USE-WEAR INSIGHT INTO THE CHIPPED STONE PLANT-PROCESSING TOOLKIT OF THE LOWER PECOS CANYONLANDS

by

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DEDICATION

I dedicate this thesis to my late grandmother, Alma Lankhorst, and my mother, Julie Ann Tatem. You have always been my biggest supporter and confidant, mom. I could not have done this without your love and encouragement. Thank you for being there for me every step of the way. Ik hou van je!

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LIST OF ABBREVIATIONS

Abbreviation	Description
ASWT	Ancient Southwest Texas Project
BRM	Burned Rock Midden
ENC	Eagle Nest Canyon
FCR	Fire-cracked Rock
LPC	Lower Pecos Canyonlands
PDSM	Post-depositional Surface Modification
RCYBP	Radiocarbon Years Before Present
SfM	Structure from Motion
TARL	Texas Archeological Research Laboratory

I. INTRODUCTION

Archaeological evidence and ethnographic accounts from the Chihuahuan and Sonoran Deserts of North America show that evergreen rosettes were critical plant resources for Indigenous people. These desert plants were processed in earth oven facilities as food and major fiber resources. More research, however, is needed to understand which tools were used to process these plants and how. The Lower Pecos Canyonlands (LPC) of southwest Texas and northern Mexico has thousands of sites that potentially could provide further insight into identification and analysis of the chipped stone tool assemblages associated with plant-processing activities; for the purpose of this study, I targeted four sites in the LPC. This thesis presents the results of a use-wear analysis of plant-processing tools from Eagle Cave (41VV167), Skiles Shelter (41VV165), Little Sotol (41VV2037), and Sayles Adobe (41VV2239) in Val Verde County, Texas. Analyzing wear patterns from experimental and archaeological assemblages using low- and high-power microscopy provides concrete evidence towards identifying the prehistoric chipped stone toolkit linked to the processing of evergreen rosettes.

In this study, the goal of my research is to formulate an understanding of the use and variety of chipped stone tools needed to process plants, in order to correlate tool type with tool function. With my research I identify which tool types were used for certain tasks, as well as whether tools were used during single or multiple events. I identify the contact material that was processed with each tool and evaluate which tools were used to process plant material. Further, I establish guidelines for adequately identifying plant-processing tools within the field and the lab, for those not experienced with use-wear analysis.

Lower Pecos Canyonlands

The geographic and cultural boundary of the LPC is largely defined by the distribution of Pecos River Style Art and other cultural materials/features (Figure 1; Bement 1989:63; Turpin 2004:226). The Lower Pecos region is a semi-arid landscape dissected by the Pecos River, Devils River, the Rio Grande and their tributaries, whose confluences are now inundated by the Amistad Reservoir (Black and Dering 2008; Turpin 1995). These were major water resources that prehistoric people depended on, and the intensification of archaeological habitation and plant-processing sites surrounding these rivers throughout the LPC reflects their importance.

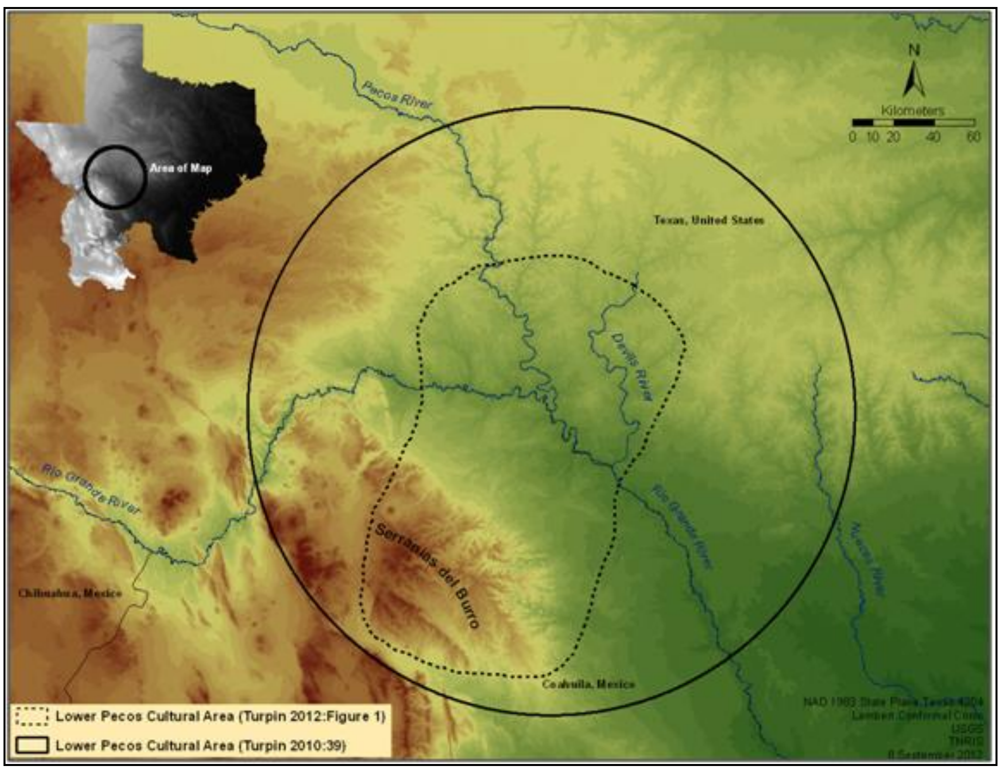

Figure 1.1. Approximate geographic extent of the Lower Pecos archaeological region and cultural area (Koenig 2012:12).

The Lower Pecos archaeological region has been investigated by archaeologists and researchers since the early 1930's. Investigations in the area began with the 1932 excavations at Fate Bell Shelter in Seminole Canyon by Pearce and Jackson of the University of Texas, in addition to test excavations of Eagle Cave and Kelley Cave the same year by E.B. Sayles under a private Arizona research organization (Black 2013; Story and Bryant Jr. 1966). Several other institutions quickly followed suit and began excavations in the area, including the Smithsonian Institute in 1933, the Witte Museum of San Antonio in 1933 and again in 1936, and Texas Tech University in 1937. Forrest and Lula Kirkland, originally artists before their interests turned to archaeology, conducted a rock art study from 1933-1942 and sketched/painted the pictographs from many areas of Texas (Kirkland and Newcomb, Jr. 1967). After this five-year period of excavations, the LPC remained largely untouched by archaeologists for over twenty years until the Amistad Reservoir archeological salvage program began in 1958 (Black 2013:144; Dering 2002; Story and Bryant Jr. 1966). This program ultimately led to the discovery of hundreds of archaeological sites and decades of further research. In 2009, the Ancient Southwest Texas Project (ASWT) of Texas State University began surveying, testing, and excavating at many sites in the LPC, four of which are discussed in this thesis.

The abundance of earth oven facilities within the LPC is consistent with evidence from the archaeological record of the greater southwest (Miller et al. 2011; Shafer 1988; Turpin 1984). An earth oven is defined as a "layered cooking arrangement of fire, heated rocks (usually), food, green-plant packing materials, and sediment designed to bake food in moist heat at an even, relatively low temperature for periods of time ranging from a few hours to several days" (Black and Thoms 2014:205). Earth oven facilities are characterized as a recognized place that would be returned to many times, identified by both the pits used for cooking and associated debris such as large accumulations of fire-cracked rock (FCR), heating and reheating of cook stone, charred plant remains, and chipped stone tools (Thoms 2008). FCR results from the heating of large stones within these ovens, the accumulation of which shows up in the archaeological record as burned rock or ring middens. These earth oven facilities are found in abundance throughout the LPC landscape.

Agave and sotol have been exploited for thousands of years as a source of food and fiber used to create fire drills, quids, cordage, sandals, brushes, textiles, paint (sapogenins) and countless other items essential to hunter-gatherer lifeways, evidence of which is seen within southwest Texas and northern Mexico (Saunders 1992; Sheldon 1980). Archaeological and coprolite studies in the Lower Pecos suggest that prehistoric people had a broad-spectrum diet which heavily relied on sotol (*Dasylirion spp.*) and lechuguilla (*Agave lechuguilla*), both of which were abundant resources used throughout history (Dering 1979, 1999; Riley 2010; Saunders 1986; Sobolik 1988, 1989, 1991, 1996b; Turpin 1995; Williams-Dean 1978). Clearly, prehistoric people in the LPC were intensively processing and consuming evergreen rosettes, like agave and sotol, through the use of earth oven technology.

In addition to coprolite analysis, there have been organic residue and low-power use-wear studies of lithics from Hinds Cave which show evidence of evergreen rosette processing at this site (Shafer and Holloway 1977, 1979:392; Sobolik 1996a:465), but this is a small sample from only one site within the LPC. More research is needed of chipped stone assemblages from several different site collections throughout the Lower Pecos to establish a formalized identification and further understanding of the general plant-processing toolkit.

Within the LPC and elsewhere, the arid environment during the Holocene made subsistence on desert plants essential to prehistoric peoples which is a basic principle of behavioral ecology (Dering 2005). Not only were these plants an important resource throughout prehistory, but ethnographic accounts from adjacent regions show that agave and sotol were maintained as important resources, used with great diversity, well into the 19^{th} century (Bell and Castetter 1941; Castetter 1935; Castetter et al. 1938; Gentry 1982). Though these ethnographic accounts are not from the LPC specifically, many of the activities described are comparable between the regions. Furthermore, evidence of the extensive use of plants and earth ovens in prehistory can be seen on an even wider scale across the American Southwest and eastward in Central Texas which provides context to parallel evidence from the LPC (Creel 1991; Miller et. al 2011; Wilke and McDonald 1989).

Along the ecotone between North America's Southeastern Woodlands and the Southern Plains, the "carbohydrate revolution" marked an unprecedented intensification of the exploitation of plant foods (Thoms 2008). These plant foods included sotol, lechuguilla, yucca, cholla, prickly pear, wild onions, among others. The carbohydrates/inulin in plant foods become more nutritious, digestible, and sweet tasting when hydrolyzed through application of heat (Fish et al. 1992: 73; Thoms 2008: 122). In the Archaic period, people were well adapted to a semi-nomadic hunter-gatherer lifestyle exploiting the variety of natural resources available. Plant processing was particularly important and predominated earth oven technology, and we can gain insight into this process partially through available ethnographic literature.

Evergreen Rosette Plants

The term “evergreen rosettes” is a category of xeric plants, referring to species found within arid environments that share morphological characteristics such as leaf margins with spines and fleshy/pulpy leaves in a rosette spiral pattern (Dering 2008; Gentry 1982; Hawk 2016; Turner 2009). These are robust plants with parallel-veined leaves that bloom once a year in a tall stalk from the center. The rosette pattern of the leaves works in such a way that water can trickle down towards the base of the plant as a natural irrigation system. Thus, these plants do not require high annual precipitation to thrive. Examples of evergreen rosette plants include agave, yucca, and sotol among others. Throughout this thesis, I refer to evergreen rosettes as a whole because of the similarity in native habitat range, morphology, and processing techniques. My experimental research will specifically focus on sotol (*Dasylirion spp.*) and lechuguilla (*Agave lechuguilla*) which are notably prevalent within the LPC. In the Langtry area of Texas, sotol and lechuguilla rival each other in extent and occupy the lower ridges within the coarse stony debris and arid climate (Castetter et al 1938: 22-24).

Sotol, also known as the “desert spoon” referring to the concave bases of the leaves, has a heavily matted root structure and occurs on rocky canyon slopes and calcareous soils on the edge of drainages. It is a polycarpic plant, meaning it flowers multiple times throughout its lifetime. Unlike agaves, the sotol inflorescence (i.e., blooms) do not diminish the plant. Today these plants are often used in modern desert landscaping. The innermost portion of the plant is white and is often referred to as a “bulb,” “crown” or “heart;” it is marginally edible raw but much more palatable and digestible when cooked (Hawk 2016; Turner 2009:113). The tough and flexible leaves radiate from the bulb in a rosette pattern and are edged with hooked teeth/spines. The tips of the leaves lack sharp points and are often tufted and weather worn. When the leaves are removed the base of the sotol resembles a large pineapple. The dried stalks are excellent sources of kindling that will burn when wet; these have long been used for a range of activities by prehistoric people. A large variety of animal life is attracted to these plants and their flowers. Deer, rats, gophers, and rabbits all feed on the younger plants, which would allow for ideal hunting and gathering areas for prehistoric people. Today, the landscape of the Lower Pecos is still dominated by sotol.

Agaves are monocarpic plants that prefer low elevations and low levels of precipitation and much like sotol, dominate within rocky canyon slopes and calcareous soils. They are not truly perennial or annual plants and may be more accurately thought of as long-lived desert succulents. Due to an agave's water-storage and photosynthetic needs, the fibers within the leaves are few but strong and are aptly named "hard fibers" or *ixtle*, a term used in the fiber industry of Mexico (Castetter et al 1938: 24). The leaves are edged with stiff, sharp spines that are also present on the tips, and like sotol they spiral in such a way (i.e., rosette) that any rainwater is collected towards the base of the plant as a natural irrigation system. The agave is also known generally as the century plant, largely based on the belief that these plants only flower once in their life cycle after they have reached 100 years of age. This belief, however, is largely incorrect (Gentry 1982; Hawk 2016). Many agave species flower at varying times of the year and the small varieties often mature well before the century mark. Once the seeds have matured, the agave leaves start to wither and the plant dies, giving space for the seeds to root and begin the cycle anew.

No other agave species has been found to have a larger extent or range than agave lechuguilla (Castetter et al. 1938:6; Gentry 1982), therefore the technology to process these plants has been widespread and well-developed since prehistoric times. In modern Mexico, lechuguilla is currently the most harvested species of agave for fiber production (i.e., *Tampico*, a term used in the fiber industry of Mexico analogous with *ixtle*) (Turner 2009:113). They are also thought to be the most important soap species of the southwest because out of all the agaves, lechuguilla has the highest quantities of saponins. When combined with water, these saponins produce suds that create an effective cleaning agent (Castetter et al. 1938:8). These plants are found in the lower mountains, limestone highlands and foothills and are generally not found in valleys. Lechuguilla is also often eaten by rabbits, gophers, and collared peccaries, so prehistoric people would have had the opportunity to exploit multiple resources at once when harvesting these plants. The word lechuguilla can translate to “cabbage-like” or “small lettuce” depending on the source (Castetter et al. 1938; Gentry 1982; Hawk 2016). Commercial production of fibers from lechuguilla began in the 19th century (Sheldon 1980).

In addition to food and fiber uses, evergreen rosettes were fermented for alcoholic beverages. In central Mexico, pulque was a fermented drink made from the sap of large agave species. In the southwest, agave was used to make mescal. Here, mescal is a generic term used to describe fermented agave beverage and should not be confused with the modern distilled agave liquor. This required roasting and pounding of the plant, and then burying underground for two days in an animal hide pouch. This was then uncovered, and the juice squeezed into another container for fermentation (Castetter et al. 1938:60). In historic times in areas of northern Mexico and the southwestern United

States, sotol has been fermented and distilled into a liquor. Though the process of making alcoholic beverages out of these plants varied depending on the type of plant being processed and the processing technology, this type of activity was drastically increased after European contact and continues to the present day in the production of tequila.

Lithic Use-Wear Research

Evidence of intensive processing and use of evergreen rosettes can be observed on chipped stone tools using use-wear analysis. I use methods of microscopic use-wear analysis established by Semenov (1964) and Keeley's (1980) comprehensive publications to inform my analysis. Odell (2003) and Andresfksy Jr (2005) have further refined these methods. Though I do not focus on hafting wear or organic residue analysis, I identified evidence of such when seen (Fischer et al. 1984; Shafer and Holloway 1979). Hafting is an indication of a more formal tool that had a greater use-life as compared to hand-held expedient tools. I also follow the research methods of contemporary experts and scholars including: Helle Juel Jensen (1994) who has done extensive work on chipped stone plant-processing tools, Dale Hudler (1997) who analyzed Clear Fork tool use in Texas, and Marilyn Shoberg (2010) who has conducted use-wear analysis on Clovis tools and their function from the Gault site in Texas.

Characteristics of use wear depends on the resource being processed, whether it be meat, wood, or plants. Evidence of processing desert succulents/evergreen rosettes for earth oven use should be seen on chipped stone tools in the form of polish, striations, and edge-modification which can provide insight into direction of use and intensification of wear/episodes of use. Polish can often be seen macroscopically and is defined as a highly reflective surface with a fluid appearance resulting from the spread of plant phytoliths and/or as a result of friction (Keeley 1980:61). Also known as "sickle-" or "corn-gloss," polish refers to the smooth, fluid-like and highly reflective appearance of the surface caused by using tools on plant material (Jensen 1994:13), though the process of formation of polish is debated upon. Heavy layers of overlapping polish result in a scaly, reflective and fluid surface in appearance and is caused by plant polish being pushed up along the working edge of the tool.

Striations are the grooves and pits resulting from friction of the tool on the resource, usually intruding into the polished area (Jensen 1994:12). These are generally only seen with higher magnifications, though larger striations can be seen with the naked eye. Striations are generally linear grooves that vary in depth, width, and shape and are used as an indicator to infer direction of use (Jensen 1994:12; Vaughan 1985: 12). Edge-modification is a deliberate act that provides insight into initial production, retouching/resharpening events, post-depositional processes, and the hardness of the material being processed (Jensen 1994:12). "Edge damage" (Keeley 1980:24) refers to the scars produced along the lateral edges of a tool resulting from utilization or natural mechanisms and may also be referred to as microchipping as well as other terms (Vaughan 1985: 11). This should not be confused with intentional retouching of a tool's edge.

Research Objectives

The goal of my research is to formulate an understanding of the use and variety of chipped stone tools utilized in the Lower Pecos Canyonlands to process and bake plants in earth ovens (both for consumption and as a resource for fiber production) in order to correlate tool type with tool function. With my research I attempt to identify if a particular tool type was used for a specific process/task, as well as whether tools were used during single or multiple events. Different tool types were likely used for different functions or steps in the processing of evergreen rosettes, though one tool type may have been used for multiple functions. My goal is to provide a greater understanding of the function of each tool and thus into the general toolkit throughout the process. Being able to distinguish whether a tool was used during one event or multiple can provide insight into which tools were essential or preferred for the intensive processing of evergreen rosettes.

To reach this goal, I have conducted a use wear analysis on chipped stone tools from several archaeological sites in the Lower Pecos archaeological region, focusing on tools used to process evergreen rosettes. I have analyzed a selection of both expedient (e.g., flake tools) and formal tools (e.g., agave knife) in order to identify the components of the toolkit involved in the practice of harvesting and processing these evergreen rosettes. I use the term "agave knife" as a typological classification rather than functional; the terms "butted biface" and "Kerrville knife" are essentially synonymous (Black 2016). First, a low magnification microscopic analysis of the chipped stone tools was conducted to visually identify characteristics such as edge-attrition, polish, presence or absence of cortex, stage of manufacture, and organic residue/fiber. High magnification microscopic analysis was then used in order to identify and recognize the microwear patterns to further infer direction of use and contact material. A control sample of replicated chipped stone tools used on other contact material such as hide/animal flesh, grass, bone, and wood was used to inform this analysis.

