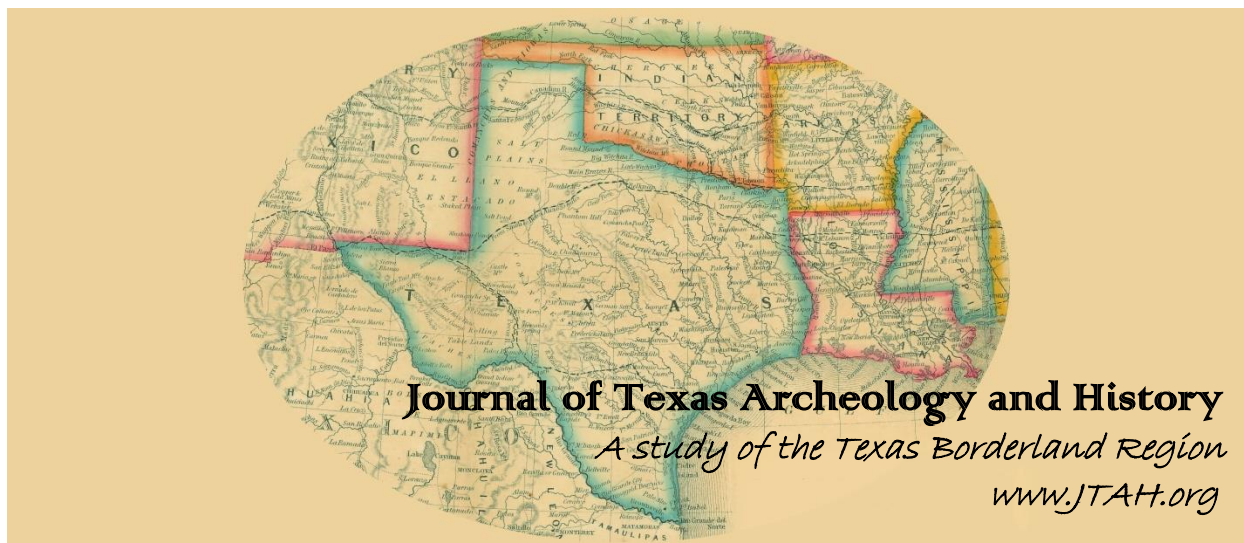
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# Ethnohistoric Records of Hunter-Gatherer Diet of the Texas/Mexico Borderlands: Implications for Staple Foods of the Lower Pecos Canyonlands During the Holocene

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## ABSTRACT

Hinds Cave (41VV456) and other rockshelters excavated in the Lower Pecos Canyonlands have yielded thousands of coprolites spanning the Holocene. To date, several hundred specimens have been analyzed, providing a detailed record of meals consumed by hunter-gatherers who called this landscape home. This article compares the paleodietary records derived from these specimens with the foodways documented in the ethnohistoric records available for the Lower Pecos Canyonlands and adjacent landscapes. This comparison confirms the deep temporal roots of the foodways recorded in the earliest written records of the Texas/Mexico borderlands. Coprolite data corroborate the strong dependence on the seasonal staples of lechuguilla (*Agave lechuguilla*), nopales (*Opuntia sp.*), and tunas (*Opuntia sp.*) observed in the ethnohistoric literature. The temporal endurance of this subsistence strategy suggests that there may be some components of this dietary pattern that could inform on many of the diet-related health issues observed among modern Native American and other populations.

The Lower Pecos Canyonlands and adjacent regions have some of the oldest European written records of native foodways as well as incredible preservation of coprolites (desiccated feces) that span the Holocene. Across this region, hunting and gathering lifeways persisted with little interruption from the northward expansion of maize agriculture and throughout the tumultuous time of early European contact. These ethnohistorical accounts provide a framework of known seasonal resource exploitation to assess the coprolite data from Hinds Cave (41VV456). Due to the dominance of indigestible plant resources reflected in coprolite data, the review of the ethnohistoric literature in this manuscript focuses on floral resources and does not reflect patterns of faunal exploitation. Staple resources identified in the literature are corroborated in dietary data from archaeological sites, providing a view of a remarkably stable adaptation to the arid landscapes of the Lower Pecos Canyonlands and beyond. The time-depth of this adaptation has implications for dietary health concerns among contemporary native groups.

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## THE LOWER PECOS CANYONLANDS

Located on the eastern periphery of the Chihuahuan desert (Figure 1), the Lower Pecos Canyonlands have a long history of archaeological investigations, due primarily to the remarkable preservation conditions of the numerous rockshelters and distinctive rock art styles (Shafer 2013:1-2). The Lower Pecos Canyonlands is bound by the mesquite-chaparral zone of the Tamaulipan biotic province to the southeast, the oak-cedar zone of the Balconian biotic province to the northeast, and the sotol-lechuguilla zone of the Chihuahuan biotic province to the west (Figure 1) (Blair 1950; Dering 2002). These biotic provinces are defined primarily by the distribution of fauna without detailed references to the underlying floral communities (Blair 1950). A review of the distribution of vascular plants demonstrates that nearly all plant species identified as food resources in the Lower Pecos Canyonlands archaeological record are found in surrounding biotic provinces (Hatch et al. 1990:13-14). The mosaic of habitats in the Lower Pecos provided a remarkably diverse environment for the prehistoric hunter-gatherers (Dering 1979). The diversity of habitats allowed human populations in the area to engage in an extremely broad-based subsistence strategy, with many seasonally available resources supplementing the cactus and succulent staples including agave and sotol (Dering 1999).

### ETHNOHISTORY OF STAPLE PLANT RESOURCES THROUGHOUT THE BORDERLANDS

Ethnohistorical source material documents the use of wild plant resources as foods. This section recounts the seasonal subsistence patterns noted in the earliest reports of native lifeways in the general region. Most of the available literature is based on early Spanish reports of the nomadic hunter-gatherers of the modern states of Nuevo Leon and Coahuila, Mexico, as well as south Texas. Although a number of secondary sources were consulted (Beals 1973; Campbell 1979, 1983; Griffen 1969; Hester 1989; Kenmotsu and Wade 2002; Newcomb 1961; Taylor 1972; Thoms 2007), most of the data about the region presented in these sources is based upon Don Alonso de León's First Discourse (Brown 1988; De León 1971) or the account of Cabeza de Vaca (Krieger 2002). This review of ethnohistoric accounts from the region follows a broadly chronological approach, presenting details about seasonality and intensity of use for each resource. This is followed by a brief overview of the more recent ethnographic literature on the use of each of the three previously identified staples across the Greater Southwest. The seasonal availability of foods identified in these records is summarized in Table 1.

#### **Cabeza de Vaca (1530s)**

Though he did not traverse directly through the Lower Pecos Canyonlands, the account of Cabeza de Vaca provides the earliest record of Native lifeways across parts of South Texas (Krieger 2002; Thoms 2008). For the sake of brevity, the reports of coastal lifeways near Galveston Bay will be bypassed, as the environment there is very different from the Lower Pecos Canyonlands. Upon moving to stay with bands in the area surrounding the lower reaches of the modern-day San Antonio and Guadalupe Rivers, Cabeza de Vaca provides an account of pecans (*Carya illinoensis*) as an important fall staple (Krieger 2002:189-190; Thoms 2007, 2008). Along with an unidentified "little grain", these