Experimentally replicated tools made of Edwards chert were produced in order to harvest and process sotol and lechuguilla. After using the experimental tools to process several evergreen rosettes, these tools were then analyzed to document the wear pattern evidence produced from these activities. Once the use wear on the experimental assemblage was analyzed, the experimental use-wear evidence was compared to the wear evidence documented on the archaeological tools (Fischer 1984; Shafer and Holloway 1979). The comparison between experimental and archaeological use-wear evidence aids in distinguishing the function of these tools using a known point of reference. The information derived from the experimental portion of my research helped form the control of my analysis, which in turn helped to draw informed conclusions upon the archaeological data.

Thesis Organization

This thesis is organized as follows: Chapter 2 discusses the environmental background of the LPC, the regional cultural chronology, and previous site investigations of the targeted sites. Ethnographic accounts of plant use within the greater southwest region of North America, specifically of evergreen rosettes like sotol and agave, is detailed in Chapter 3. Chapter 4 accounts the archaeological evidence of sotol and agave within the LPC, describing the variety of artifacts produced from these plants as well as evidence from coprolite analysis and macrobotanical research. The methodology used to analyze both the archaeological and experimental chipped stone tool assemblages is described in Chapter 5. Chapter 6 discusses the results of the use-wear analysis including the low- and high-power microscopic analysis of both the archaeological and experimental samples. Chapter 7 presents a discussion of my interpretations and includes a summary of the information presented, with concluding remarks and areas for future research.

II. REGIONAL BACKGROUND

This chapter summarizes the natural environment and chronology of the Lower Pecos Canyonlands, and previous investigations of the targeted sites explored within my research. The natural environment of the LPC is reviewed here in order to understand how it affected Indigenous populations in the past and how they adapted to it. This includes how the geography, geology and soils, and precipitation influenced local and regional resource exploitation and technological developments (i.e., earth oven technology and plant baking). The prehistoric cultural chronology helps to characterize periods of time in the LPC based on fluctuations of certain technologies and adaptive strategies. The regional information provides context and perspective about the four targeted sites described below: Little Sotol (41VV2037), Skiles Shelter (41VV165), Eagle Cave (41VV167), and Sayles Adobe (41VV2239).

Natural Environment

The Lower Pecos region is dissected by the Pecos River, Devils River, the Rio Grande and their tributaries, whose confluences are now inundated by the Amistad Reservoir (Turpin 1995, 2004). The natural environment has been well researched, documented and described over the years by archaeologists studying the LPC, therefore I will only provide a brief description here. The region is elliptical in shape and extends approximately 150 km north and south of the Rio Grande (Bement 1989:63; Shafer 2013). The southernmost boundary of the LPC is bordered by the Los Burros Mountains in Mexico. The region is situated along the southeastern portion of the Edwards Plateau, the western portion of the Balcones Escarpment, and the western Stockton Plateau. The plateaus converge to form the southernmost extent of the Great Plains Province of North

America. This region is a semi-arid landscape within the northeastern margin of the Chihuahuan Desert and receives a low amount of annual precipitation with an average annual rainfall of 44 cm (Black and Dering 2008; Dering 2002; Office of the State Climatologist 1987).

The Lower Pecos region is unique in that it lies within three distinct biotic zones: Chihuahuan, Balconian, and Tamaulipan (Dering 2002). The convergence of these different zones provides a diverse natural environment with a wide variety of flora and fauna. Vegetation includes juniper-oak savannah, mesquite-acacia, and sotol-lechuguilla-creosote bush vegetation.

The region is characterized by rolling terrace hills and steep canyonlands, underlain by Cretaceous-age limestone bedrock (i.e, Boquillas, Eagle Ford, and Salmon Peak) and a variety of soil types derived from these formations and alluvium (Dering 2002). Uvalde and Rio Grande chert gravel outcrops can be found in the region, which would have been exploited for lithic procurement when available. These soils are rocky and permeable, which are ideal conditions for evergreen rosettes. The porous limestone also allowed many temporary springs/streams that provided relief in the xeric landscape in addition to the major rivers (Black and Dering 2008).

Lower Pecos Canyonlands Chronology

The Lower Pecos Canyonlands has a long history of occupation over thousands of years that has been divided into periods. This section describes periods of the LPC as characterized by Solveig A. Turpin. The Paleoindian period in this area, according to Turpin, extended prior to 12,000 RCYBP (Radiocarbon Years Before Present) and through 8800 RCYBP (2004:268). The Archaic period covers 8900 to 1300 RCYBP. The

Late Prehistoric period ranged from 1320 to 250 RCYBP and the Historic period extends from 1600 A.D. to present. Because many of the tools from the targeted sites within my research are largely from the Archaic period, I will discuss the Archaic subperiods as characterized by Turpin: Viejo, Eagle Nest, San Felipe, Cibola, Flanders, and Blue Hills.

The Viejo subperiod covers the Early Archaic period from 8900 to 5500 RCYBP (Turpin 2004:269). This period is characterized by the use of rockshelters as common habitation sites and the processing of evergreen rosettes such as sotol and agave for food and fiber. Turpin describes that this is likely as a response to an increasingly arid environment where these plants would be widely available as other resources such as big game declined due to cooler weather and lack of consistent resources. Projectile point types common for this subperiod include Uvalde and Martindale points, but also included a multitude of point variations with corner-notched, stemmed, and barbed basal edges. The site of Seminole Sink suggest that prehistoric populations of this period buried their dead in natural sinkholes found throughout this karstic region (Turpin 2004:270); the proportional amount of young/old and male/female suggest an egalitarian society.

The Eagle Nest subperiod from 5500 to 4100 RCYBP is distinctive due to the Pandale projectile point (Turpin 2004:270). As indicated by Turpin, this time period is also characterized by further intensification of plant baking and processing of lechuguilla, sotol, and yucca. Sites from this period such as Baker Cave suggest this shift signals higher mobility, larger groups, and increased diet breadth which would be ideal for earth oven technology advancement (Dering 2002). Considerable energy was placed on the low-risk but high-labor method of processing evergreen rosettes to adapt to the increasingly xeric environment.

The San Felipe subperiod ranged from 4100 to 3200 RCYBP, characterized by increasing mobility and refinement of projectile point styles and technologies (Turpin 2004:270-272). Arenosa, Langtry, and Val Verde dart points were common in this subperiod. Sites from this period show intensive plant-processing as a staple during this dry/hot interval. Rock art pictographs called the Pecos River Style are also thought to have emerged during this time, some of the oldest and most elaborate religious art types of the Americas which points to an increased reliance on shamanism to promote social cohesion according to Turpin. Carolyn Boyd's recent work on the White Shaman Mural in the LPC has been groundbreaking for the future of rock art interpretation in this area (Boyd and Cox 2016). This style of rock art is a defining characteristic of the Lower Pecos cultural and archaeological region.

The Cibola subperiod ranged from 3150 to 2300 RCYBP and is defined as the beginning of the Late Archaic by Turpin (2004:272-273). This time period is characterized by an abrupt shift of technology, economy, and site distribution which resulted from a break in the arid climatic condition of the times where the environment trended toward more wet/cool conditions. This environmental shift promoted the growth of the grasslands and the return of large game herds for hunting, though plants were still an important part of prehistory people's economy. Projectile points styles from this period include Marshall, Castroville, and Montell.

The Flanders subperiod of the Late Archaic dates to around 2300 RCYBP (Turpin 2004:273). Though not much is known from this time, the Shumla projectile point style is indicative of this time period. This period is characterized by an increase in aridity and a return to the resource exploitation strategies of the Early/Middle Archaic period.

The Blue Hills subperiod ranged from 2300 to 1300 RCYBP (Turpin 2004:274). The Ensor and Frio projectile point styles are indicative of this time period. There is an increase of production of more elaborate painted mats and grave goods for bundle burials, which were flexed individuals wrapped/bundled in woven mats and interred in dry rockshelters. The processing of evergreen rosettes for these mats would have been very important to the economy. This time period is also characterized by increased processing of plant materials within an increasingly diverse diet.

Previous Site Investigations

My research mainly focuses on documented artifacts from three sites within the Lower Pecos Canyonlands: Little Sotol (41VV2037), Skiles Shelter (41VV165), and Eagle Cave (41VV167). In addition to these three sites, I examine a unique artifact from Sayles Adobe (41VV2239). Investigations of these sites were conducted between 2011 and 2017 by the Ancient Southwest Texas (ASWT) Project of Texas State University under the direction of professor Stephen L. Black.

Eagle Cave (41VV167)

Eagle Cave is the largest rockshelter in Eagle Nest Canyon (ENC) and one of the largest in the region, located approximately 400 meters upstream from Skiles Shelter and Sayles Adobe. The site contains a large panel of Pecos River Style pictographs, deeply stratified cultural deposits, and ground stone bedrock features. This site assemblage includes a variety of plant remains and perishable items, chipped stone tools, painted pebbles, and human coprolites. A long history of excavations was conducted at the site, in addition to rock art documentation, which began in the 1930’s. The first major investigations were conducted by the Witte Museum in 1935-36 who excavated a large trench into the site and then the University of Texas researchers re-opened and further excavated the trench in 1963 as part of the Amistad Salvage project (Black 2013:142; Koenig et al. n.d.); this work identified 6 broad stratums with several dozen smaller lenses interspersed.

In 1995 the Texas Archeological Society Rock Art Task Force started a new wave of archaeological investigations at Eagle Cave, producing grid-drawings of the pictograph panel (Koenig et al. n.d.). Research by ASWT and Shumla was conducted in 2010 for a total data station mapping of the site, organized by Dr. Stephen Black, and a ground penetrating radar survey was conducted by Tiffany Osburn of the THC. Major excavations at the site were continued by ASWT from 2013-2017 under the direction of Charles Koenig and Dr. Stephen Black, made possible by the generous bequest of E. Thomas Miller to Texas State University in support of ASWT research (Koenig et al. n.d.). The ENC Archaeological Field School in 2013 combined dirt (under Black) and rock art archaeology (under Carolyn Boyd), where Boyd, Castañeda, and Koenig directed students recording rock art at Eagle Cave.

The 2014 Eagle Nest Expedition was a six-month season that removed the disturbed slump and fill areas of the site until intact layering was reached; a total of five stratigraphic sections were exposed and defined in this season (Koenig et al. n.d.; Nielsen 2017). Each unit and profile was intensively documented with Structure from Motion (SfM) photogrammetry, in addition to annotated orthographic photos. “The sampling strategy included collecting as much intact matrix as possible from each stratum exposed within the small sampling units for use in a variety of analyses. Special samples such as radiocarbon samples, spot samples, archaeoentomology samples (discussed below), and residue samples were recorded and collected separately, and burned rock was tabulated and weighed in the field and then discarded following ASWT "Rock Sort" methodology (see Heisinger 2019)" (Koenig et al. n.d).

The 2015-2017 Eagle Nest Canyon archaeological work kicked off with a five-month season beginning in January 2015 which recovered thousands of artifacts. During this season researchers were able to correlate ASWT stratigraphic layer designations to the UT/Witte profiles. In 2016, ASWT researchers returned and discovered Feature 14: "a layer of butchered *Bison antiquus* bones along with lithic debitage, tools, and decomposed wood centered around a surface hearth," approximately 10-20 centimeters underneath the where the UT/Witte archaeologists terminated their excavations in 1963(Koenig et al. n.d). Based on several radiocarbon dates, Feature 14 dates to 12,680-12,480 cal BP which suggests association with Bone Bed 2 at Bonfire Shelter. In preparation for stabilization and backfill, ASWT excavated columns in order to collect archaeoentomology samples in November 2016, and January to February 2017; thus marking the final ASWT excavations at Eagle Cave (Koenig et al. n.d). Continued analysis and research of the site is ongoing.

Skiles Shelter (41VV165)

Skiles Shelter is located in the lower canyon near the mouth of ENC just above the Sayles Adobe terrace, roughly 250 meters upstream from the confluence of the Rio Grande (Heisinger 2019:1). In the 1930's, the first archaeological work at Skiles Shelter was conducted by Forrest Kirkland who recorded the Pecos River Style pictographs at the site (Kirkland and Newcomb, Jr. 1967). The Texas Archeological Society Rock Art Task Force conducted work in the 1990s, with the most intensive rock art recording conducted by Shumla between 2010-2013). Archaeological excavations of the site began with ASWT when Skiles Shelter was tested in 2013, during a Texas State University field school under the direction of Dr. Stephen L. Black and Dr. Carolyn Boyd. Dan Rodriguez directed testing in 2013 and analyzed the results of testing for his thesis research (Rodriguez 2015). Charles Koenig directed more substantive ASWT excavations at Skiles Shelter in 2014 for a six-month season to expand upon initial testing and geoarchaeological analysis of deposits. During this 2014 season, SfM photogrammetry was used to create a 3D record of the site and excavations. Bryan Heisinger analyzed and reported the site for his thesis research (Heisinger 2019).

The site is a bi-lobed rockshelter with a tufa mound, a massive burned rock midden (BRM), a panel of Pecos River Style rock art, and numerous ground stone features which contained residue from agaves (Castañeda 2015:69; Heisinger 2019:1). The site measures approximately 36 meters in length and 7 meters in width and is the most threatened by flooding out of all the sites in ENC. In 2013 and 2014 excavations, a total of fifteen radiocarbon dates and all but two dated to the Late Prehistoric period (1000-350 RCYBP) (Heisinger 2019:4). Evidence shows that this site was used intermittently from the Early Archaic onward, and heavily during the Late Prehistoric. At least 2,000 earth ovens were estimated to have been constructed at Skiles Shelter using ASWT's Rock Sort FCR quantification method.

Heisinger identified several lithic tools, which he classed using descriptive categories, that show evidence of wear and residue traces associated with plant processing. These artifacts include sequent flakes, edge-modified flakes, unifaces, bifaces, retouched blades, and miscellaneous tool types. Additionally, intact layers of evergreen rosette fiber were found in the uppermost deposits of the shelter and charred plant remains were found throughout (Heisinger 2019:137). The large accumulation of FCR from the BRM, the wide variety and sheer amount of charred plant remains, along with tools associated with these features, strongly indicate that there was intensive evergreen rosette processing at this site.

Little Sotol (41VV2037)

The Little Sotol site is located on the west bank of Windmill Canyon above the confluence of Dead Man's Creek, a tributary of the Devils River (Knapp 2015:57). Unlike the other sites analyzed for this thesis, Little Sotol is the only one located outside of ENC. This is intentional in order to observe the differences, if any, between the tools and wear at open air terrace sites versus rockshelter sites and between sites in the eastern portion of the Lower Pecos (i.e., Dead Man's Creek) and the western LPC (Eagle Nest Canyon).

Little Sotol was excavated in 2011 during the Texas State University field school as part of the ASWT Project, with excavation continuing into 2012 (Knapp 2015). Ashleigh Knapp managed the excavation and analyzed the site for her thesis research. The site consists of a small rockshelter with an adjacent and sizeable open-air BRM that was used intermittently from the end of the Early Archaic into the Late Prehistoric period. The radiocarbon dates at the site ranged from 6980 to 720 cal. B.P. (Knapp 2015:157). Macrobotanical remains show evidence of evergreen rosette processing at this site (Knapp 2015:8). Knapp identified a large number of chipped stone plant processing tools including artifacts that she classed as agave knives (formal and expedient), scrapers, and choppers (2015:110). Knapp uses the class of "scraper" which encompasses tools such as sequent flakes (Knapp 2015:113). A sequent flake, sometimes called a "cortex flake", is generally unifacial and made from striking one end of an oblong cobble, gradually working backwards until the core is exhausted. Sequent flakes have a negative bulb on one side and a positive bulb on another, with cortex above the bulb of percussion (Epstein 1962:28). A preliminary investigation of use-wear of the chipped stone tools from Little Sotol was conducted by Sarah Himes-Morris (Himes 2012). The large BRM, charred plant remains, and tools associated with these remains all point to intensive plant-processing at this site.

Sayles Adobe (41VV2239)

Sayles Adobe is located on an inset terrace near the mouth of Eagle Nest Canyon below Skiles Shelter, approximately "260 meters upstream from the current bank of the Rio Grande and Eagle Nest Canyon confluence" (Pagano 2019:1). Sayles Adobe was excavated in 2016 and comprises the smallest assemblage among the targeted sites. The site is named after E.B. Sayles' sketch map from 1932 that marked the area as "sandy adobe" below Skiles Shelter. Victoria Pagano directed the excavation and analyzed the site for her thesis research in order to investigate cultural deposits and natural terrace formation (Pagano 2019). The site has produced dates ranging from the Late Paleoindian to the Late Prehistoric period. For present purposes, the most notable chipped stone artifact recovered from this site is an agave knife found *in situ* among fire-cracked rock remnants of an earth oven (Black 2016; Pagano 2019:62,149). This artifact is posited to be a formal tool for processing plants such as sotol and lechuguilla.

III. ETHNOGRAPHIC ACCOUNTS OF EVERGREEN ROSETTE PLANT PROCESSING AND BAKING

Ethnographic information is used in support of archaeological evidence in order to gain insight into the daily life of prehistoric people. This chapter serves to describe ethnographic accounts of evergreen rosette processing, illustrated by relevant and marvelous historic photographs of the Western Mescalero Apache of New Mexico and the southwestern U.S, presented and discussed by Alan Ferg (2003). Though these accounts are not specifically from the LPC, the region's plant processing activities can be paralleled to areas with similar resources and environments. This approach must be taken with caution because prehistoric cultures/economies fluctuated often and were not static. In this chapter, I argue that while tool materials and resource availability may have changed since contact, the processes are much the same.

Archaeological and coprolite studies in the greater Southwest suggest that evergreen rosettes such as sotol (*Dasylirion sp.*) and lechuguilla (*Agave lechuguilla*) were abundant resources used throughout many time periods which is supported by ethnographic accounts of the Athapascan language group and others (Castetter 1936; Castetter et al. 1938: 34-37; Sheldon 1980: 378). Though these peoples had a wide and varied diet that fluctuated seasonally, it appears that sotol and lechuguilla, particularly, were a dominant and important staple in these people's diet prehistorically, which continued into historic times (Figure 3.1). Evergreen rosettes such as yucca, sotol, and agave were processed in much the same way, and were often used interchangeably (Castetter 1936: 38; Ferg 2003: 4).

Figure 3.1. “Mescal harvest,” Spring 1906. Western Mescalero Apache. National Anthropological Archives, Photographer: Edward S. Curtis, NAA Neg. No. 76-4667.