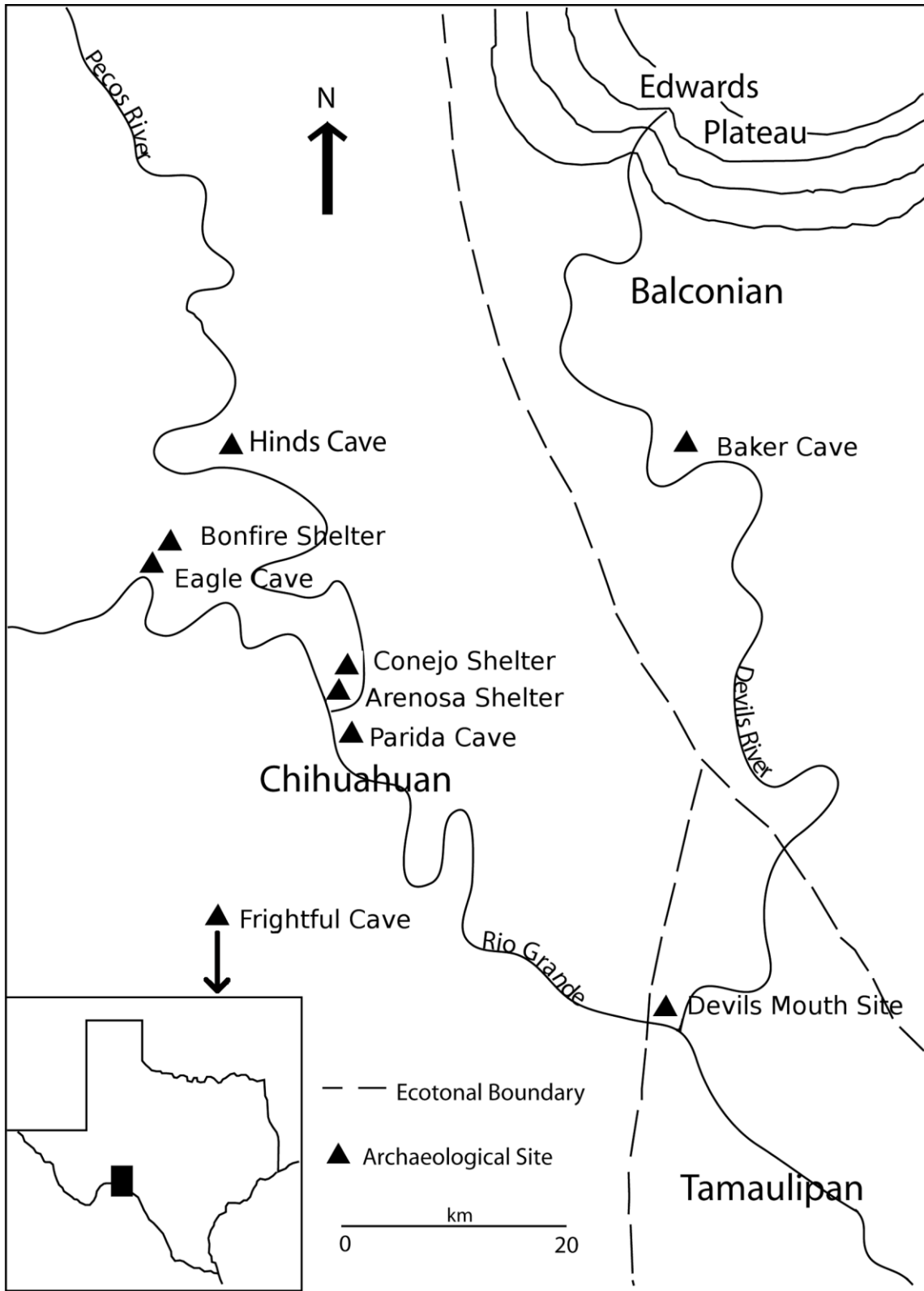


Figure 1. Map of the Lower Pecos Canyonlands

**Table 1. Seasonality of Plant Use based on Ethnographic Sources**

Species	Plant Part	Winter	Spring	Summer	Fall
<b>Storage Organ</b>					
<i>Agave lechuguilla</i>	Caudex	Heavy Use	Heavy Use	Available	Available
<i>Dasyllirion sp.</i>	Caudex	Heavy Use	Heavy Use	Available	Available
<i>Opuntia sp.</i>	Cladode	Available	Heavy Use	Heavy Use	Available
<i>Allium sp.</i>	Bulb	Available	Heavy Use	Available	Available
<b>Fruit/Nut</b>					
<i>Prosopis sp.</i>	Legume			Heavy Use	Heavy Use
<i>Carya illinoensis</i>	Nut				Heavy Use
<i>Juglans sp.</i>	Nut				Heavy Use
<i>Opuntia sp.</i>	Fruit		Heavy Use	Heavy Use	Available
<i>Opuntia leptocaulis</i>	Fruit		Available	Available	Available
<i>Echinocercus sp.</i>	Fruit			Available	
<i>Celtis sp.</i>	Fruit			Available	Available
<i>Dasyllirion sp.</i>	Fruit			Available	
<i>Diaspyros texana</i>	Fruit	Available			Available
SOLANACEAE	Fruit			Available	
<i>Vitis sp.</i>	Fruit			Available	
<i>Yucca sp.</i>	Fruit		Available	Available	
<i>Coryphantha sp.</i>	Fruit			Available	
FABACEAE	Legume			Available	
<i>Chamaecrista sp.</i>	Fruit			Available	Available
<b>Cereal/Small Seed</b>					
<i>Helianthus sp.</i>	Achene			Available	Available
<i>Chenopodium sp.</i>	Small Fruit		Available	Available	Heavy Use
<i>Amaranthus sp.</i>	Small Fruit		Available	Available	Heavy Use
POACEAE	Caryopsis			Available	Available
<i>Sporobolus sp.</i>	Caryopsis			Available	Available
<i>Panicum sp.</i>	Caryopsis			Available	Available
<i>Cenchrus sp.</i>	Caryopsis			Available	Available
CYPERACEAE	Seed			Available	
<i>Carex sp.</i>	Seed			Available	
<i>Polygonwn sp.</i>	Seed			Available	Available

nuts formed the majority of the diet for several months during years of good yield. Preparation methods are not recorded. During the winter, these inland groups, including the Mariames and Yguazes, subsisted almost entirely on geophytes, land plants with below-ground resting buds (Raunkiaer 1934:64-65) from several unidentified species (Krieger 2002:194-195). This is the earliest European account of earth oven cookery in North America (Thoms 2008). From the description of the several day cooking necessary to render them edible, it is clear that it must be a fructan-based storage organ. However, there is no mention of rock elements in the construction of these ovens. These carbohydrate-rich geophytes are underrepresented in the archaeological record, both in the remnants of earth ovens found across the region and in the direct evidence of diet supplied by coprolites (Riley 2010).

The use of the prickly pear (*Opuntia sp.*) nopales (stems) and green tunas (fruits) as a food is mentioned by Cabeza de Vaca in the year following his trek across the Tamulipan plain and the winter spent with the Avavares (Krieger 2002:195). Cabeza de Vaca references the cooking of green tunas and nopales in earth-ovens, recording that the pads are left to cook overnight in the earth oven. Again, there is no mention of a rock heating element. It is made clear in the account, that nopales were a marginal

food resource designed to satiate until the tunas were ripe. This corresponds with the low caloric return rate of this resource (Winkler 1982). For the Avavares, a group who lived entirely in the Tamulipan plains province, nopales and green tunas were the major staple recorded by Cabeza de Vaca (Krieger 2002:190-191). The account stresses that these populations, and other groups in South Texas, were highly dependent on prickly pear pads for sustenance during much of the year.

The late summer and fall was a time of abundance, with ripe prickly pear tunas serving as a major staple (Krieger 2002:195; Thoms 2008). This seasonal abundance of tunas provided a caloric surplus that encouraged bands to congregate at large tuna grounds in the Tamulipan Plains province. Prickly pear tunas were a productive resource across the plains province and were the focal point of the largest inter-ethnic gatherings observed by de Vaca in Texas (Krieger 2002:190). Large thickets of prickly pear drew native groups from the Coastal Prairie onto the South Texas Plains for a period of abundant food, celebration, and trade. According to Cabeza de Vaca, this resource was the major dietary staple of these groups for three months in late summer/early fall (Krieger 2002:190; Thoms 2008). It appears that tunas were an important seasonal resource for all of the Native groups that occupied the Tamulipan Plains province, as Cabeza de Vaca mentions them as the major food resource among the Native groups (Avavares, Cutalches [Cutalchiches], Malicones, Coayos, Susolas, Arbadaos) encountered from the time of their fleeing from the Mariames and Yguases in September until reaching groups near the Rio Grande that consumed mesquite (*Prosopis sp.*) flour (Krieger 2002:278). The tuna continued to be noted as an important dietary constituent among these groups near the river, as well as other groups further west that had access to maize (Krieger 2002:277). This indicates that tunas were a seasonally important resource in the basin and range province along the southwestern margin of the Tamulipan plain and were an important resource wherever they occurred in abundance.

While this very brief review does not account for the intra-province environmental variation of the Tamulipan Plains Biotic Province, it is clear that groups living around the margins of this area (which includes the Lower Pecos Canyonlands) were highly mobile and willing to move great distances for a productive and dense resource stand such as prickly pear tunas. Cabeza de Vaca and his companions clearly travelled through parts of the northern Chihuahuan desert, but there is no mention of any resources resembling agave or sotol in the account. Thoms (2007) argues that Cabeza de Vaca did not encounter the uplands of the Edwards Plateau where these desert succulents are prominent.

### **De León, the Elder (1580-1649)**

Alonso De León, the elder, also provided an early account of native lifeways based on decades of observation. An early Spanish settler of the modern-day state of Nuevo Leon, Alonso de León recounted many ethnographic details of native populations living near the western margin of the Tamulipan Plains Biotic province from 1580 to 1649 (Brown 1988; Chapa 1997; De León 1971). The Native groups of Nuevo Leon and Tamaulipas living near the early Spanish settlements in the interior mountain ranges depended primarily on gathered plant resources for the majority of their diet, particularly in times of seasonal stress (Taylor 1972). De León claimed that the natives subsisted on three major staples throughout the year (Brown 1988). In the winter, the major food utilized was the caudex and basal leaves of lechuguilla (*Agave lechuguilla*). This season was described as a time of hunger



despite this dependence on lechuguilla, which De León claimed to have little substance (Brown 1988). During the spring and much of the summer, prickly pear was the foundation of the diet, both as green and ripe tunas (Brown 1988). Mesquite beans were an important staple during the late summer and fall, first as an edible raw “green bean” and then as a source of ground meal and dry bean once the pods dry. These Native populations also ate unnamed geophytes (Chapa 1997: location 345).

De León briefly recounted the cooking or “barbequing” of lechuguilla hearts over the course of two days and three nights. While there is no explicit mention of an earth oven, the length of time mentioned in the account suggests that the native groups described were using rocks as heating elements. Regardless of cooking method, the account clearly indicated that barbequed lechuguilla is the bulk of the diet across most of the cold season (Brown 1988).

As the prickly-pear blossoms in the spring, first the flowers (buds?) and then the green tunas were gathered and pit roasted (barbequed) (Brown 1988). De León claimed that there are great quantities of prickly pear in the region, allowing the natives to utilize the barbecued young tunas as the primary food supply without impacting the later tuna harvest (Brown 1988). When the tunas ripened, the local populations subsisted almost entirely on these fruits (both fresh and dried) (Brown 1988). There is no indication in this account of the use of the pads as a food resource. It is possible that De León did not distinguish green buds from the succulent young pads of the many prickly pear species.

### Later Spanish Accounts

While no other sources provide the level of detail presented in the two previous accounts, there are some passing mentions of prickly pear, sotol (*Dasyilirion sp.*) and lechuguilla in later accounts that suggest they continued to be important dietary resources for Native populations in South Texas and neighboring regions (Foster 2008; Wade 2003). In January of 1674, Friar Larrios reported the staples of the native groups meeting with him at Mission San Ildefonso in Modern-day Coahuilla as subsisting on mescal, prickly pear tunas, acorns, small nuts, fish, deer, and buffalo (Wade 2003:7). Mescal may reference any agave species whose caudex was roasted for food (Castetter et al. 1938:10; Gentry 1982:14-16). Another account of this same expedition in 1674 mentions mescal as the staple food at the establishment of the Mission Santa Rosa de Santa Maria along the Rio Sabinas (Wade 2003: 9). During the ceremony establishing the mission, Captain Elizondo asked the natives to share food with the friars, who were subsisting solely on mescal (Wade 2003:9). Reports from later in the spring of 1674 referenced mescal as the primary food resource. Friars at these two mission sites reported that they and the congregated natives had only mescal and unidentified geophytes for food (Wade 2003:9). The location of this site about 50 miles south and west of modern-day Eagle Pass, TX suggests that it was probably lechuguilla. This is corroborated by reports from the military commander, Captain Barbarigo. In his report from that same spring, Captain Barbarigo recorded that the friars subsisted on the roots of lechuguilla, “tule”, and sotol once the stored maize and other resources had been exhausted (Wade 2003:10). “Tule” may refer to a species in the bulrush genus *Scirpus* or another such aquatic resource such as cattails (*Typha sp.*). There is no mention of the method of preparation of these resources. The small nut in the accounts may be little walnut (*Juglans microcarpa*), which is common in the archaeological record of the Lower Pecos Canyonlands, but this is speculative on the author’s part. The gathered natives at this mission

establishment numbered upward of 600 individuals from at least nine separately identified bands (Wade 2003:9). The account also mentions that many other people affiliated with these bands were engaged in logistic forays to the North for bison and other resources (Wade 2003:10). These statements hint at a very flexible social organization characterized by dispersal and congregation around seasonal resources.