Challenges of Ethnographic Research

Ethnographic and ethnobiological accounts/records can be an invaluable resource for archaeologists studying past peoples. Research of this kind can help provide insight into the economy and lifeways of prehistoric people of a region, insight that would otherwise be unavailable or lacking using solely archaeological information. However, difficulties of ethnography and ethnobiology arise from the lack of understanding between the knowledge and ceremony of prehistoric people and the economic practices/uses surrounding plants (Castetter 1935: 3). For example, early explorers and writers often did not describe the number of evergreen rosette hearts roasted within a single oven event, nor the number or gender of people who involved throughout the different steps of the process (Ferg 2003: 7). However, historic photos could provide some information of gender and number of people involved in this process, There are multiple ethnographic accounts of Indigenous peoples processing plants and roots within earth ovens, though often the evidence for chipped stone tools (or modern equivalents) are also superficially described and lacking. Early writers did not have the knowledge of these plants or tools to describe them adequately relative to current scientific standards.

The misidentification of plants by early ethnographers and explorers has also often led to confusion and misinformation. Early writers of the 19th century often wrote of yucca and agave without clearly distinguishing the two (Castetter et al. 1938: 10). Ethnobiologists today look at these early accounts and compare them to known modern plant populations' native habitats in order to get a better understanding of which plant these early writings are referring. Different plant communities were held in differing significance or importance depending on the group and native habitat of the plant communities.

Evergreen rosettes have long been prevalent for food and fiber throughout the southwestern United States and northern Mexico. Similar topography and biological resources can be found within these areas, which suggests that the ethnographic accounts are comparable between the areas as well. In the following discussion, specific genus/species of plants are detailed if described within ethnographic accounts. However, due to the fact that evergreen rosettes are similar in biology and in how they are utilized by Indigenous peoples, these parallels should be extended to all evergreen rosette species. Not only were agave lechuguilla and sotol specifically an important resource throughout prehistory, but ethnographic accounts show that these plants maintained as important resources used with great diversity well into the 19th century and are still used today.

Accounts of Tools, Food, and Fiber Production

Cabeza de Vaca's narrative describes the prevalence of oven-cooked roots in the 1500s across the Gulf Coastal Plain and northeastern Mexico (Parsons and Parsons 1990; Thoms 2008: 127). Though his accounts were not specific in the type of plants or process used, he notes that the bulbs would be baked for 48 hours, which implies processing through earth oven technology and facilities. Other 16th century accounts from Mexico note similar processes with maguey and further support this conclusion. From the variety of information available, it is a reliable inference to suggest these plants were sotol and agave.

Written records of evergreen rosette use is found scattered throughout historical texts. The earliest known account and recording of agave was from 1533 in the Dominican Republic by Peter Martyr (Castetter et al. 1938: 11). The Pima Baja of Sonora in northern Mexico were recorded cultivating agave by Perez de Ribas in 1645 (Castetter et al. 1938: 54). There is an account from 1870 where the Hopi traded maize to various tribes of Arizona, including the Havasupai and Walapai, in exchange for roasted agave. In the early 1900's along the border between the United States and Mexico, the "Pimas" (or "River People," both archaic terms for the Akimel O'odham people) and the "Papagos" (or "Desert People," both archaic terms for the Tohono O'odham people) were recorded obtaining roasted evergreen rosettes through trade (Castetter and Underhill 1935: 16). In the 1900's the Mescalero Apache were recorded gathering their families to fill large pits (Figure 3.2).

Figure 3.2. "Placing the Mescal" Spring 1906. Western Mescalero Apache. National Anthropological Archives, Photographer: Edward S. Curtis, NAA Neg. No. 76-4669.

The Spanish knew the Lipan and Mescalero Apache as the Upper and Lower Lipan, referring to their geographical position with respect to the Rio Grande River (Sjoberg 1953: 76). The Lipan were recorded roasting evergreen rosettes by early Spanish documents, researchers in the 1930's conducting field work, and in particular detail in an account from Frank M. Buckelew in 1866. He was held captive by the Lipan in southwestern Texas and northern Mexico during which he described the everyday use of the "soto" (i.e., sotol) bulb/root (Buckelew 1911: 72). Sotol ranked as the second most important and valuable economic activity to the Lipan after hunting bison (Sjoberg 1953: 82).

Though I focus on prehistoric gathering and processing of wild evergreen rosettes, cultivation of agaves also occurred and is marginally relevant. The Hohokam culture of southern Arizona were adept at cultivation and changing the landscape to sustain agave populations well outside of their native habitat (Bohrer 1991). Agave was cultivated as a cool-season crop as opposed to the warm-season crops of maize, beans, and squash.

Tortillas made from a combination of maize and the perianth of the agave flower was considered a delicacy among the Tarahumara of Chihuahua Mexico (Bye et. al 1975: 90). The Tarahumara of Chihuahua Mexico utilized eight species of agave as food and fiber (Bye et. al 1975: 86). Evergreen rosettes would be eaten year-round, but particularly in the cool seasons when other staples were not available.

There is now well-documented evidence of large-scale agave cultivation by the Hohokam in Arizona, first identified by archaeologists in 1985 (Fish et al. 1992; Hodgson et. al 2018). Evidence of this is seen through agricultural features such as rock pile fields and rock alignments, chipped stone tools indicative of agave harvest and processing [such as tabular knives (i.e., agave knives), turtleback scrapers (i.e., sequent flakes) and steep-edged core tools/pulping planes (Figure 3.3, no scale available)], and large roasting/cooking pits. Figure 3.3 shows artifacts from an archaeological site near Payson, AZ with both prehistoric and historic Apache components. Researchers speculate that the agaves were cultivated in riverine fields, though evidence has also been found to indicate cultivation on terraces (Hodgson et. al 2018: 734).

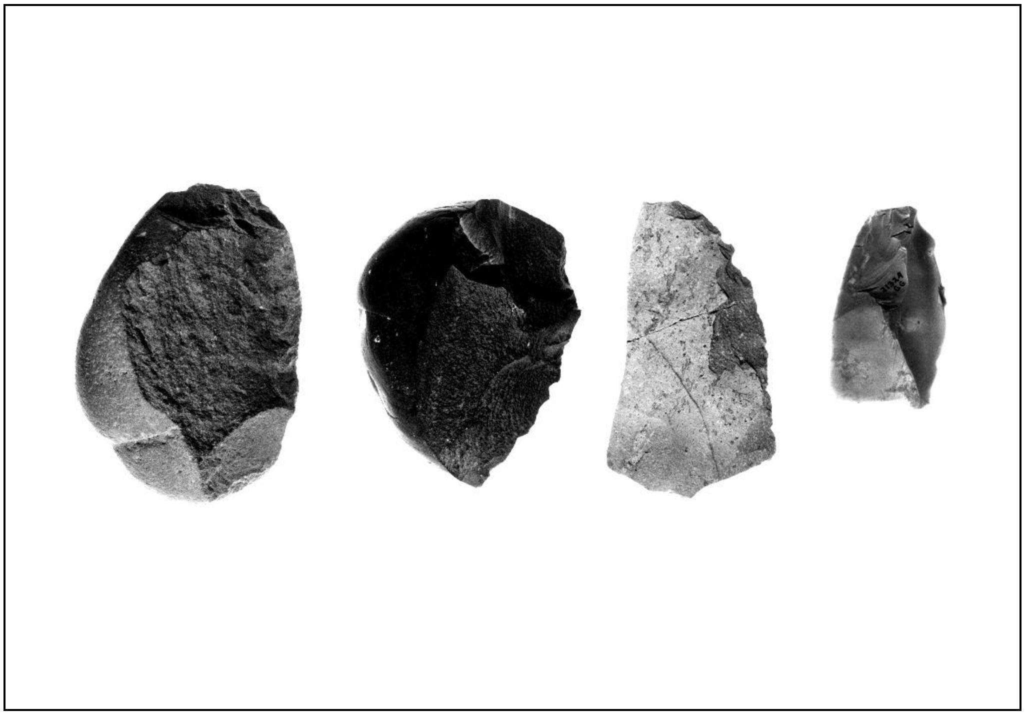

Figure 3.3. Mescal knives found by Grenville Goodwin near Payson, AZ in 1937. Arizona State Museum Collections, University of Arizona, Photographer: Helga Teiwes, ASM Neg. No. 64307.

Bell and Castetter (1941) from the University of New Mexico conducted ethnobiological studies discussing the utilization and economic importance of yucca, sotol, and beargrass by Indigenous groups in the in the American Southwest. These plants were used for a wide variety of resources vital to ceremonial and economic life from the prehistoric through to historic times, when this study was conducted. Yucca has edible fresh fruits, which do not require processing before consumption, though they were sometimes dried or made into cakes (Castetter 1936: 39). The stem and root of yucca and agave were used for common detergent soaps and tanning of hides (Bye et. al 1975: 91; Castetter et. al. 1938: 75; Gifford 1932: 214). The leaves were used for fiber to produce a variety of things ranging from mundane to ritual: cordage, matting, baskets, trays, nets, sandals, hair brushes, burial bundles for the dead (Castetter and Underhill 1935: 5, 51;

Figure 3.4, no scale available). Thin strips of leaves would also be used for brushing paints and dried flower stalks of lechuguilla and sotol for fire drills, roof beams, and spears (Fish et. al 1992: 83). The Havasupai and Walapai of Arizona also coated their parching trays with the juices of roasted evergreen rosettes to prevent burning of fine seeds.

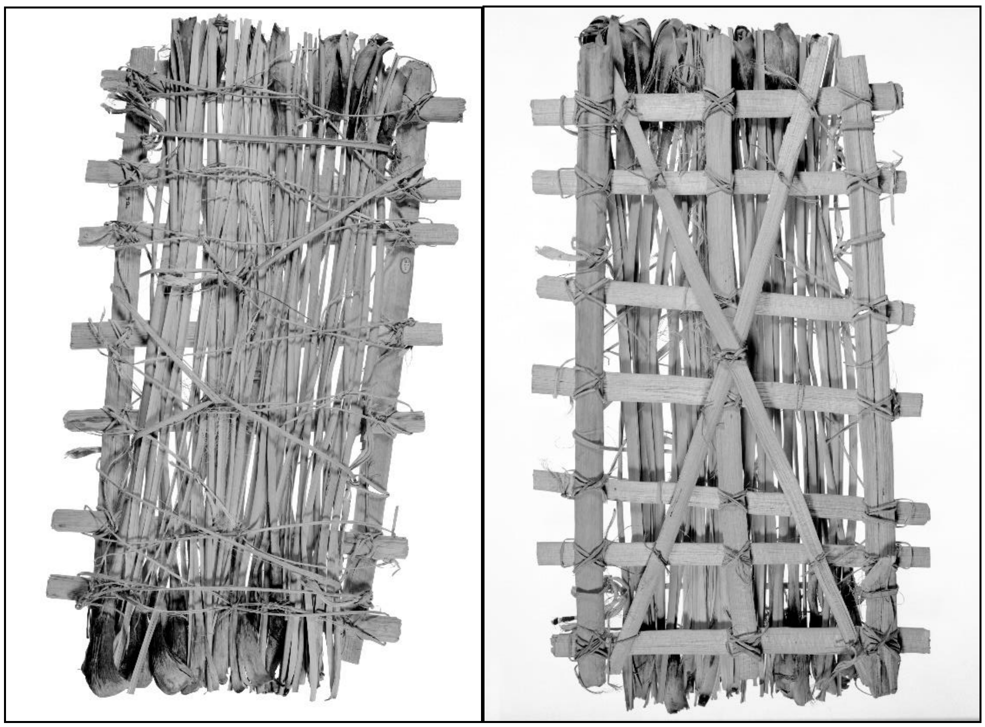

Figure 3.4. Top (left) and bottom (right) of mescal forming tray of split sotol stalks and beargrass tied with yucca strips made by Apache woman in 1932. Arizona State Museum Collections, University of Arizona, Photographer: Helga Teiwes, ASM Neg. Nos. 32057, 32058.

Early excavations from rockshelters in western Texas, southwestern Colorado, Basket Maker of Arizona and New Mexico and other early Pueblo sites have yielded yucca seeds and quids (i.e., masses of chewed up leaves), though early Spanish accounts fail to record utilization of yucca specifically among Indigenous groups they came into contact with (Bell and Castetter 1941: 7-8). Corbusier, however, does record groups utilizing yucca (Corbusier 1886: 327).

Comparable to yucca, sotol was also an important food and fiber plant to Indigenous people of the greater southwest. Sotol leaves were used in much the same way as were yuccas: to manufacture matting, sandals, baskets, etc. (Bell and Castetter 1941: 59). The heart or bulb of the sotol plant required multiple days of preparation before they were edible. Accounts from the 19th century describe the Lipan and the more populous Mescalero Apache peoples of southern Arizona and New Mexico as subsisting largely off sotol and agave (Bell and Castetter 1941: 57-59; Castetter et. al 1938: 27, 36, 44). Apache peoples lived in autonomous nomadic bands and roasted sotol bulbs in earth oven facilities which the authors refer to as "mounds" or "kilns" made of essentially soil and stone (Figure 3.5). The same earth ovens would be used year after year (Bye et. al 1975: 87). An excerpt from Bell and Castetter (1941:58) describes the process of building an earth oven:

> In preparation as food, large quantities of the crowns were gathered and placed near a site suitable for a large kiln. This kiln was a large hole three to four feet deep and several feet in diameter, and into this was placed a large pile of wood and rock in such a way that the rocks would become heated by the time the wood had been consumed by fire. The warm rocks were then arranged in the pit in such a way that the sotol could be placed on and around them. Next the pit was covered with brush and leaves, with a final covering of dirt to further insulate the mass [Figure 3.6]. The whole was allowed to remain in this manner for several days during which time heat from the rocks penetrated the sotol and thoroughly cooked it. At the end of that time dirt and leaves were removed, and the crowns of sotol were spread out in the sun and allowed to dry. When dry the burned portion of the heads could be removed, after which the crowns were pounded in depressions in large rocks, known as mortars, until the mass resembled a white flour. This was finally mixed with water and made into small, cakes and baked in the ashes and embers of a fire.

Figure 3.5. "Filling the Pit" Spring 1906. Western Mescalero Apache. National Anthropological Archives, Photographer: Edward S. Curtis, NAA Neg. No. 76-4670.

Figure 3.6. "The Covered Pit" Spring 1906. Western Mescalero Apache. National Anthropological Archives, Photographer: Edward S. Curtis, NAA Neg. No. 76-4672.

Figure 3.7. "Cutting Mescal" Spring 1906. Western Mescalero Apache. National Anthropological Archives, Photographer: Edward S. Curtis, NAA Neg. No. 76-4672.

Generally, the intensive processing of desert plants such as lechuguilla and sotol include multiple steps that begins with gathering and trimming of the desired plant using chipped stone tools and wooden implements (e.g., digging stick) (Bye et. al 1975: 87; Castetter 1935:11-14; Figure 3.7). Contemporary studies show that a metal rod or crowbar is often used in place of a wooden digging stick (Parsons and Parsons 1990: 24). After cooking the evergreen rosette pulp/cakes would be dried on racks or trays (Figure 3.8).

Figure 3.8. June 1931/1936: mescal drying rack left, roasting pit center rear, and shade to the right. Arizona State Museum Collections, University of Arizona, Photographer: Grenville Goodwin, ASM Neg. No. 18158.

Plants are ideally harvested in the southwest just as they were beginning to flower in the early summer, which is when they are at their sweetest and most tender. The youngest flower stalks were also removed and cooked as greens, but the older stalks were often hard/woody and not suitable for eating (Castetter 1936:38; Castetter and Underhill 1935:16; Ferg 2003:4). Apparently, Native people would choose “female” plants (which were just blooming, as opposed to “male” plants which were not) because they tasted the best. They were also selected based on the thickness of leaves: thin-leaved specimens were avoided because they would be deficient in nutrition as compared to a thicker-leaved and fuller plant (Castetter et al. 1938).

Once the stalk and leaves were chopped/sliced off the plant using stone tools such as agave knives or flake tools (Sjoberg 1953: 85), fiber would be extracted by boiling the leaves, drying them in the sun, or baking them in earth ovens. Each evergreen rosette heart was trimmed in a specific way as to distinguish personal plants when placed in the communal earth oven, whether by cutting the heart diagonally, square, notched, or tying the still-attached ends of leaves into knots (Corbusier 1886: 327; Gifford 1932: 206; Figure 3.9, no scale available). The base of the stalk of the agave served as containers and coiled baskets were sewn with a yucca/ agave leaf point awl (Gifford 1932: 218-219). Chipped stone tools would be employed for scraping, sawing, and cutting the leaves for fiber production.

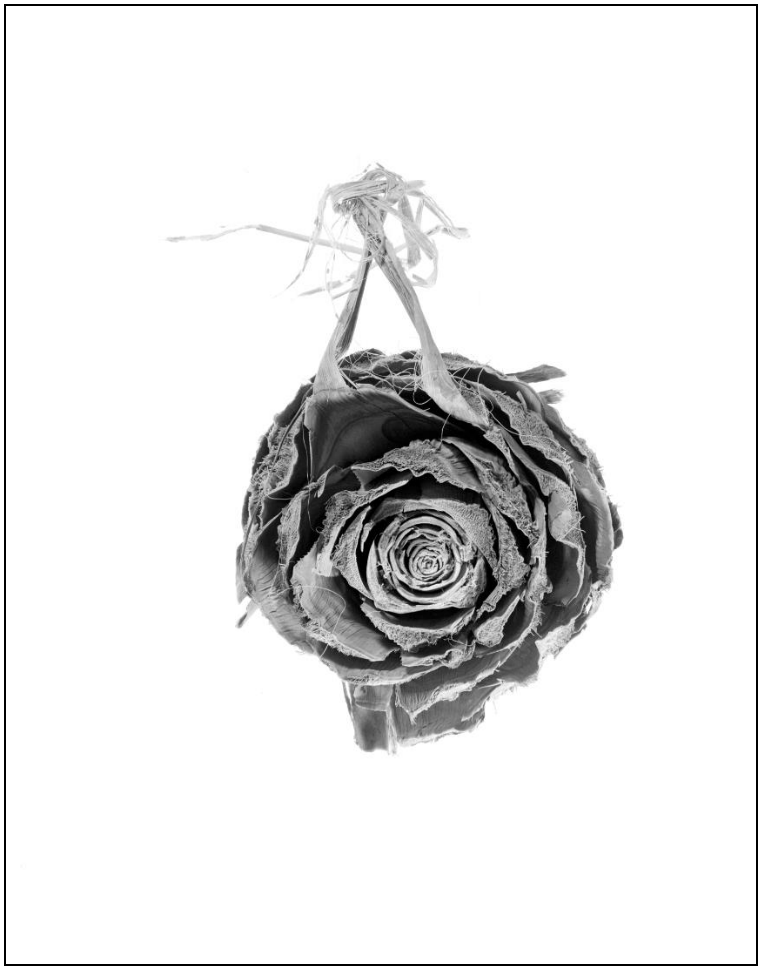

Figure 3.9. Trimmed mescal head: two knotted leaves used as carrying strap and/or property marker. Arizona State Museum Collections, University of Arizona, Photographer: Helga Teiwes, ASM Neg. No. 56720.