Wade (2003:14) mentions the importance of prickly pear tunas in the dispersal of Native groups from the mission Santa Rosa during the harvest season, which began in June in this region. The friars had congregated over 3000 natives at the mission, who were subsisting on the large tuna grounds that abounded in the immediate vicinity of the mission (Wade 2003:14). The friars realized that the native populations would have to disperse once the tuna supply was exhausted and were desperate for supplies to keep the congregation together at the mission (Wade 2003:15). This account extends the recorded use of tunas as a seasonal staple to the western margins of the Tamulipan plains.

Griffen (1969) presents an overview of native lifeways recorded in Early Spanish accounts from the Bolsón de Mapimí of Central Northern Mexico. This closed drainage system is located to the west and south of the Lower Pecos Canyonlands, in the modern-states of Chihuahua, Coahuila, Durango, and Zacatecas. The majority of these accounts are from the Parras and La Laguna districts, which were better watered and became the center of Spanish colonial life in the region (Griffen 1969:6). The Spanish accounts from the late sixteenth and seventeenth centuries record a number of wild plant resources utilized as staple foods. For most of the groups in the region, mescal, tunas and mesquite were recorded as the major wild plant resources (Griffen 1969:110-111).

There are several reports of other terms for agave, including maguey and noas, as well as specific mention of lechuguilla use by natives in the area of modern-day Parras, Coahuila (Griffen 1969:110). The term “maguey” today references any of the large, thick leaved Agave species (Parsons and Darling 2000). However, the use of the term in the Spanish colonial records suggest that it is generally used as sub-grouping of mescal (Griffen 1969:110). Noas is another type of mescal, that is less fibrous than those species classed as maguey (Griffen 1969:110). Nopales are mentioned as a food resource for two groups in the region as well. At least two different aquatic resources were used by native groups in the region, “espadaña” (probably *Typha sp.*) and tule. Flour made from the roots of these resources, as well as mesquite, tunas, and mescal were all used to make solid loaves. Griffen (1969:110) also reports bread made from a small seed he tentatively identifies as the canarygrass, *Phalaris canariensis*, which grows in such abundance that it resembles a wheat field. The accounts also indicate that native groups made wine out of the staples of mescal, tunas and mesquite (Griffen 1969:110). The above accounts are centered on the relatively well-watered La Laguna district and may not be reflective of the region as a whole. Accounts recorded as early as 1598 characterize the diet of groups located in regions with minimal water as composed wholly of lechuguilla, mesquite, maguey, and tunas (Griffen 1969:111). This is re-emphasized in later accounts as well, indicating that some groups were entirely dependent on lechuguilla and wild maguey for the bulk of the caloric needs (Griffen 1969:111).

The Lipan Apaches incorporated mescal and prickly pear tunas and nopales into their seasonal round (Minor 2009:62). In 1761, the Lipan captain El Cabezón requested a military escort from Presidio de las Amarillas on the San Saba River during the prickly pear season (Wade 2003:93). In the following year, the captain of the Presidio agreed to establish a mission for another Lipan captain, El Turnio. El

Turnio made it clear that his group would abandon the mission during the prickly pear season (Wade 2003:194). The accounts of this mission from 1762 suggest that groups of Lipanes interrupted bison hunting to participate in the tuna harvest. Reports from the friars at Mission Santa Cruz de San Saba indicate that much of the mission population left in June to hunt bison, in August to gather tunas, and again in the fall to hunt bison again (Wade 2003:194-195). These two accounts recorded during the founding of the mission in 1756 (Wade 2003:186), along with the group name “Come Nopales,” which is Spanish for the “nopale eaters,” suggest that the prickly pear was an important seasonal resource for the Lipan Apache. The name “Come Nopales” suggests that the use of the pads as food was also encountered in the region, since only the pads of the prickly pear are referred to as nopales (Powell and Weedin 2004:74). This account has a dual importance in the current study. First, it indicates that the pattern of prickly pear dependence described for the Tamulipan plains by earlier accounts may also be an important component of the subsistence strategy of Native groups in the Edwards Plateau. Second, it suggests that the productivity of this resource was great enough that displaced groups migrating from areas with a low density of prickly pear, such as the Southern High Plains, would adopt this subsistence strategy in areas with a sufficient density of prickly pear. It appears that the drier areas of the Edwards Plateau have a high enough resource density to facilitate this shift to a seasonal dependence on prickly pear tunas by the Lipan and other Apache bands including the Mescalero, who are named for their dependence on mescal or agave (Opler 1983).

### COPROLITE STUDIES FROM HINDS CAVE

Ethnohistoric records of hunter-gatherers exploiting the available wild plant resources available in the Texas/Mexico Borderlands provide a framework to evaluate the dietary data recovered from Hinds Cave coprolite specimens that span most of the Holocene. Six studies have been conducted on coprolites recovered from Hinds Cave (Belknap 2011; Edwards 1990; Reinhard 1989; Riley 2010; Stock 1983; Williams-Dean 1978). The coprolites analyzed in these studies span much of the Archaic occupation of the Lower Pecos (Turpin 1991). Each of these studies has added to our knowledge of diet and nutritional health of the hunter-gatherer groups that populated the canyonlands. There appears to have been a remarkably stable human exploitation of the landscape over this period (Edwards 1990; Stock 1983; Williams-Dean 1978). Data from three studies (Edwards 1990; Stock 1983; Williams-Dean 1978) were evaluated in Riley (2008) using cluster analysis. An additional 30 specimens were examined in Riley (2012). The coprolite studies from Hinds Cave inform on the exploitation of the Lower Pecos Canyonlands by hunter-gatherer populations across the Holocene. This robust dataset provides direct evidence of individual dietary choices. These prior studies suggest human populations occupying the canyonlands were highly dependent on a limited suite of xeric resources for the bulk of their caloric intake. However, few of the prior studies approached the reconstruction of diet at the scale of individual coprolite specimens and, by extension, individual actors in the archaeological record. The current study rectifies that by considering each specimen as a discrete record of seasonal exploitation of available food resources.

Each coprolite represents a combination of dietary items that can generally be considered to represent a meal (Fry 1985) or perhaps several meals (Sutton and Reinhard 1995), both relatively focused windows into an individual’s dietary decisions. This provides a framework for analysis, but it

also requires that each specimen be considered as a discrete unit in order to observe the relationship between dietary constituents recovered together. This is complicated by the large number of dietary items generally recovered in coprolite studies, which results in a cumbersome matrix with many empty cells. Patterning within this large data set is hard to explore without the use of statistics, which are limited, in turn, by the nature of coprolite quantification as well as comparability between studies (Jouy-Avantin et al. 2003).

Riley (2008, 2012) uses cluster analysis as an exploratory statistical technique to look for patterning in the macrobotanical components of the coprolite studies from the Lower Pecos Canyonlands. Further details on this technique are available in Riley (2010). Overall, this statistical approach yields patterns of similar dietary exploitation between coprolites while maintaining the relationship between various components in individual specimens. These patterns of resource combination inform on seasonality of deposition.

The three clusters of specimens from Riley (2012) correlate nicely with dietary predictions based on the ethnohistoric record (Table 2) (De León 1971; Krieger 2002; Thoms 2008). The first cluster (n=16) indicates a diet focused on the desert succulent resources of lechuguilla and sotol, with smaller amounts of onion bulbs also consumed. These specimens fit the expectations of a winter/early spring diet focused on the highest caloric return resources available in the canyonlands during that season. The inclusion of “calorically limited” onions (Sobolik 1991) may indicate that diet breadth for these spring and winter meals is fairly broad. However, there is little indication of small animal resources in these specimens compared with the other clusters. This cluster also includes the only direct evidence of large animal consumption from the current study. Overall, this cluster represents meals with a mixed diet-breadth, incorporating both low and high ranked resources available in the cold season. Thus, the dietary decisions reflected in these specimens are better understood as a reflection of seasonal availability rather than diet-breadth ranking (Table 3).

The second cluster (n=4) from Riley (2012) represents the digested residue of meals composed almost entirely of nopales and sotol hearts, with the nopales making up the bulk of the plant-based diet. These specimens represent a seasonal dietary strategy focused on low-ranked nopales somewhat supplemented by the relatively high-ranked sotol hearts. This cluster accords nicely with the seasonal expectations of a spring diet from the ethnohistoric record (De León 1971; Krieger 2002). The third cluster (n=10) consists of coprolite specimens that reflect a diet dominated by prickly pear tunas. Other than less predictable and abundant mast resources such as walnuts, tunas are the highest ranked resource in the diet-breadth model. Both the ethnohistoric record and the model predict that hunter-gatherer populations in the canyonlands would depend on these resources as a major staple during the summer. This is exactly what is seen in this cluster, which contains little evidence of other plant components in these meals. The diet reflected in these specimens is focused on highly-ranked tunas to the exclusion of other plant resources. Prickly pear cactus was an invaluable food resource across the Archaic. The tunas and seeds were a mid-summer staple and the nopales provided a reliable resource in times of seasonal scarcity.

**Table 2. Seasonal Interpretations of Coprolite Clusters from Hinds Cave Data**

Cluster	Chronological Period	Number of Specimens (n)	Major Dietary Compounds	Season of Operation
Riley 1	Early Archaic	16	<i>Agave sp.</i> caudex, <i>Dasyllirion sp.</i> caudex, <i>Allium sp.</i> bulbs	Winter/Spring
Riley 2	Early Archaic	4	<i>Opuntia sp.</i> cladodes and <i>Dasyllirion sp.</i> caudex	Winter/Spring
Riley 3	Early Archaic	10	<i>Opuntia sp.</i> tunas	Summer
Stock 1	Early Archaic	33	Unidentified epidermal tissue—may be <i>Agave sp.</i> , <i>Dasyllirion sp.</i> or other	Fall/Winter
Stock 2	Early Archaic	10	<i>Opuntia sp.</i> tunas	Late Summer/ Fall
Stock 3	Early Archaic	12	<i>Opuntia sp.</i> cladodes and <i>Allium sp.</i> bulbs	Spring
Williams-Dean 1	Early Archaic	31	<i>Opuntia sp.</i> cladodes and <i>Allium sp.</i> bulbs	Spring
Williams-Dean 2	Early Archaic	50	Bone fragments, <i>Agave sp.</i> caudex, <i>Juglans sp.</i> nuts, and <i>Opuntia leptocaulis</i> fruits	Fall/Winter
Williams-Dean 3	Early Archaic	19	<i>Opuntia sp.</i> tunas	Summer
Edwards 1	Early and Late Archaic	24	Burnt Bone	Fall/Winter
Edwards 2	Early and Late Archaic	7	<i>Opuntia sp.</i> tunas and <i>Diospyros sp.</i> fruit	Summer
Edwards 3	Early and Late Archaic	8	<i>Allium sp.</i> bulbs and unidentified epidermal tissue—may be <i>Agave sp.</i> , <i>Dasyllirion sp.</i> , <i>Opuntia sp.</i> or other	Spring