Scrapers/pulping planes or simple flake tools would be used for extracting fiber strands and removing excess plant tissue, both before and after cooking. The more formal tools such as agave knives were to chop the tougher inner leaves toward the heart of the plant and root bulb in order to easily extract it from the ground once it was partially dug up with a wooden digging stick (Figure 3.10; Gifford 1932: 206). The fibers would then be cleaned and left in the sun which would both bleach and dry them. The large mass of fresh pulp from the scraped leaves, called *guishe* or *shite* (a term used in the fiber industry of Mexico), contains microbes and could be used as a soapy scrub to wash a variety of things and was good for about two weeks (Sheldon 1980: 385-386; Gifford 1932: 214). This pulp was also used as a mild poison to tip weapons or put in the water to stun fish (Bye et. al 1975: 91; Shafer 1981). Though some types of agave are not as caustic as others, much care was taken to ensure that the skin was not exposed to raw evergreen rosette pulp lest the harvester get irritated and red blotches (Ferg 2003: 8).

The “Papago” of Sonora Mexico and southern Arizona used deer scapula as scrapers and pulping tools on agave and sotol to remove plant flesh and a semi-circular stone blade/knife referred to as a “mescal hatchet” (Castetter et al. 1938: 48, 64). One or two leaves were left in place on the top of the plants, so the bulbs/crowns could be tied together for easy transportation from the collection area to the processing area by hand or by basket. (Figure 3.11; Bell and Castetter 1941; Castetter 1935).

Figure 3.10. "Trimming Mescal" Spring 1906. Western Mescalero Apache. National Anthropological Archives, Photographer: Edward S. Curtis, NAA Neg. No. 76-4663.

Figure 3.11. "At the Mescal Pit" Spring 1906. Western Mescalero Apache. National Anthropological Archives, Photographer: Edward S. Curtis, NAA Neg. No. 76-4668.

Ground stone implements were used throughout plant-processing procedures (e.g., grinding seeds or pounding pulp into cakes). Once evergreen rosette crowns were baked, they were removed from the earth ovens, pounded up and formed into cakes or sheets and left out to dry in the sun for two days (Figure 3.12; Gifford 1932:207). Once dry, the plant crowns were pounded in mortars with ground stone tools until it resembled white flour which was then mixed with water, formed into ~5x90 cm cakes/breads, and baked in the coals of a fire (Bell and Castetter 1941; Ferg 2003:30,40; Sjoberg 1953:85). Dried evergreen rosette cakes or sheets could be stored for up to a year, with some accounts recording theses dried food resources staying edible for as many as six years if stored properly (Ferg 2003:4; Figure 3.13). This was invaluable food resource that people could enjoy year-round and especially in times of scarcity. When resources were plentiful, these dried evergreen rosette cakes or sheets would also be a valuable source of trade between groups and regions as recorded between Navajo and Zunis (Ferg 2003:4).

The Paiute of the Great Basin represents the northernmost extent of agave utilization. The Pima Bajo of Sonora Mexico also cultivated agave in addition to countless other groups. Multiple accounts from differing groups describe a broad and specialized knife called *beedas* (i.e., mescal/agave knife) used in the processing of these plants, some hafted and some hand-held, which were used to saw rather than chop (Bell and Castetter 1941; Castetter 1936: 35; Ferg 2003: 30; Sjoberg 1953).

Figure 3.12. June 1931/1936: Apache woman peeling apart cooked mescal. Arizona State Museum Collections, University of Arizona, Photographer: Grenville Goodwin, ASM Neg. No. 18186.

Figure 3.13. June 1931/1936: Apache woman forming cooked mescal to dry. Arizona State Museum Collections, University of Arizona, Photographer: Grenville Goodwin, ASM Neg. No. 18183.

Much like in the southwestern United States, the maguey plant (a very large agave species) has played a major role for several thousand years in cultural adaptation and cultural change within Mesoamerica. Contemporary studies of maguey utilization in Orizabita and Zona Ixtlera, central highland Mexico, for pulque and fiber (i.e., *ixtle, sisal* and *henequén*) production can provide insight into the archaeological site formation processes associated with plant related activities (Parsons and Parsons 1990; Sheldon 1980). Though the communities studied in the 1980's used mainly metal tools and implements, the comparison is still useful. Accounts from the 16th century provide supporting evidence that practices remained similar throughout time in the region, regardless of the fact that the material of the tools changed. Even though stone implements were replaced by iron after their introduction by Europeans, it appears that the form and style of the tools were largely comparable/similar throughout time.

Once the maguey plant was mature and the central woody stalk (i.e., *quiote*) began to form, the plant would be castrated (i.e., *capazon*) with a large knife and then picked (i.e., *picazon*) for the sap after an interval of time (Parsons and Parsons 1990: 35). The innermost leaves toward the heart of the plant would be removed with the use of a specialized tool called a *quebrantador* or *rejada*. These tools may be comparable to the mescal/agave knife. During the process of "picking," the inside of the plant is scooped out with the use of handheld scrapers two times a day to promote good flow and sap production; this would last for three to six months. This sap would be fermented to make *pulque*, a term used in Mexico. Experienced workers could process up to 120 plants a day. Agave and sotol were both used to make fermented beverages, but in a slightly different way. Sotol crowns were roasted by the Apache for one night, then removed, peeled, crushed, and mixed with water in a rawhide container to let ferment buried underground for a day (Castetter 1936: 52). This drink made by the Apache was called “mescal” by outsiders.

Once sap and drink production were finished, the bulk of the evergreen rosettes would be processed. The leaves would be removed for fiber once sap production slowed down. The younger plants contain finer white fibers and the older plants are comprised of coarser, dark fibers, which would be selected based on the type of artifact being produced (Parsons and Parsons 1990: 145). Fine fibers would be more specialized (e.g., fine cloth) while the coarse fibers more utilitarian (e.g., sandals or baskets). Two methods for fiber production would be employed using a scraper or pulping plane, either with a raw leaf (i.e, *penca cruda*) or a cooked leaf (i.e., *penca asada*). Lechuguilla leaves are often processed raw and contain a higher fiber count than maguey. A pounding stone (i.e., ground stone) implement would be used to crush the leaf in order to make scraping easier. After bleaching and carding the fiber, it would be spun into thread. Once a maguey plant loses its production value and starts to wither, they are dug up and piled elsewhere to be used as fuel once dried.

Myth and Ritual

Earth oven facilities were certainly a persistent place for food and fiber production, but also for ceremony and ritual. Evergreen rosettes were an integral part of Indigenous peoples’ spiritual ideologies. The Apache considered sotol the “brother” plant and yucca the “sister” plant: cradleboards would be constructed out of either plant based on the gender of the baby (Castetter 1936: 17). The Apache people have been documented placing pollen in the cardinal directions around the central food packing within earth ovens before praying, tossing four rocks within, and then closing the earthen cap as a close to the ceremony (Castetter 1936: 36; Castetter et al. 1938: 29). As shown in Figure 3.14, the "chief mescal" was painted black as a ritual to ensure that all of the evergreen rosette hearts would be cooked well. They would then wait until nighttime when the Big Dipper was pointed over the west before lighting the *tselke* or roasting pit (Ferg 2003: 30)

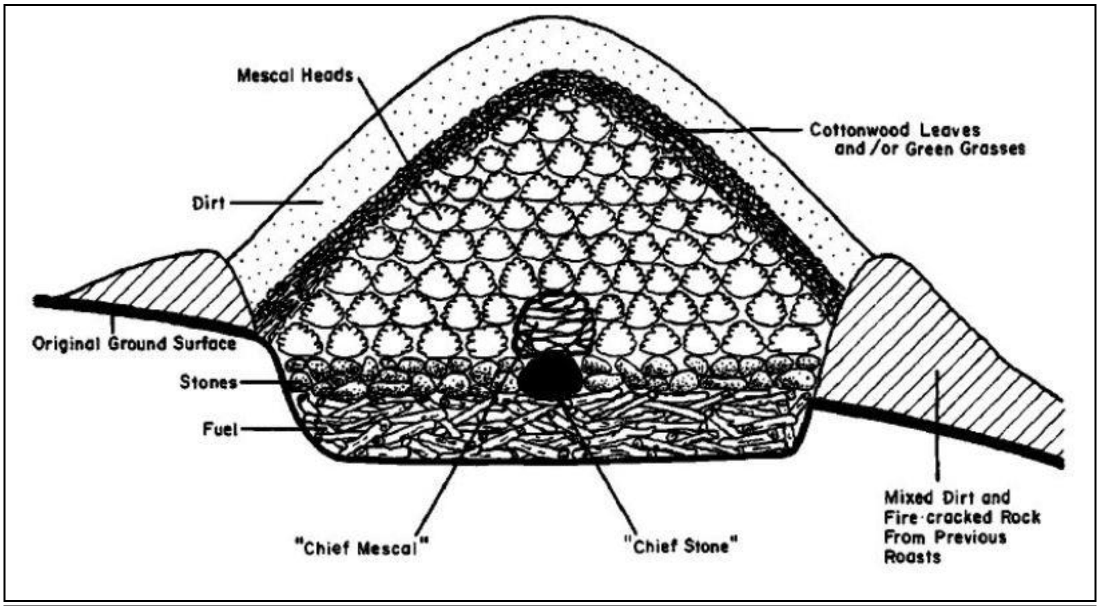

Figure 3.14. Idealized mescal roasting pit, showing "chief stone" and "chief mescal" based on statements from the western Apache (Ferg 2003: Figure 1).

While the earth oven roasting was in process, the Apache would refrain from drinking before midday in order to prevent rainfall (Castetter et al. 1938: 29). Apache women were also known to stay away from their husbands during the roasting process, and improper cooking was often blamed on the incontinence of some members of the group. Though no praying, singing, or dancing was recorded, the Yavapai of Arizona (neighbors of the Apache) had certain restrictions lest the evergreen rosette roast be tainted: the fire must be lit by a person born in the summer, sexual intercourse was prohibited, and no one could scratch their head or body with their fingers (Gifford 1932:

207).

In the 1930s, a 90-year-old Mescalero Apache woman named Anna Price, daughter of Chief Diablo, recounted a myth of her people in which the Coyote taught their people the process of ritually starting the pit fire, roasting, and drying agave (Ferg 2003: 4). Coyote taught their people how to "trim the different kinds of mescal with stone knives, how to dig a roasting pit and gather wood, stones, leaves, and grasses, how to ritually start the fire, how many days to cook the mescal, how to make brush drying racks and sotol forming trays, how to pound up the cooked mescal, and how to spread it into sheets (*náhilgané*), and let the sheets dry for two days."

A variety of ceremonial objects and materials were produced utilizing all parts of the plant. Early ethnographers described the Lipan and Mescalero Apache as baking these plants in "sotol pits" and making a fine black paint from charred roasted evergreen rosette crowns (Castetter et al. 1938: 74). The Papago used a ceremonial basket made from sotol leaves, called a *waca,* to hold sacred objects belonging to the village (Castetter and Underhill 1935: 56). The Yavapai of Arizona held a ceremony marking the second day of the birthing of a child, where both the mother and the child were bathed in warm water and a lather of yucca root (Gifford 1932: 199). Body adornment is an effective way to enact ritual. The ear lobes of every Yavapai baby were pierced with the sharp spine of an agave leaf, and both cactus and agave spines were used as tattoo needles (229). There is also an account of a Yavapai female child being named *Wiyela*, meaning "mescal" or agave (202).

Among the Tarahumara of Chihuahua Mexico, a medicine made from a combination of pounded up roasted agave and sotol mixed with water was used as a common ritual cure for people, fields, and animals (Bye et. al 1975: 91; Castetter et al. 1938: 76). As documented with the Apache, the sick ingested “mescal-water” as an effective purging method (Corbusier 1886: 327).

Prehistoric people used evergreen rosette plants for an astounding range of purposes that are still seen and reflected in modern cultures. Clearly, ethnographic accounts provide a strong source of information regarding the processing and earth oven baking of evergreen rosettes. Though there are many other ethnographic accounts that discuss other evergreen rosettes and desert plants, the above discussion highlights what can be explored through ethnographic and ethnobiological research.

IV. ARCHAEOLOGICAL PREVALENCE OF SOTOL AND LECHUGUILLA

The Lower Pecos Canyonlands of southwest Texas contains abundant evidence for the intensive processing of evergreen rosettes such as sotol and lechuguilla. Archaeological, ethnobotanical, and paleoenvironmental information helps researchers explore the dynamic relationship between resource exploitation and mobility patterns of prehistoric people (Koenig 2012; Koenig and Black 2019; Sobolik 1996b; Williams-Dean 1978). Environment plays an important role for cultural stability, and the environment of the southwest allowed for a stable lifestyle subsisting on reliable and abundant resources such as desert plants and small game.

This chapter serves to discuss archaeological evidence of evergreen rosette processing for food and fiber from the four targeted sites and additional sites within the LPC. Multiple lines of evidence of evergreen rosette processing are present in the region including BRMs, charred plant remains, and chipped stone tools indicative of plant processing (e.g., silica polish on tool edges). This evidence of plant processing throughout the region is confirmed by the use-wear analysis conducted as part of this study, detailed in Chapter 6.

Evidence from Targeted Sites

Eagle Cave (41VV167) is the largest and most intensively occupied rockshelter in Eagle Nest Canyon. The location and previous investigations of Eagle Cave are detailed in Chapter 2. Excavations of Eagle Cave recovered multiple types of perishable items including bulk fiber, cordage, knotted fiber, matting and sandal fragments made from evergreen rosettes, in addition to a vast array of other artifacts such as chipped stone tools with macroscopic plant polish (Koenig et al. n.d.; Ross 1965:121-125; Story and Bryant

1966:20-21).

Macrobotanical analysis conducted on bulk matrix samples, collected during 2014 excavations from Feature 2 in Eagle Cave, showed that the most common leaves recovered were from evergreen rosettes such as lechuguilla and sotol (Nielsen 2017:98). Feature 2 was a rock-lined fiber filled pit indicative of plant processing discard (Nielsen 2017:169). (Koenig et al. n.d.)

Descriptions for the Eagle Cave archaeological assemblage used in this study can be found in Chapter 5, Table 5.2. These tools were selected because polish was macroscopically observed on the tool's edges either during initial analysis or while I was looking through the site assemblage. In most cases, the tools were not washed by ASWT in order to preserve residue and use-wear traces.

Skiles Shelter is also in Eagle Nest Canyon located just above Sayles Adobe, and as described in Chapter 2, is a targeted site for this research. Skiles Shelter (41VV165) excavations conducted in 2013 and 2014 recovered burned evergreen rosette fiber and several features (Heisinger 2019:53,85; Rodriguez 2015:74). Feature 5 was a cluster of burned rock with lithic debitage, faunal, and botanical remains. Excavations from Feature 5 in 2014 recovered two carbonized agave lechuguilla leaf fragments that were used to radiocarbon date the feature. Three AMS radiocarbon assays from Feature 5 dated to the Late Prehistoric period (710-660 median cal. B.P.) indicating that this feature was a single-use cooking event, likely for cooking lechuguilla (Heisinger 2019:77). Feature 6, located just below the alluvium of Feature 5, was comprised of 3-6 remnants of different heating elements and contained evergreen rosette leaf bases, lithic debitage, two manuports, one biface, and one uniface. Sotol and agave leaf bases were used to radiocarbon date Feature 6 to the Early and Middle Archaic periods, 7387-3729 median cal. B.P. (Heisinger 2019:81).

Macrobotanical analysis from features at Skiles Shelter showed a majority of the evergreen rosette leaf fragments were lechuguilla (Heisinger 2019:73,81,85). Skiles Shelter excavations recovered chipped stone tools indicative of plant-processing such as knives, unifaces, sequent flakes, and flake tools (Heisinger 2019; Rodriguez 2015:79). The tools analyzed for use-wear traces in this study from Skiles Shelter are detailed in in Chapter 6, Table 5.3.

Many tools had microscopic epidermis/fiber fragments adhering to the edges of tools that were observed during analysis (Heisinger 2019:124-127), such as Specimen 20056.8 from Excavation Unit E and Specimen 20029.9 from Excavation Unit G, both included in this study. The following tools were recovered from Excavation Unit E: Specimen 20003.1, Specimen 20020.2. A fiber strand and potential epidermis fragment were observed on the dorsal edge of Specimen 20020.2 (Heisinger 2019:219). Specimen 20040.5 was recovered from Excavation Unit B during the 2013 excavations at the site and plant epidermis fragments were identified on both dorsal and ventral edges (Heisinger 2019:218). Specimen 20062.1 and Specimen 20031.4 were recovered from Excavation Unit G; the former tool’s dorsal surface had plant epidermis adhering to the edge (Heisinger 2019:219). Specimen 20082.7 was recovered from Excavation Unit M and during initial analysis, unburned epidermis and white reside (potential fat) were observed on the dorsal distal edge (Heisinger 2019:220).

Specimens 20073.4 and 20073.1 were recovered from Excavation Unit N; the latter tool had unburned epidermis observed on the dorsal right modified edge during analysis (Heisinger 2019:221). A fiber strand, plant epidermis, and a charred seed were observed on the contact edges of Specimen 20107.5 from Excavation Unit P. Also from Unit P, Specimen 20121.4 had “animal product or plant residue” observed by the tool’s platform during analysis (Heisinger 2019:221). Residue studies conducted on the bedrock features from this site confirm the presence of a saponin found in agave (i.e., neotigonen) on one feature, indicating plant-processing (Castañeda 2015:84).

The following Skiles Shelter tools had no plant fibers or epidermis adhering to the edges, but polish was noted during macroscopic analysis: Specimens 20018.15, -.7, -.17 were recovered from Excavation Unit D; Specimen 20054.5 was recovered from Excavation Unit H; Specimen 20063.15 and 20063.9 were recovered from Excavation Unit J; Specimen 20078.3 was recovered from Excavation Unit O; and Specimen 20105.10 was recovered from Excavation Unit P.

Little Sotol (41VV2037) showed multiple lines of evidence for plant-processing and evergreen rosette baking in earth ovens, including charred plant material, chipped stone tools (e.g., agave knives, scrapers, flake tools), and BRMs. As described in Chapter 2, Little Sotol is a terrace site located along Dead Man’s Creek in the eastern portion of the LPC. This is the only targeted site that is not located within ENC. Features at the site contained fragments of evergreen rosette leaves such as sotol and lechuguilla that were used to obtain radiocarbon dates for the site (Knapp 2015:144). Due to the open-air nature of Little Sotol, little to no perishable artifacts were recovered as compared to the rockshelter sites. The chipped stone tools analyzed for use wear traces in this study are detailed in Chapter 5, Table 5.4.