**Table 3. Caloric Value of Known Food Resources from the Lower Pecos Canyonlands**

Plant	Plant Part	Caloric Value/ 100g	Cooking Method	Source
<i>Agave lechuguilla</i>	Caudex	319	Intensive cooking	Dering 1999
<i>Dasyllirion sp.</i>	Caudex	343	Intensive cooking	Dering 1999
<i>Opuntia sp.</i>	Cladode	27	Varied	Sobolik 1991
<i>Allium sp.</i>	Bulb	35	Varied	Sobolik 1991
<i>Prosopis sp.</i>	Legume Pod	273	Pounding	Sobolik 1991
<i>Juglans</i>	Nut	618	Minimal	USDA 2006
<i>Opuntia sp.</i>	Fruit	41	Minimal	USDA 2006
<i>Diospyros texana</i>	Fruit	127	Minimal	USDA 2006
<i>Vitis sp.</i>	Fruit	69	Minimal	USDA 2006
<i>Helianthus sp.</i>	Achene	570	Minimal	USDA 2006
<i>Chenopodium sp.</i>	Small Fruit	195	Pounding	Sobolik 1991
<i>Amaranthus sp.</i>	Small Fruit	374	Pounding	USDA 2006
POACEAE	Caryopsis	314	Pounding	Cane 1987
<i>Polygonum sp.</i>	Seed	92	?	USDA 2006

Prickly pear cactus seeds and epidermal tissue were also important clustering variables in the other coprolite assemblages from Hinds Cave considered in this present study. Most specimens with high levels of tuna seeds [Stock Cluster 2 (n=10), Williams Dean Cluster 3 (n=19), and Edwards Cluster 2 (n=7)] have relatively low levels of other constituents, which reinforces the ethnohistoric record of the

seasonal dominance of cactus tuna as a mid-summer resource (Brown 1988; Krieger 2002; Taylor 1972; Wade 2003:14).

The clusters with high levels of prickly pear cactus epidermal tissue [Stock Cluster 3 (n=12), Williams Dean Cluster 1 (n=31), and Edwards Cluster 3 (n=8)] also have a low diversity of other constituents. Each of these clusters also has higher levels of onion bulb fragments than the other clusters. This supports the view of Edwards (1990) that cold season coprolites will contain a low diversity of dietary constituents and a heavy dependence on a handful of seasonally available staples such as nopales or onions (see Table 2).

The remaining clusters [Stock Cluster 1 (n=33), Williams Dean Cluster 2 (n=50), and Edwards Cluster 1 (n=24)] are more difficult to evaluate, due to the limited identification of primary dietary components noted above. Cluster membership seems to be due to the absence of high levels of prickly pear cactus seeds and epidermal tissue. The specimens in these three clusters (which account for most specimens in each study) reflect a high diversity and low abundance of dietary resources. I maintain that this is due to the lack of detailed identification of the major dietary constituents of fiber and epidermal tissue. It seems likely that some of these specimens reflect a dietary dependence on lechugulla and sotol hearts, while others may indicate a broad-based diet on seasonally available fruit and seed resources, similar to clustering exhibited by specimens from Baker, Frightful, and Parida Caves (Riley 2010).

Overall, the combined coprolite data presented here provide a robust set of data to explore the subsistence strategies employed by the Holocene hunter-gatherer populations occupying Hinds Cave. There are 224 coprolite specimens from Hinds Cave, ranging from the Early Archaic to the Late Archaic. While differing levels of identification and expertise limit direct comparison between these data sets, there are general observations that reinforce the more detailed analysis presented above. Of the 224 specimens analyzed by various researchers from Hinds Cave, 66 (29.5%) contain the digested residue of a meal including baked sotol or lechuguilla caudex (Table 4). Another 47 (20.3%) contain evidence of nopale consumption. Forty-three specimens also contain onion bulbs, suggesting that these two resources were frequently consumed together as a meal. Forty-six (19.8%) specimens from Hinds Cave are the residue of meals focused on tunas as a staple resource. The remaining 65 specimens (29.0%) from Hinds Cave are not classifiable due to a lack of identification of the primary components recovered from the specimens. It seems likely that many of these remaining specimens reflect the consumption of either desert succulent resources or nopales, but the lack of epidermal and fiber identification from these studies (Edwards 1990; Stock 1983) precludes any secure statement of dietary reconstruction.

**Table 4. Dominant Dietary Resources in Coprolite Specimens**

Dominant Resource	Hinds Cave	
	Number of Specimens	Percentage
Nopales	47	21.0
Tunas	46	21.0
Caudex	66	30.0
Unknown	65	29.0
Small Seeds		0.0
Total	224	100.0

The data indicate that the plant resource components of many of the meals represented by these coprolite specimens were dominated by one or two staple plant resources. While this is frequently supplemented with trace amounts of secondary resources such as hackberry fruits and other small fruits and seeds, the data indicate a stable exploitation of the four major resources considered in this study that spans the Holocene. This fits well with the ethnohistoric observations of Cabeza de Vaca and De León the elder, both of whom indicate that the seasonal diet of the native groups observed was almost monolithic in composition (Brown 1988; Krieger 2002; Thoms 2008). While this may be partly due to the outsider perspective and clear disdain accorded native lifeways by De León (1971), the coprolite data corroborates the overall pattern of heavy dependence on a few staple resources across the annual cycle.