Area 1 is the excavation block on top of the site’s BRM with diagnostic artifacts that indicate a date range from the Early to the Late Archaic period (Knapp 2015:60,71). Matrix samples from this area were collected for flotation and charred fragments of agave-sotol leaves were identified from these, indicating plant-processing (Knapp 2015:94). The following artifacts analyzed for this thesis were recovered from Area 1: Specimens 64.2, 25.13, 56.1, 4.4, 4.2, 93.6, 2.7, 2.5, and 46.3.

Area 2 is the excavation block at the mouth of Little Sotol Cave which contained an abundance of charred plant material (including agave) with radiocarbon assays dating to the Late Prehistoric (Knapp 2015:60, 74, 77). The following artifacts analyzed for this thesis were recovered from Area 2: Specimens 12.2, 67.5, 8.4, 23.4, 81.9, 21.6.

Area 3 is the excavation area in front of the cave at the location of the limestone bench and roof collapse (Knapp 2015:60). Specimen 57.5 was recovered from above boulder and Specimen 24.1 was recovered from the limestone bench of Area 3. No datable material was recovered from this area. Specimen 58.52 has an unknown context while Specimens 20.11 and 20.5 were recovered from the surface of the site.

These tools were selected for this study because during analysis of the site assemblage either tools were described as sotol knives or “polish” on the tool edges was noted within the specimen inventory. As I was looking through the site collections, I also selected tools that showed evidence of polish which were not noted during analysis. Ashley Knapp identifies Specimen 46.3 as being morphologically consistent with formal hafted agave knives and noted heavy polish on both sides (Knapp 2015:118). This tool was recovered from lower elevations of excavated BRM areas and was associated with projectile point types and radiocarbon dates from the end of the Early Archaic. Specimens 4.2 and 67.5 exhibited heavy polish and were recovered from BRM and cave contexts from higher elevations at the site (Knapp 2015:126). Specimen 2.5 is described as an expedient agave knife and heavy polish was observed on both sides; this tool was recovered from the surface/upper layers of the BRM (Knapp 2015:128-129). Specimens 2.7 and 20.11 were also described as expedient agave knives with heavy polish, and further, Specimen 20.11 is described as a sequent flake. Specimen 8.4 is described as a modified flake tool with polish observed on the right ventral surface (Knapp 2015:131).

Located on the terrace just below Skiles Shelter is the Sayles Adobe site (41VV2239) as described in Chapter 2. Evidence from Sayles Adobe suggests evergreen rosette processing and earth oven cooking at this site (Pagano 2019:246). A pristine example of a formal agave knife comes from a buried occupational surface at Sayles Adobe dating to the Late Archaic (2867 cal. B.P.) (Pagano 2019:148-149). Specimen 50158.1 was recovered from the surface of Occupation #2 in the "Sand Box" excavation area. Flotation samples were processed which yielded radiocarbon samples from this area dating to 2700 cal BP, indicating a Late Archaic occupation (Pagano 2019:239). This chipped stone tool is the only one if its kind found in Eagle Nest Canyon thus far. This agave knife was analyzed as part of this thesis and further detail is described in Chapter 6. Macrobotanical analysis of bulk matrix samples from Borrow Pit 1 and 2 Features and the Sandbox at the Sayles Adobe site were analyzed and revealed carbonized remains from leaf bases of evergreen rosettes in all examined samples (Pagano 2019:129;243).

Evidence from Additional Sites in the LPC

Fossil pollen records, geomorphological, and macrobotanical analyses from several Lower Pecos sites and fossil pack rat middens provide a chronology of the paleoenvironmental conditions of the LPC throughout prehistory (Dering 1979, 2005;

Bryant and Holloway 1985:47,52; Story and Bryant 1966). Applying this information to coprolite evidence from sites within the LPC has been particularly useful developing that chronology. Coprolite analysis provides direct evidence of what food resources were consumed because these desiccated fecal samples contain pollen grains, seeds, plant epidermis/fiber, shells, insects, animal bones, etc. (Williams-Dean 1978:2). Such an analysis can provide insight into health and nutrition of an individual as well as overall food economy for a group of people (Sobolik 1988:201; 1996b).

Though analysis of LPC coprolites often shows a varied diet that includes insects, animals, fish etc., the following discussion will focus on evidence from coprolites specifically indicating evergreen rosette consumption. The presence of evergreen rosettes within coprolites can potentially serve as environmental indicators of the time they were deposited and possibly serve to identify seasonality of site occupation (Williams-Dean 1978:231). Recent coprolite evaluations, from previous excavations of multiple sites within the Lower Pecos Canyonlands, have investigated individual dietary decision using the diet-breadth model (Riley 2010:15; Sobolik 1996b). As discussed below, there are some variances in diet between different sites. However, the differences among coprolite studies regarding diet change in the LPC could be due to changes of seasonality/resource distribution and/or cultural practice/preference throughout time (Sobolik 1989:123). Regardless, this research confirms that evergreen rosettes were indeed dominant staples used throughout the year and, though calorically costly, were exploited intensively during the cool fall/winter season when other resources were scarce (Riley 2010).

Centipede Cave and Damp Cave are both rockshelters located in close proximity to each other on a high bluff of the Rio Grande within the LPC (Epstein 1962:8). A large number of perishable material artifacts made from evergreen rosettes have been recovered from these sites. Cordage and netting/knotted fiber, basketry and matting, sandals, cradles, fire drills, all made from lechuguilla and sotol, comprise the rather large fibrous material assemblage from these sites (Epstein 1962:89-102).

Excavations of Shumla Cave recovered large amounts of fiber bundles, cordage artifacts, netting, sandal fragments, basketry and matting artifacts made from lechuguilla and sotol plants (Schuetz 1962:131-133, 136). All of these fibrous artifacts showed different styles of weaving, intricately and expertly made.

Hinds Cave is a rockshelter located within the LPC, off the Pecos River ten miles upstream from its confluence with the Rio Grande (Edwards 1990:10; Riley 2010:136; Shafer et al.: 2008). Excavations from this site also resulted in the recovery of thousands of coprolites: the largest collection in North America from a single hunter-gatherer site (Riley 2010:135). Of these, hundreds of coprolites were recovered during the 1975 excavations *in-situ*. A subsample of 100 of these were analyzed by Williams-Dean in 1976 from Lens 13 in Area B of the site; plant remains were present in nearly every coprolite (Williams-Dean 1978:242). Analysis showed evidence of high levels of pollen, seeds, epidermis, and fiber from evergreen rosettes such as lechuguilla and sotol (Williams-Dean 1978:138,163,190). This suggests that the leaves, hearts/crowns, and flower stalks of these plants were by prehistoric people occupying Hinds Cave. A later study of 40 different coprolites from the same area of Hinds Cave also confirms this with comparable results of analysis (Edwards 1990:19,40,86).

Organic residue and wear pattern analysis conducted on 11 chipped stone flake tools from Hinds Cave showed evidence of evergreen rosette fiber and phytoliths from lechuguilla, sotol, and yucca, which provides further evidence of intensive plant-processing for food and fiber at this site (Shafer and Holloway 1979:398). Almost 20 years later, another organic residue analysis was conducted on 55 chipped stone tools (i.e., blade tools and oval unifacial chert flakes) from Hinds Cave dating to the Middle and Late Archaic (5000-2000 B.P.) (Sobolik 1996a:462). This study showed evidence of evergreen rosette fiber and phytoliths adhering to the multipurpose stone tools. Agave, prickly pear, and sotol fibers were observed on tool edge residue samples, indicating those tools were used for plant-processing (Sobolik 1996a:466). Agave and yucca fiber were observed on hafted specimens, indicating these plant stalks/fibers were used to haft those tools.

Conejo Shelter overlooks the confluence of the Rio Grande and Pecos River within the LPC. A palynological analysis (i.e., study of pollen) was conducted on 43 coprolites recovered during excavations of Conejo Shelter and results showed that evergreen rosettes were a large portion of the diet from these samples (Bryant 1974:417-418). Baker Cave is located directly above the Devils River, upstream from Little Sotol. Sobolik conducted a palynological analysis on 38 coprolites from Baker Cave that provided evidence comparable to Conejo Shelter (1988). The author discussed, in excellent detail, other studies done in the area from several different sites (Hinds Cave, Conejo Shelter, Parida Cave, and Frightful Cave), with material evidence spanning an 8,400-year-period. The analysis of the 38 coprolites showed high concentrations of evergreen rosette fiber but low concentrations of pollen (Sobolik 1988:211; 1989:119). This indicates that while prehistoric people of this time were intentionally eating the leaves/hearts, they were not eating the flowers themselves.

The Baker Cave coprolites from this study dated to 900 A.D. which provides important information on the diet of prehistoric peoples of the LPC extending into the Late Prehistoric period (Sobolik 1989:111; 1991:139). While the other sites provide information on earlier time periods, the analysis from Baker Cave provides a unique insight into the diet of more recent periods. Feature 84-3 from Baker Cave was a 30-cm-deep grass-lined pit containing bundles of sotol flower stalks (Sobolik 1989:115). This shows that the stalks/flowers of evergreen rosettes were an important resource for a range of utilitarian purposes for the prehistoric inhabitants of Baker Cave.

Following Sobolik's research design (1988;1989), Riley looked at coprolite data from four sites within the LPC: Hinds Cave, Conejo Shelter, Parida Cave, and Baker Cave. Conejo Shelter and Parida Cave are located near the mouth of the Pecos River and Baker Cave is east of the Devils River (Bryant 1974:408; Riley 2010:5). Riley also looked at coprolites from Frightful Cave in the center of modern Coahuila, Mexico as a comparison to the coprolites recovered from the four sites in the LPC. A total of 348 coprolites examined by other researchers were included in Riley's study and a selection of 30 were analyzed by Riley himself (Riley 2010:155). The data presented shows that while a variety of small animals and seasonally available resources were observed, the highest percentage of the diet came from evergreen rosettes throughout the sites within the LPC (Riley 2010:278).

Though variable, the targeted sites discussed in this thesis from the Lower Pecos have multiple lines of evidence showing the prevalence and importance of evergreen rosettes. In Chapter 6, I describe the results of the use-wear analysis from the targeted sites in the LPC, providing further evidence of the intensive reliance on these desert plants for food and fiber.

V. METHODOLOGY

A total of 76 tools were analyzed for this study. The use-wear methodology for my research was essentially the same for both archaeological and experimental tools. This involved procedures that included cleaning, sketching, microscopy, and photography. As described in Chapter 4, the archaeological artifact assemblage consists of 61 tools drawn from collections from the four targeted sites excavated by ASWT. Ten tools from the experimental chipped stone assemblage were produced by flintknapping local Edwards Chert and Rio Grande-derived chert with the help of Dr. Robert Lassen and Christopher Ringstaff (Figure 5.1), including agave knives, sequent flakes, choppers, scrapers, and flake tools. I also acquired a few experimental tools from other sources, bringing the total experimental collection to 15 tools. After the experimental assemblage was acquired, I sketched each chipped stone tool and recorded the natural features present under the low-power microscope prior to experimental use.

Figure 5.1 Christopher Ringstaff using an antler billet to produce chipped stone tools for experimental use.

Prior to analysis, the experimental and archaeological tools were cleaned using an ultrasonic cleaner. Each tool was placed in a four-millimeter plastic bag with three drops of household (clear unscented) ammonia and enough water to cover the tool. Each bag was then placed within the ultrasonic cleaner for 15 minutes, with a maximum of four tools per cleaning session. The working edge of each tool was further cleaned with 70-percent alcohol using cotton swabs prior to examination under the microscope to ensure removal of oils and debris.

Analysis was conducted using a Leica DM LA Motorized Microscope with reflected DIC, and photomicrographs were taken using a Nikon QImaging digital camera (Figure 5.2). Images were processed using the digital imaging software Image Pro-Plus 7.0. Modeling clay was used to prop up the tool at the correct angle on the microscope’s stage for analysis (Figure 5.3). Each tool was placed under the microscope at varying magnifications and any indication of use wear was extensively documented on dorsal and ventral edges. Generally, 10-30 images of each area of use wear evidence were taken to ensure adequate focus/clarity; these were then stacked together using the CombineZP software to create the final image. Some tools were either too large or had such an extreme edge angle that analysis under the Leica microscope was impossible. These tools were analyzed using a DynoLite at 50X magnification; photos were not taken in this situation.

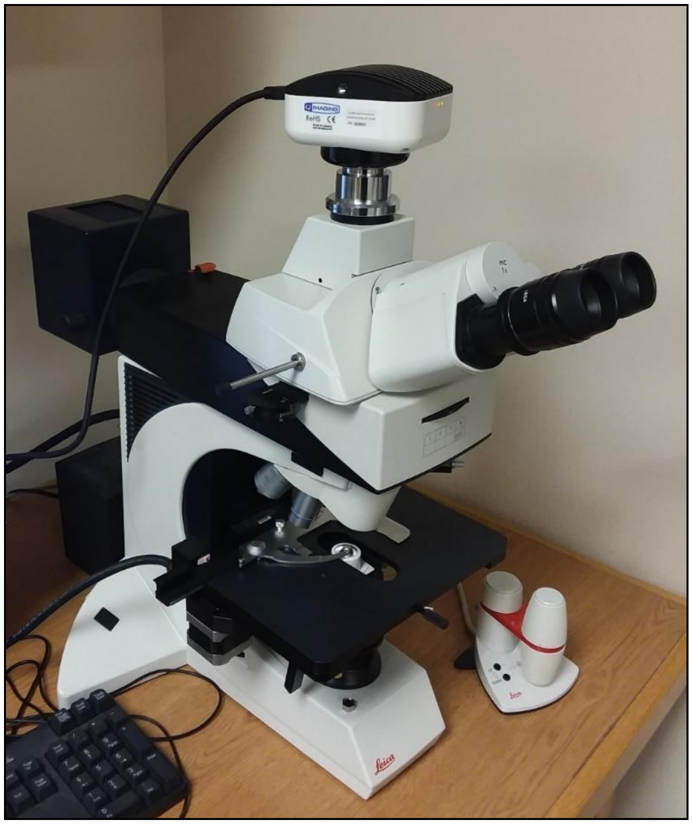

Figure 5.2. Leica DM LA Motorized Microscope at Texas State University.

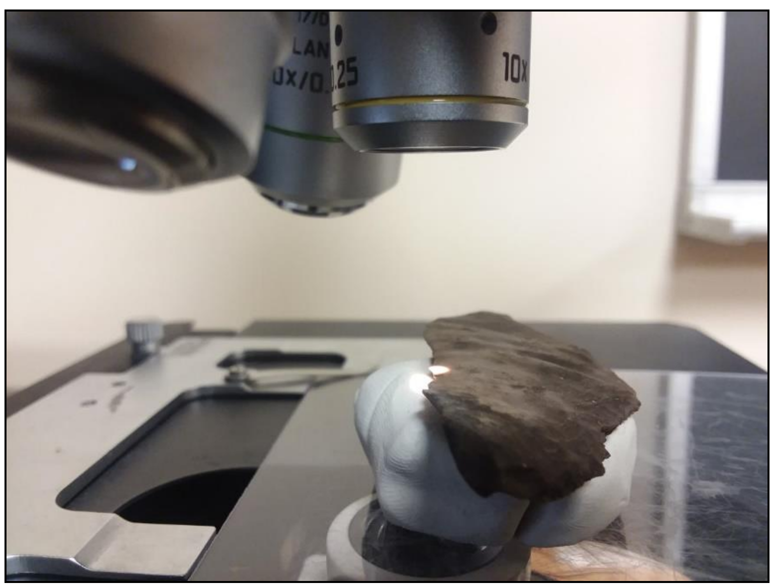

Figure 5.3. Modelling clay used to prop up Eagle Cave Specimen 32457.26 for analysis.

As described in Chapter 3, there are multiple intensive procedures required to process evergreen rosette plants for a variety of resources, food and otherwise. Therefore, multiple tool types would be required to process these plants efficiently and effectively. The chipped stone tools required for intensive plant processing includes a range of expedient flake tools, bifacial tools, scrapers/pulping planes, and formal agave knives, all of which are represented within the experimental and archaeological assemblages described below.

Experimental Sample

The experimental assemblage (N = 15) serves as a comparative assemblage to complement the analysis of the archaeological collections. My aim was to re-create use wear through documented and controlled events with experimental work to compare with and identify similar wear patterns seen on the archaeological samples. This experimental sample assemblage was produced by flintknapping a variety of types of tools and I attempted to mirror the flint sources and tool types observed at the archaeological sites in this study. As shown in Figure 5.1, I was assisted in creating this assemblage by expert flintknappers. The experimental sample is comprised of six tool types: flake tools, agave knives, sequent flakes, choppers, and unifaces (Table 5.1).

Table 5.1. Experimental Assemblage Descriptive Statistics and Duration of Time Used on Contact Material.

Lot #	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Description	Contact Material	Use (minutes)
X_12	8.6	60.8	13.8	47.71	flake tool	Sotol	68
X_7	86.4	33.5	10.9	25.53	flake tool	Lechuguilla	89
X_8	68.7	36.6	10.9	21.98	modified flake	Sotol	50
X_6	84.5	74.7	27.1	124.42	chopper	Sotol	57
X_1	144	77.7	19.6	195.39	Agave knife	Sotol	122
X_4	122.7	70.1	32.8	237.16	Agave knife	Lechuguilla	95
X_11	90.6	46.7	19.8	67.37	modified flake	Lechuguilla	74
X_9	117.5	70.3	27.7	150.68	chopper	Lechuguilla	47
X_2	59.11	43.56	5.28	10.65	sequent flake	Sotol	28
X_3	85.5	112.9	16.95	61.71	sequent flake	Lechuguilla	30
MBC-1	107.6	34.4	10.8	42.6	Flake tool:blade	Grass	5
CJ-13	45.8	24	4.6	4.71	flake tool	Deer foreleg	unknown (strokes)
EG Scr-1	56.2	41.5	12	34.86	Uniface:scraper	Buffalo hide	unknown
AH-36	100.5	28.5	15.2	42.73	Flake tool:blade	Bison bone	unknown
E-33	77.3	35.4	14.6	50.93	flake tool	Wood	unknown (strokes)

One of each tool type was used to process sotol plants and one of each tool type was used to process lechuguilla. Flake tools and sequent flakes were used for cutting/slicing evergreen rosette leaves off the base/bulb of the plants, unifaces were used for scraping actions against removed leaves, choppers for taking off root balls, and agave knives for multiple tasks (though the main use was for cutting/slicing of leaves). In addition to the tools created for this study, Marilyn Shoberg loaned me previously used experimental tools (*n* = 5) that had been used on contact materials such as bone, grass, animal flesh, etc.; this provided examples of use wear from contact materials other than evergreen rosettes. M.B. Collins of Texas Archeological Research Laboratory (TARL) experimentally processed grass in 2006 using tool MBC-1 (Table 5.1). Chris Jurgens of

TARL experimentally processed a deer foreleg in 2004 with CJ-13. EG Scr-1 was used by Mike McGonigal of TARL in 2008 to experimentally scrape buffalo hide. AH-36 was used in 2008 by A. Hemmings of TARL to experimentally cut/saw bone. E-33 was used by Jessie Daniel of TARL to experimentally saw wood. X_1 was replicated by Glen Goode in 2006 but had not been used before my experiments.

During my field experiments, I documented the process with photographs and notes. For each tool from the experimental assemblage, I recorded the duration of time spent processing plants as well as the type (sotol or lechuguilla) and number of plants processed. Gloved hands were used to hold the plants for ease of processing, but each tool was handled with bare hands. The type of material of the tool was noted and each tool was used for only one activity each. The only exception is the agave knives, as noted above, which were used for different actions on different sections of the tool. The amount of time each tool was used was recorded to indicate what length of time was needed to complete a certain task, as shown in Table 5.1. Stroke counts were not recorded, though I estimate each tool was used for over 500 strokes. Measuring the amount of time each tool was used for a task proved more useful for this study than counting the specific number of strokes. I used sotol and lechuguilla largely because evidence of intensive prehistoric use of these plants is prevalent throughout the archaeological record as discussed in Chapter 4. Additionally, these plants are still abundant in the present-day environment.

After my field experiments, I first conducted a low-power microscopic use wear analysis under 100X magnification of these experimental tools, in order to characterize the following five elements of use wear related to plant-processing activities: polish, striations, edge-modification, direction of use, and intensification of wear. I then conducted a high-power microscopic use wear analysis under 500X magnification of each tool in order to identify the plant-processing characteristics listed above in further detail. The results of this analysis are elaborated in Chapter 6.

Archaeological Sample

As discussed in Chapter 4, the archaeological collections analyzed for this study (N = 61) were recovered from excavations of four sites within the LPC: Little Sotol, Skiles Shelter, Eagle Cave, and Sayles Adobe (Tables 5.2 through 5.5). First, I selected a sample of twenty chipped stone tools from each of the three main sites (and the one from Sayles Adobe) that fit certain requirements for ideal use-wear analysis. These requirements include little to no patination of the tool surface, complete or minimally fragmented tools with intact working edges, and a primary archaeological context, to the extent possible. Also described in Chapter 4, I chose this sample based on the identification of polish and plant epidermis by previous researchers and analysts who have worked on these collections, indicating these tools likely were used to process evergreen rosettes. The chipped stone tool samples include a range of formal tools to expedient tools.

Table 5.2. Descriptive Statistics for Eagle Cave Assemblage

Lot #	Spec #	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Description
32600	4	58.3	51.6	11.4	29.71	modified flake
31956	15	62.7	65.8	22.2	77.45	modified flake
32457	26	55.5	25.7	6.1	7.3	flake tool
34173	2	39.7+	48.6	9.4	20.62	modified flake
31084	3	94.5	71.5	22.9	130.09	modified flake
30904	7	37.8+	45.9	11.4	15.81	modified flake
30904	8	39.3+	46.7	17.6	34.69	modified flake
34758	3	58.9+	49.8	17.2	66.4	Adze
36029	7	49.5+	27.5	7.6	10	flake tool
30835	15	75.6	54.3	73.3	82.65	Biface
33411	16	42.9+	35.8	9.6	14.4	modified flake
33986	8	52.3	45.8	11.2	25.34	modified flake
35761	3	39.2	34.3	3.2	3.8	flake tool
32054	6	67.9	56.2	21.6	78.37	modified flake
33263	13	37.2	13.4	3.9	1.7	flake tool
33770	2	62.6	61.9	16.2	63.64	flake tool
31224	9	86.2+	48.7+	23.4	84.02	modified flake
32088	16	46.8	54	14.9	29.56	modified flake
32398	11	31.3	43.8	13.5	14.86	modified flake
34092	4	41.2	37.3	17	27.7	modified flake

Table 5.3. Descriptive Statistics for Skiles Shelter Assemblage

Lot #	Spec #	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Description
20107	5	32.2	30.7	5.3	3.29	edge-modified flake
20121	4	22.5+	41.1	10.3	10.6	edge-modified flake
20018	15	58.1	48.8	11.9	18.3	thin uniface
20018	7	36.3	47.3	14.8	14.9	sequent flake tool
20018	17	44.9	51.7	13.9	15.7	sequent flake tool
20073	4	44.3	52.4	12.8	32.65	sequent flake tool
20029	9	47.6	68	11.6	24.2	sequent flake tool
20082	7	46.6	28	7.7	10.95	edge-modified flake
20063	15	76.1	37.6	11.3	38.6	Biface
20063	9	46.2	39.6	9.6	13.92	Biface
20054	5	22+	25.6+	7.5	4.5	edge-modified flake
20078	3	34.7+	36.3+	8	10.36	edge-modified flake
20003	1	64.4	36	8.1	12.7	thin uniface
20040	5	23.5	29+	5.8	2.4	sequent flake tool
20073	1	81.5	56.1+	14.1	61.83	thin uniface
20020	2	51.1+	42.3	13.2	19.5	edge-modified flake
20056	8	63.7	48.1	20.4	54.22	edge-modified flake
20105	10	48.3+	39.1	14.6	29.15	thin uniface
20062	1	62.7	31.7	12.9	34.76	thin uniface
20031	4	38.1	45.6	13.5	16.2	thin uniface

Table 5.4. Descriptive Statistics for Little Sotol Assemblage

Lot #	Spec #	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Description
12	2	89.9	65.8	24.1	171.83	Uniface
67	5	78.1	46.4	17.7	49.72	flake tool
64	2	76.2	48.1	8.2	24.12	flake tool
25	13	65.7	67.5	20.6	80.07	flake tool
58	52	42.3	52.8	8.4	23.51	flake tool
57	5	112.2	44.8	21.1	114.05	flake tool
56	1	55.3	67.3	15.6	59.14	flake tool
4	4	73.5	50.8	16.7	57.9	flake tool
93	6	91.2	55.4	18.6	94.37	Modified flake tool
4	2	87.3	39.9	14.4	46.59	flake tool
2	7	86.7	42.8	10.5	42.16	Modified flake tool
8	4	68.2	50.5	10.4	37.91	flake tool
2	5	97.2	63.6	15.7	87.48	flake tool
23	4	33.4+	49.4	12	20.57	Uniface
20	11	98.7	71	19.3	131.51	flake tool
81	9	117	68.7	46.3	407.47	chopper
21	6	131	75.5	21.7	229.59	Biface
24	1	49.4	22.6	5.3	4.38	biface/drill
20	5	87.5	51	12.5	60.93	flake tool
46	3	83.5	48.5	17.1	66.24	Biface

Table 5.5. Descriptive Statistics for Sayles Adobe Assemblage

Lot #	Spec #	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Description
50158	1	114.2	66.7	29.7	199.67	Agave knife

After selecting the archaeological tools for this study, I analyzed them under the microscope. I conducted a low-power use wear analysis under 100X magnification, in order to characterize the following five elements of use wear related to plant-processing activities: polish, striations, edge-modification, direction of use, and intensification of wear. I then selected five tools from each archaeological collection, and the agave knife from Sayles Adobe, to conduct a high-power microscopic use wear analysis under 500X magnification. These high-power sub-sample was selected based on preliminary results from the low-power microscopic analysis. From this sub-sample, I worked to identify the plant-processing characteristics listed above in further detail. The results of this analysis are elaborated in Chapter 6.

VI. LITHIC USE-WEAR ANALYSIS

This chapter presents the results of the macroscopic and microscopic analysis of the archaeological and experimental assemblages, including photomicrographs from the low- and high-power microscopic analysis. A total of 76 tools were analyzed for this study. I begin by presenting the analysis of the experimental assemblage that complements the analysis of the archaeological assemblages that follows. The results and interpretations of this analysis will be presented in Chapter 7.

Macroscopic and Microscopic Analysis

Experimental

As described in Chapter 5, there are fifteen tools included in the experimental assemblage. Ten were created for this study and used to process evergreen rosettes such as sotol and lechuguilla. Five were given to me from other sources that were used on a variety of contact material such as hide/animal flesh, grass, bone, and wood. The analysis of these tools is detailed below.

X_12

Specimen "X_12" is a flake tool made from a tan-colored chert. As shown in Table 5.1, this tool was used to experimentally process sotol plants. I used this tool to cut away the sotol leaves from the bulb, slicing in a perpendicular motion. Macroscopically, the lateral edges of this tool show no evidence of wear, such as edge damage or polish, visible with the un-aided eye. However, microscopic analysis conducted using both low- and high-power magnification shows one small area of plant use-wear present on the ventral left lateral edge. The photomicrographs show striations parallel to the edge and well-developed overlapping polish with striations at an oblique angle to the edge (Figure

6.1). Because I only used this tool briefly to process a couple of sotol plants, there is not much evidence of wear other than that one small portion of the left ventral lateral edge.

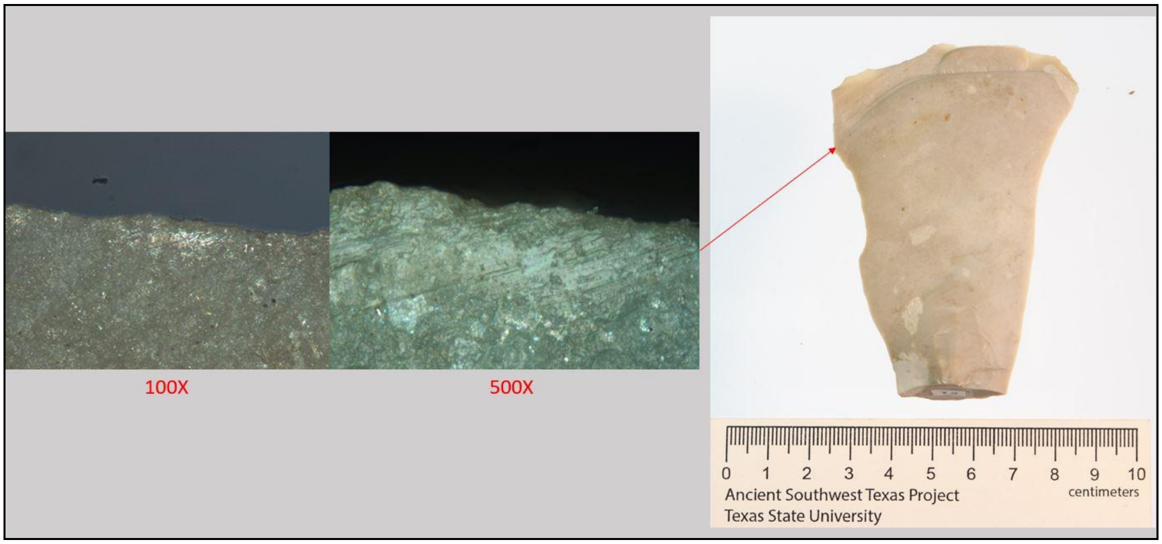

Figure 6.1. Experimental specimen "X_12" artifact photo and photomicrographs.

X_7

Specimen "X_7" is a flake tool made from a dark brown chert with cortex on the dorsal face of the tool (Figure 6.2). It was used to experimentally process lechuguilla for 30 minutes (Table 5.1). Microscopic analysis was conducted using both low- and high-power magnification. No use-wear was observed macroscopically nor microscopically, therefore no photomicrographs were taken. The quality of material of the tool is a factor in the formation and development of polish (Semenov 1985:11). As Figure 6.2 shows, this tool was made from a high-quality chert, so the lack of observable use-wear is likely due to the fact that this tool was only used for a short amount of time.

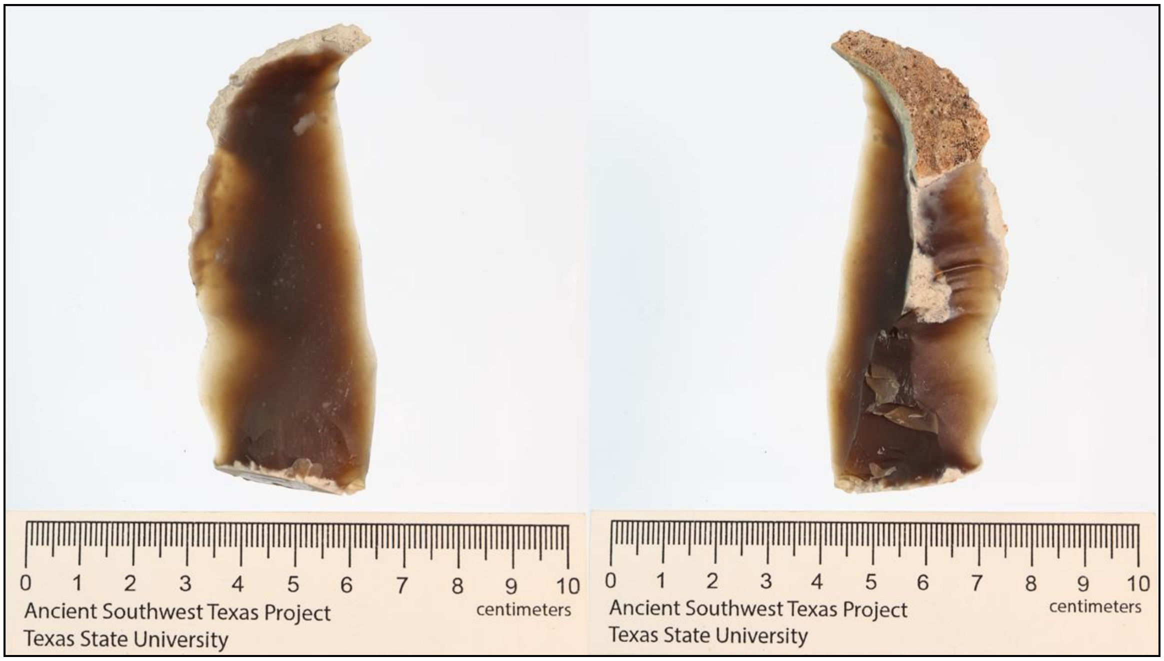

Figure 6.2. Experimental specimen “X_7” artifact photo.

X_8

Specimen “X_8” is a modified flake tool made from a tan-colored chert that was used to experimentally scrape sotol leaves. The leaves were scraped with the tool edge perpendicular to the contact material. When this tool was created experimentally, the left dorsal lateral edge was flaked to create a steeper edge angle for ease of scraping. Macroscopically, green plant material was still present after washing along the worked edge. Use wear analysis was conducted using both low- and high-power magnification in these areas. Bright, well-developed polish is present on the dorsal and ventral edges which correspond to the location on the tool that was used to process the sotol plants (Figure 6.3A-C).

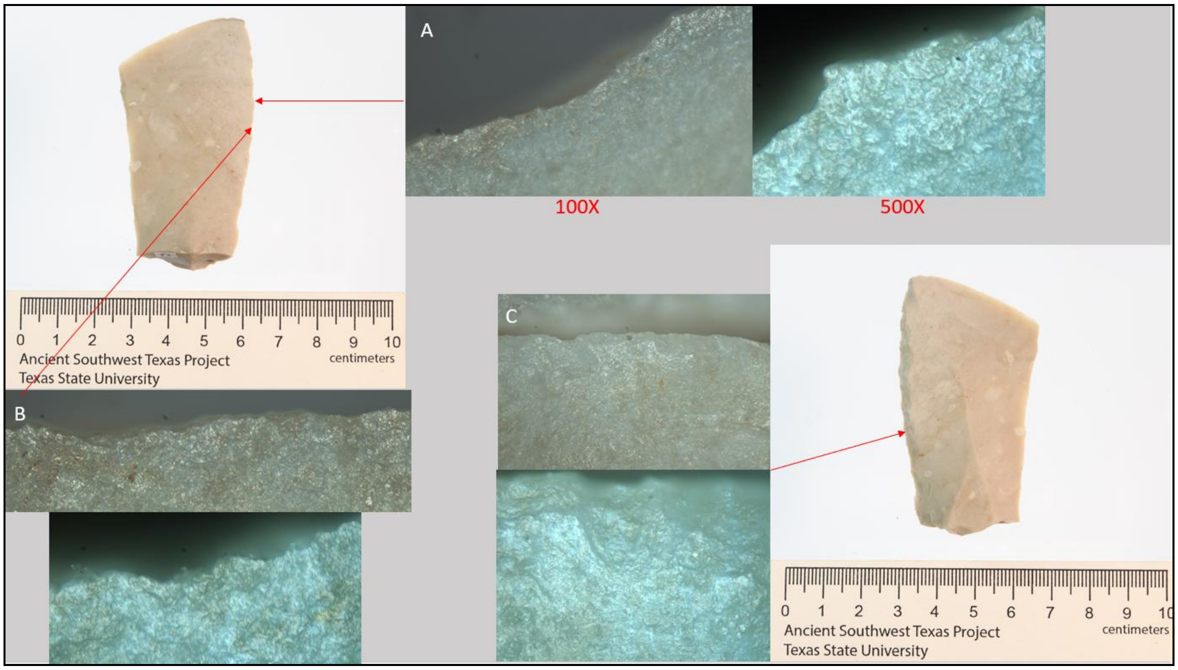

Figure 6.3. Experimental specimen "X_8" artifact photo and photomicrographs.

X_6

Experimental specimen "X_6" is a light tan-colored chopper tool (Figure 6.4) used to process sotol plants, specifically chopping off a green stalk of a freshly bloomed plant. As described in Chapters 3 and 4, sotol stalks were used often by Indigenous people. Macroscopically, edge damage was observed along the lateral edges of the tool, but it could not be analyzed microscopically under the Leica microscope because the relatively large size of the tool and steep edge angle were too extreme for the equipment, further detailed in Chapter 5.

Figure 6.4. Experimental specimen “X_6” artifact photo.

X_1

Specimen “X_1” is an agave knife that I used to experimentally process sotol plants by slicing off the leaves perpendicular to the contact material, as detailed in Chapter 5. This artifact was made from gray-colored Georgetown chert. Analysis was conducted using both low- and high-power magnification and showed evidence of wear macroscopically and microscopically. Figure 6.5A shows striations parallel to the tools’ edge. Figure 6.5B-D show bright, well-developed polish along multiple ridges, or arrises, on both sides of the tool edges.