The coprolite data demonstrate that nopales and onions are much more important resources than would be predicted with a diet-breadth model (Riley 2012). This brings into question the measured caloric value for these resources. As Wandsnider (1997) points out, fructans require extensive cooking times to render them digestible in the human gastrointestinal system. While the caloric values for sotol and lechuguilla are based on samples prepared using traditional earth oven technology (Dering 1999), the values for onions and nopales are based on modern cooking methods that likely under-represent their total potential caloric contribution in the paleodiets of the Lower Pecos Canyonlands (Sobolik 1991; Winkler 1982). Additionally, recent research by Lawrence et al. (2015) has also demonstrated that there is previously unidentified starch in both the nopales and tunas of the prickly pear cactus. This starch was not encountered in any of the coprolite specimens containing other microfossil traces of nopales (Riley 2010), which highlights the possible under-representation of starch-based resources in coprolites due to digestion.

A different explanation for the cluster of coprolites reflecting diets dominated by nopales and onions is a seasonal dependence on these low-ranked resources. The clusters exhibiting high amounts of prickly pear cactus epidermal tissue indicate a late winter/early spring occupation of the site and generally have little evidence of meals incorporating higher-ranked resources. Alternatively, a diet-breadth model based on a currency of gross caloric return may not fully explain the dietary choices made by human populations occupying the Lower Pecos Canyonlands. It is possible that onion bulbs and nopales were incorporated into the diet for reasons other than gross caloric intake. Nopales have been an important food resource across the Holocene among the human populations occupying the Lower Pecos Canyonlands.

As previous studies (Bryant 1974; Dering 1979; Edwards 1990; Sobolik 1991; Stock 1983; Williams-Dean 1978) have concluded, the human exploitation of the Lower Pecos environment appears to have followed a similar pattern across much of the Holocene. In the studies presented here, which span most of the Archaic, prickly pear cactus was an important seasonal resource, both during the summer when tunas were available and during the cool season, when the abundant nopales of these cacti would have been a low calorie but bulky food source. This study also indicates that Hinds Cave has been used as a habitation across the seasons during the Archaic. The present research suggests that the mobility of populations in the Lower Pecos was more random and opportunistic than predicted in the model

developed by Shafer (1986:117-119), responding to both long term and seasonal fluctuation in resource availability.

## **INFORMING CONTEMPORARY DIET THROUGH ARCHAEOLOGICAL AND DOCUMENTARY DATA**

The data presented in this study show that the human populations living along the northern fringe of the Chihuahuan Desert were dependent on fructan-based plant resources for the majority of their carbohydrate intake. The temporal depth and spatial breadth of this strategy across most of arid North America has some important dietary implications for modern populations exhibiting genetic continuation with the pre-Columbian inhabitants of the region. Many populations living near the Mexican-United States border, especially Native Americans and Mexicans with indigenous heritage, have extremely high levels of diet-induced health issues, such as obesity and diabetes (Archer et al. 2002; Wiedman 2005). This is due, at least partly, to a major change in the carbohydrate composition of the diet of these populations over the last half-millennium of cultural change (Johnston 2007; Richards and Patterson 2006; Teufel 1996). Soluble dietary fibers generally, and specifically fructans, have been shown to have a positive, ameliorating effect on lipid and glucose metabolism (Beylot 2005; Daubioul et al. 2002; Daubioul 2005; Delzenne and Daubioul 2000; Roberfroid 1999; Williams and Jackson 2002). Studies have shown that the fructan components of both *Agave* sp. and *Dasyliirion* sp. have similar effects on metabolic function as the commercially available fructans derived from chicory root (*Cichorium intybus* (LINN.)) (Urias-Silvas et al. 2008). These data suggest that attempts to address the high prevalence of obesity and diabetes among indigenous populations in the Chihuahuan Desert with diet should focus on the promotion of neglected, traditional food resources, both as whole foods as well as sources of fructans for the food industry (Huazano-Garcia 2009; Lopez and Urias-Silvas 2007). In addition to the metabolic regulation benefits mentioned above, fructans have a positive impact on colon cancer (Leach 2007; Pool-Zobel and Sauer 2007; Taper and Roberfroid 2002) and general colonic health (Heizer et al. 2009) as a prebiotic soluble fiber. The incredible temporal depth of fructan consumption by human populations in the Chihuahuan desert has already been noted by some researchers (Leach 2007; Leach and Sobolik 2010) and, it is hoped, may inform on the community health strategies applied in the borderlands today.

## **CONCLUSION**

The combined coprolite data available for the Lower Pecos Canyonlands record a long-term dietary pattern of seasonal dependence on a handful of staple resources, throughout the Archaic. There are three major seasonal menus reflected in the coprolite data. The first menu consists of nopales, and was principally, although not exclusively, consumed in the late spring. This menu is primarily consumed when other resources were not readily available and may be considered a dependable but undesirable meal. The second menu consists of pit-baked lechuguilla and sotol, common throughout the cool season. This menu entails high processing costs, but would provide a reliable caloric return. The third menu exhibits a monolithic reliance on tunas during the summer. The ease of harvest and consumption is reflected in the seasonal dominance of this resource, which was assuredly a highly desirable meal. These patterns of dietary consumption, which extend back eight thousand years, are corroborated by



the written accounts of early European observers in the broader region. This long temporal depth is a reflection of how successful this subsistence pattern was at extracting a living foraging in a marginal, arid environment.

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## DATA AVAILABILITY STATEMENT

All data utilized in this article is available in Riley (2010).

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