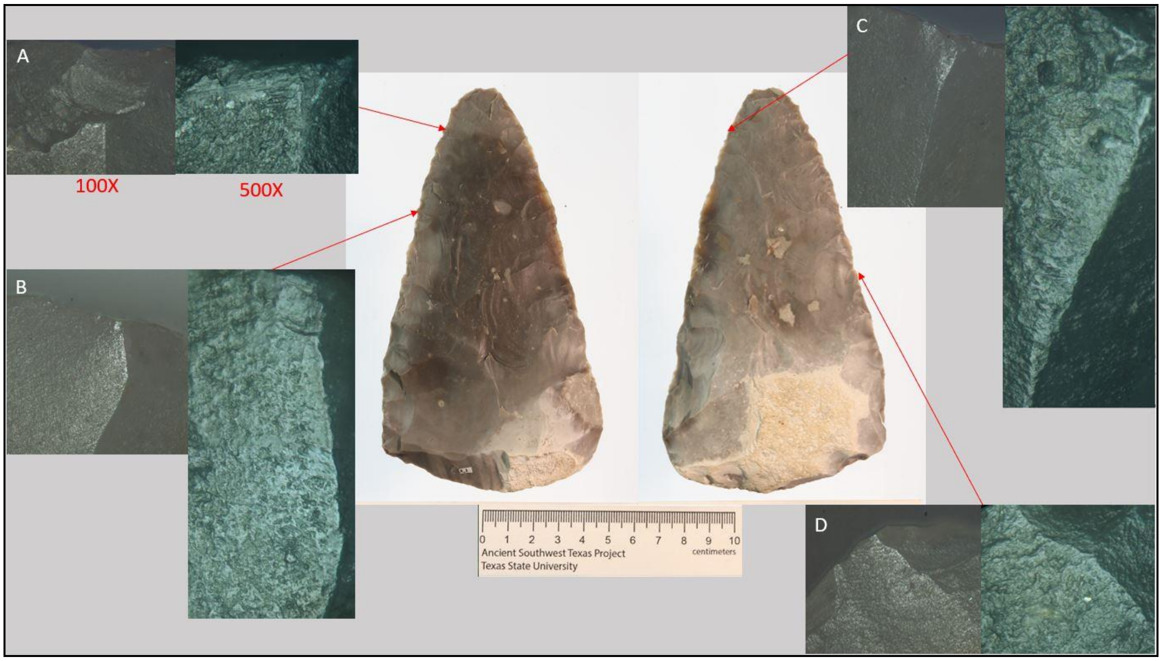

Figure 6.5. Experimental Specimen “X_1” artifact photo and photomicrographs.

X_4

Specimen “X_4” is an agave knife made from a dark brown-colored chert that was used to experimentally process lechuguilla. I used this tool to cut the leaves away from the bulb with the tool perpendicular to the contact material. Figure 6.6A-D shows polished arrises, or ridges between flake scars, all along the edges on both sides of the tool at the highest points on the topography of the tool.

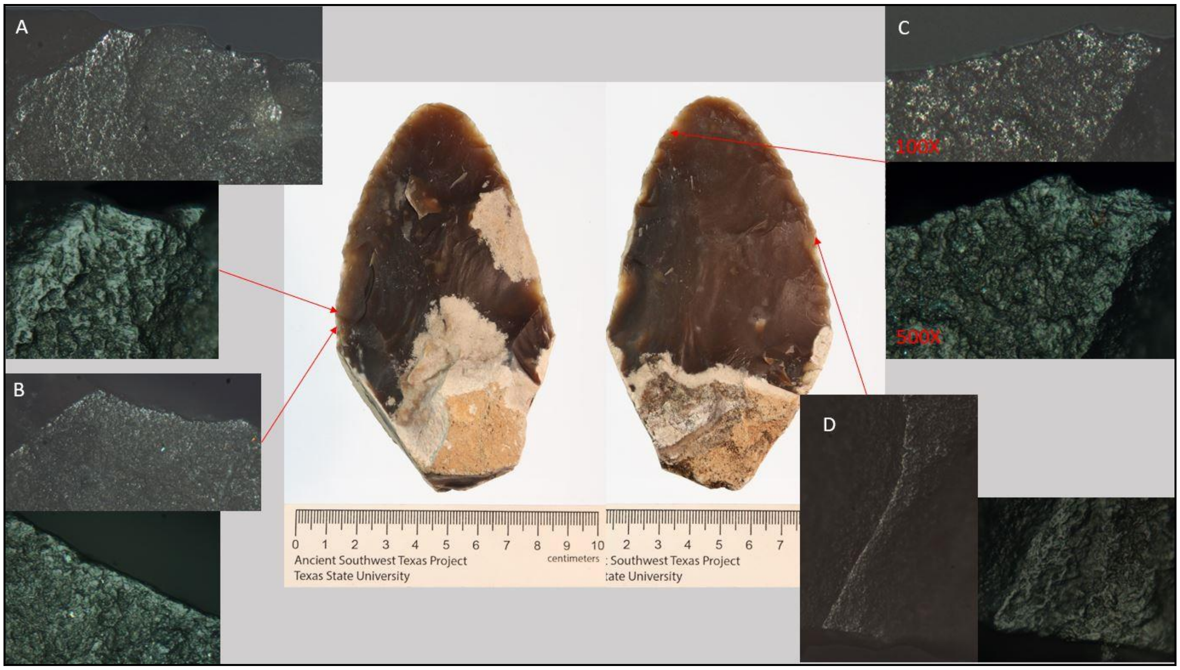

Figure 6.6. Experimental Specimen "X_4" artifact photo and photomicrographs.

X_11

Specimen "X_11" is a modified flake tool made from a light tan chert. This tool was used to experimentally process lechuguilla plants by scraping the contact material in a perpendicular motion. Much like X_8, when this tool was created experimentally, the left dorsal lateral edge was flaked to create a steeper edge angle for ease of scraping. Analysis was conducted using both low- and high-power magnification. On the distal edge on the ventral side of the tool use-wear traces are present. Figure 6.7 shows polish and striations parallel to the tools' edge.

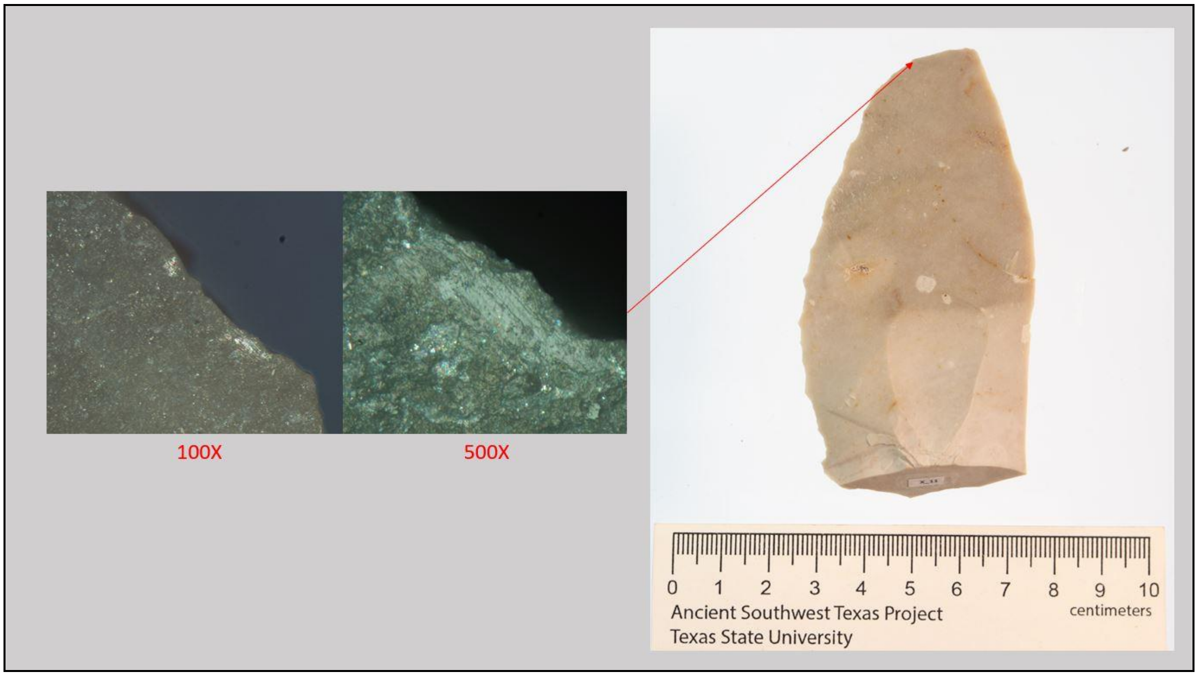

Figure 6.7. Experimental Specimen “X_11” artifact photo and photomicrographs.

X_9

Specimen “X_9” is a chopper that was used to experimentally process lechuguilla (Figure 6.8). This tool was used to chop, in a straight downward motion, perpendicular to the leaves and roots to separate them from the bulb. Macroscopically, edge damage was observed on the worked edge. However, this tool could not be analyzed under the Leica microscope because the large size and steep edge angle were not suitable for the equipment, which is detailed in Chapter 5.

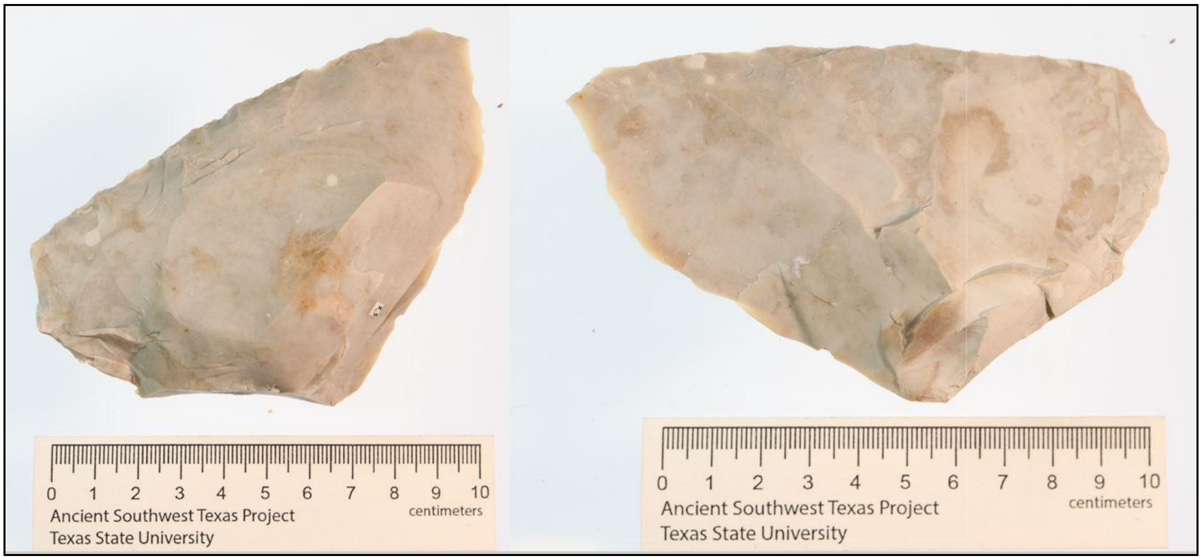

Figure 6.8. Experimental Specimen "X_9" artifact photo.

X_2

Specimen "X_2" is a sequent flake tool made from dark brown chert and used to experimentally process sotol plants. This was used perpendicular to the contact material to separate the leaves from the bulb of the plant. Macroscopically, edge damage can be observed on the right ventral/left dorsal edge. Microscopic analysis was conducted using both low- and high-power magnification, as described in Chapter 5. Figure 6.9A-C shows this edge damage and polish use-wear evidence along these lateral edges.

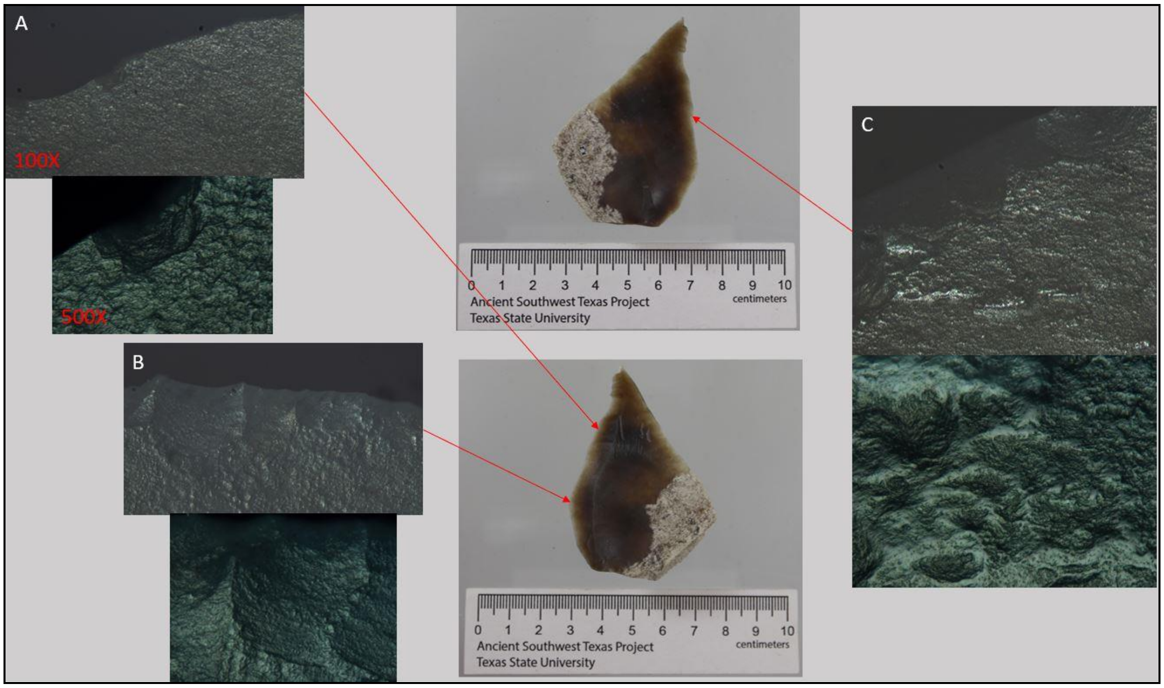

Figure 6.9. Experimental Specimen “X_2” artifact photo and photomicrographs.

X_3

Specimen “X_3” is a sequent flake tool made from a tan colored chert. This tool was used to experimentally process sotol plants by slicing the leaves from the bulb at a perpendicular angle to the contact material. Slight microchipping can be seen along the distal edge macroscopically, though very little. Analysis was conducted using both low- and high-power magnification. Edge damage and slight polish was observed on the distal edge that was used to remove leaves from the plant (Figure 6.10). The lack of developed use-wear evidence is likely due to only processing two sotol plants which was insufficient time to create much wear.

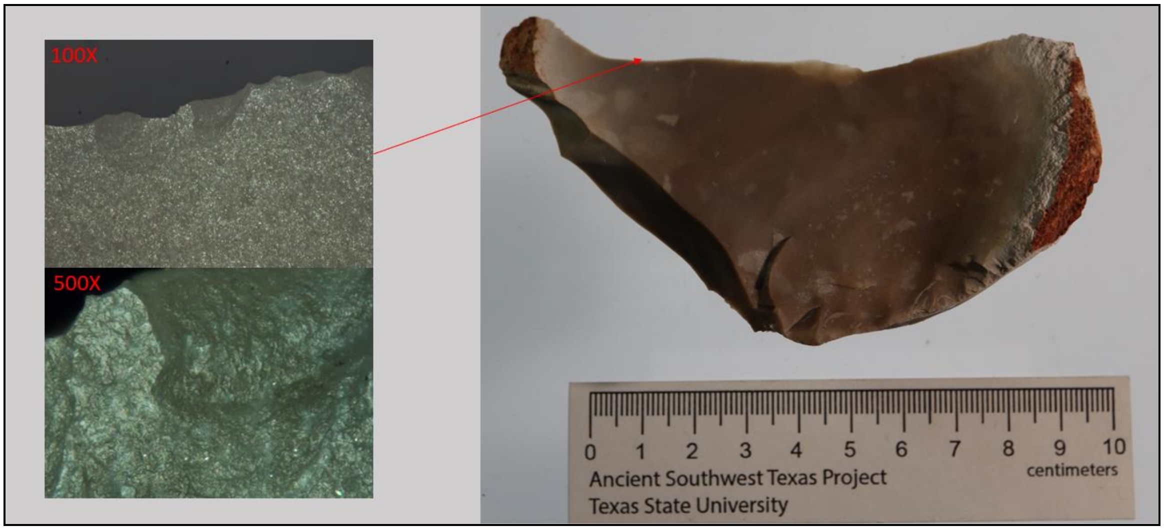

Figure 6.10. Experimental Specimen "X_3" artifact photo and photomicrographs.

MBC-1

Specimen "MBC-1" is a blade tool made from gray-colored Edward's chert with cortical surface on the left lateral edge of the dorsal side. As described in Chapter 5, this tool was used to cut grass. Macroscopic evidence of edge damage is visible on the ventral lateral edge. Microscopic analysis was conducted using both low- and high-power magnification, and well-developed use-wear was observed on this edge. Figure 6.11A-C shows continuous polish wrapping around the right ventral lateral edge of this tool. Figure 6.11D-E also show polish and microchipping.

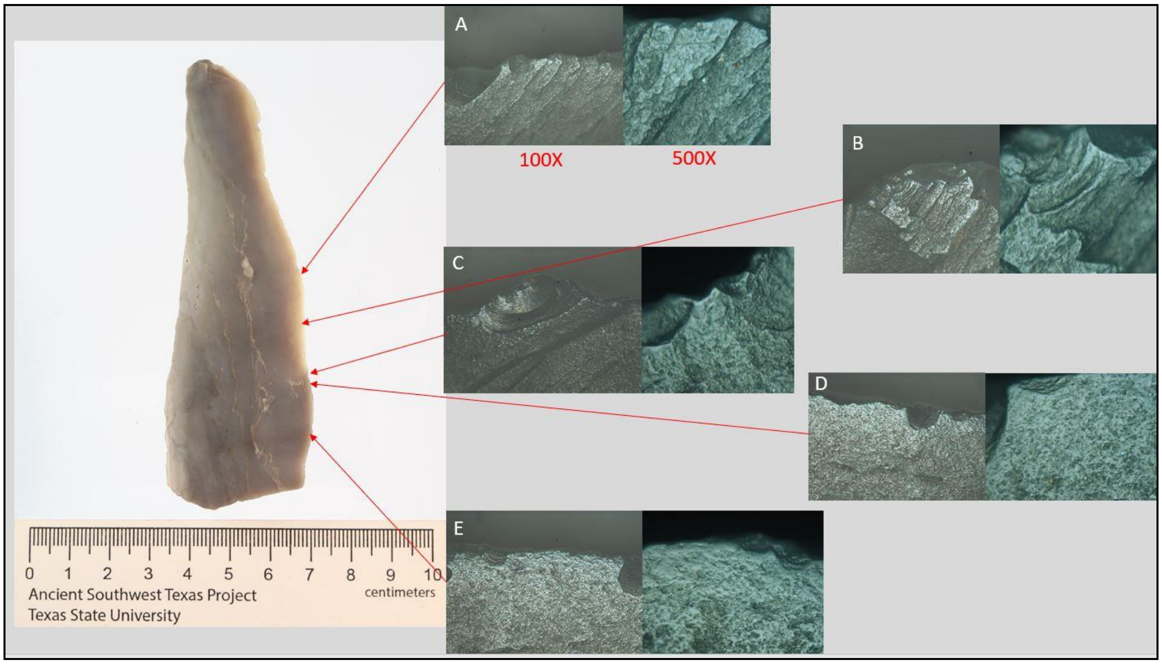

Figure 6.11. Experimental Specimen "MBC-1" blade artifact photo and photomicrographs.

CJ-13

Specimen "CJ-13" is a flake tool made from brownish-gray chert distally broken with a snap termination. This tool was used to dismember and skin the foreleg of a deer, as described in Chapter 5. Though this experimental tool is small in size, use-wear evidence was observed macroscopically and microscopically on the dorsal right/ventral left lateral edges. Microscopic analysis was conducted using both low- and high-power magnification. Figure 6.12A-B, Figure 6.12D, and Figure 6.13E-F show well-developed polish and microchipping, indicative of soft tissue butchering, all along the lateral edges of the ventral and dorsal side of the tool. Figure 6.12C shows an unidentified dark reddish residue that remained after washing; Figure 6.13E also shows this residue. This residue is very likely ochre, thought further testing is needed to confirm this.

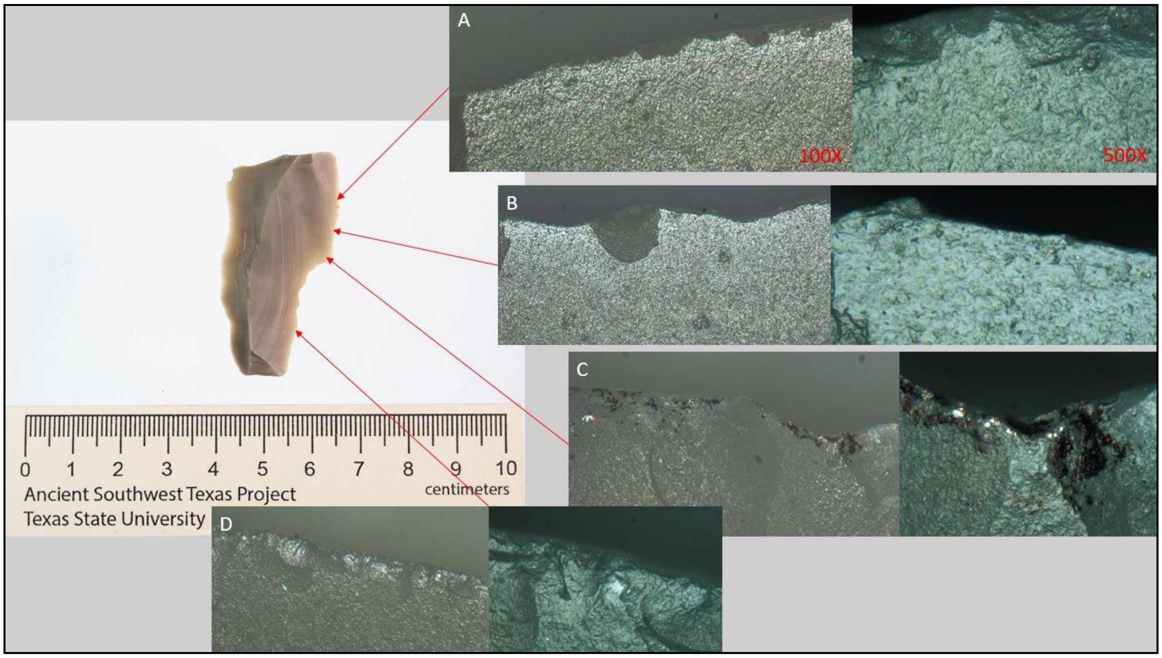

Figure 6.12. Experimental Specimen "CJ-13" dorsal artifact photo and photomicrographs.

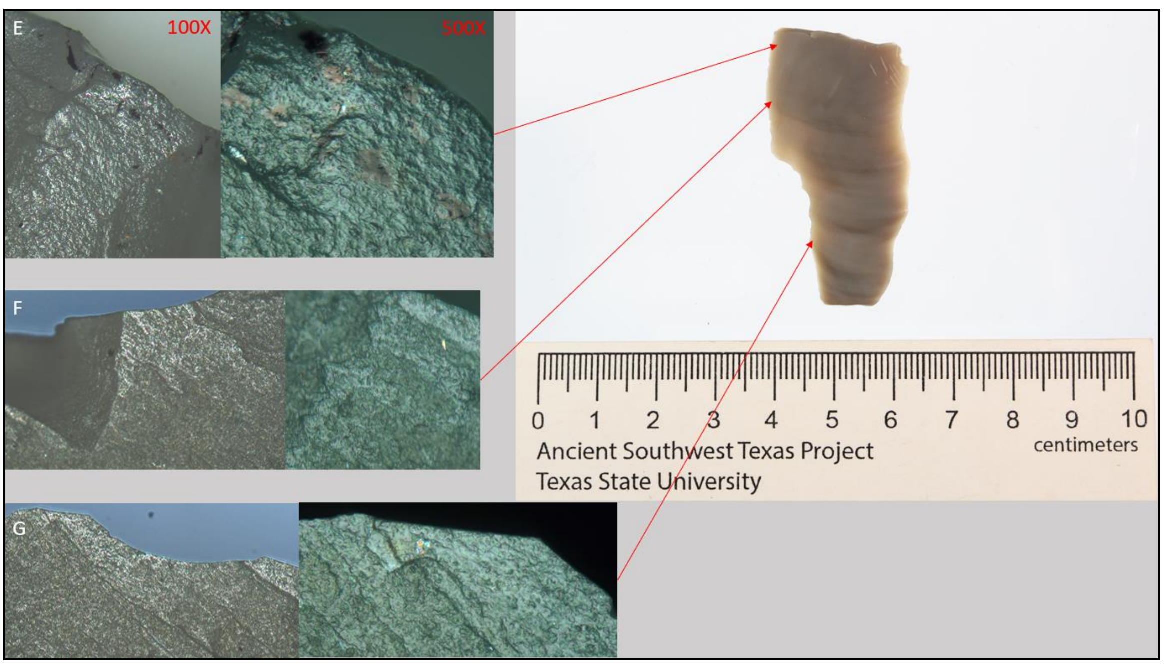

Figure 6.13. Experimental Specimen "CJ-13" ventral artifact photo and photomicrographs.

EG Scr-1

Experimental specimen “EG Scr-1” is a scraper tool made from a high-quality banded grayish brown chert worked on all edges of the dorsal side. Detailed in Chapter 5, this tool was used to scrape buffalo hide. Macroscopically I did not observe any polish, however microscopically there were several areas on the ventral side of the tool with use-wear evidence. Microscopic analysis was conducted using both low- and high-power magnification and showed discontinuous polish along the tools’ edge (Figure 6.14A-D and Figure 6.15E-H).

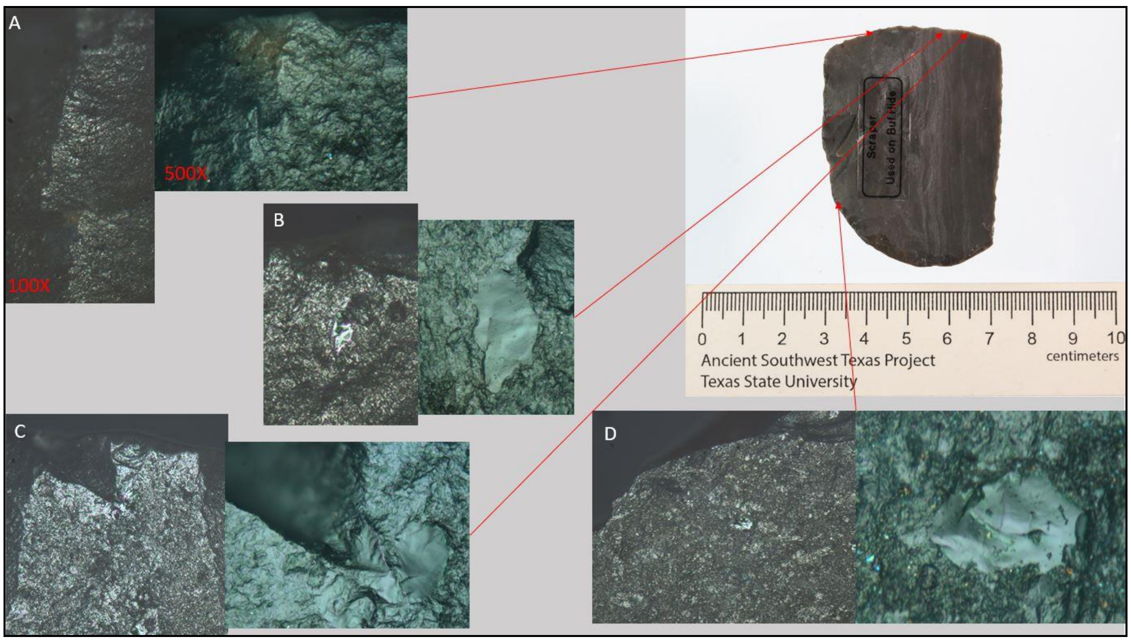

Figure 6.14. Experimental Specimen “EG Scr-1” artifact photo and photomicrographs.

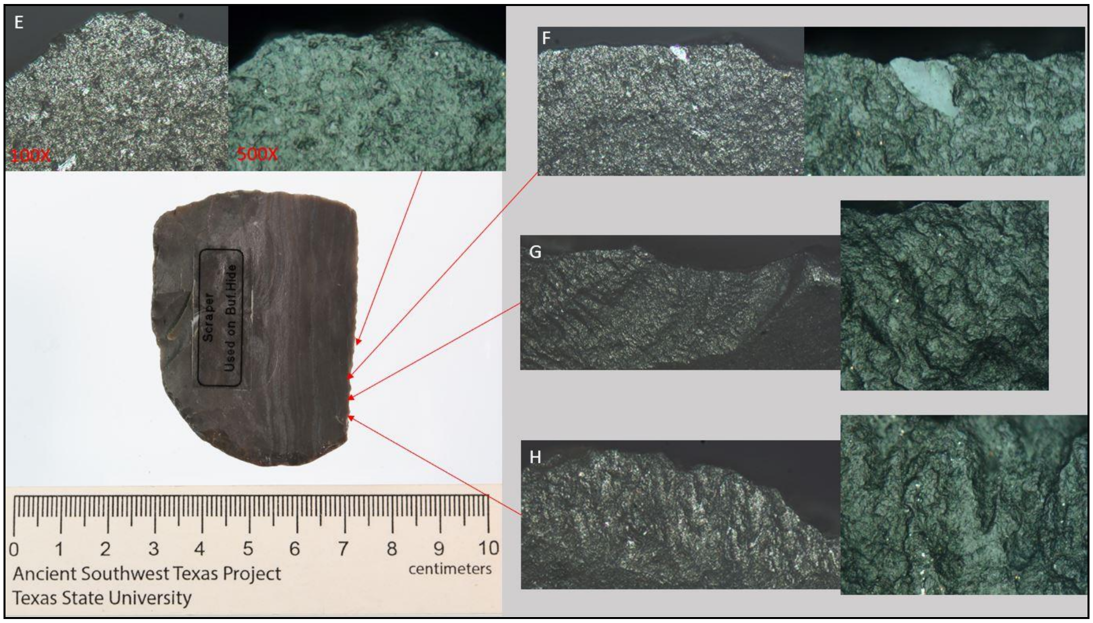

Figure 6.15. Experimental Specimen “EG Scr-1” artifact photo and photomicrographs.

AH-36

Specimen “AH-36”is a blade tool made from light, gray-colored chert that was used to experimentally cut/saw bison bone. Macroscopically and microscopically, well developed use-wear was evident along the dorsal left lateral edge. Macroscopic evidence of heavy edge damage and polish along lateral edges was observed. Microscopic analysis was conducted using both low- and high-power magnification which showed polish and overlapping subparallel, multidirectional striations (Figure 6.16A-C).

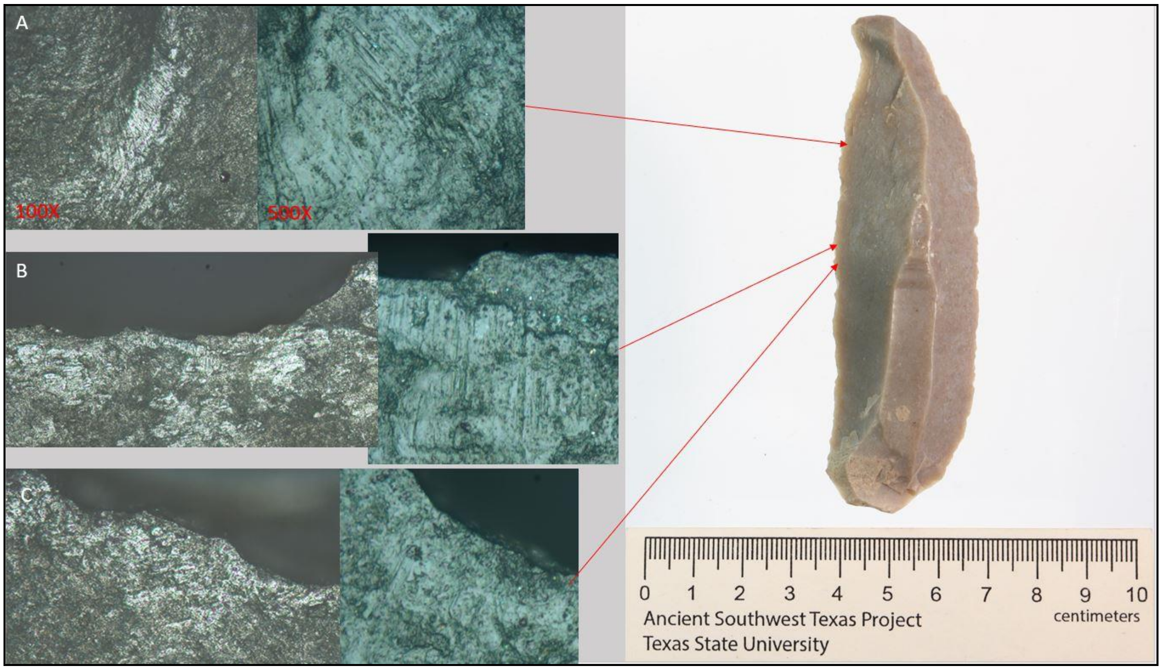

Figure 6.16. Experimental Specimen "AH-36" artifact photo and photomicrographs.

E-33

Specimen "E-33" is an un-worked flake tool made from dark, gray-colored chert with a cortical surface on the dorsal side. As described in Chapter 5, this tool was used to experimentally saw wood. Macroscopically, edge damage present on the distal edge of the tool was noted. Microscopic analysis was conducted using both low- and high-power magnification and the photomicrograph shows just one small area of polish on the distal edge (Figure 6.17).

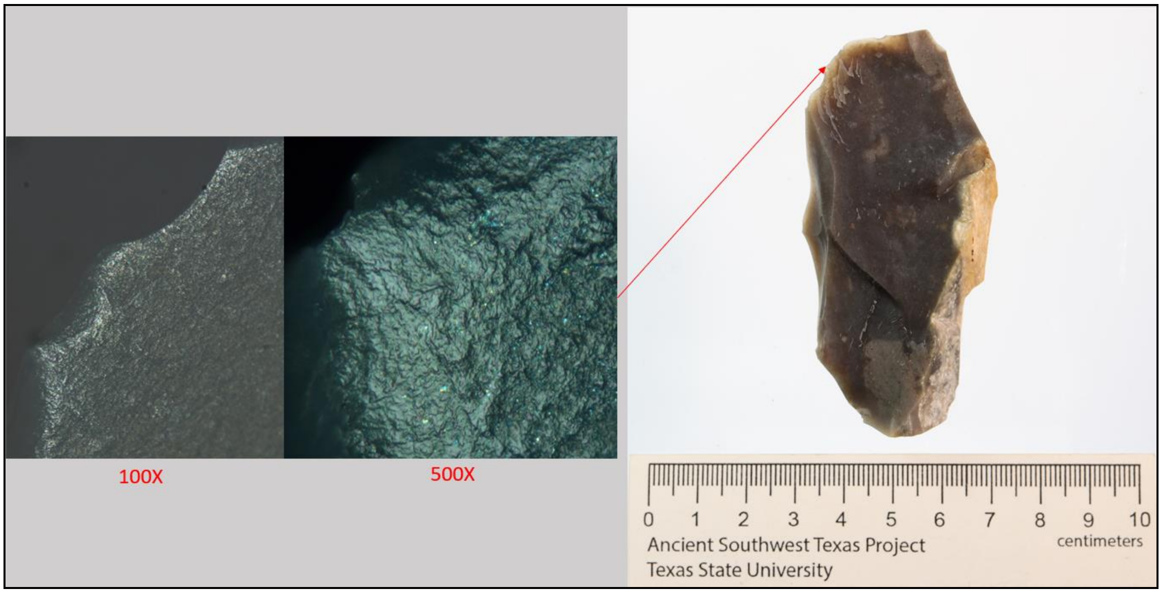

Figure 6.17. Experimental Specimen “E-33” artifact photo and photomicrographs.

Archaeological Assemblages

Four archaeological sites from the LPC were included in this study: Eagle Cave, Skiles Shelter, Little Sotol, and Sayles Adobe. Chapter 4 describes the context and reasoning for choosing these samples from these sites. A total of 61 tools were analyzed from these sites. The analysis of these tools is detailed below.

Eagle Cave

The descriptive statistics of the Eagle Cave tools analyzed for this thesis are detailed in Table 4.2. The Eagle Cave archaeological sample included in this study is comprised of edge-modified flakes, unifaces, flake tools, bifaces, and an adze. A total of twenty tools were analyzed from this site from collections excavated by the ASWT Project.

32600.4

Eagle Cave specimen 32600.4 is a modified flake tool made from brown chert. Macroscopically, a slight sheen was noted along the lateral edges of the tool.

Microscopically, when analyzed under low- and high-power magnification, discontinuous polish is observed in just one location on the dorsal right lateral edge of the tool (Figure 6.18) and in two locations on the ventral distal and right lateral edge as shown by the photomicrographs (Figure 6.19A-B). Figure 6.18 shows prehension wear traces from where the tool was gripped. The linked, well-developed polish shown in Figure 6.19A-B suggests that this artifact was used to process plant material.

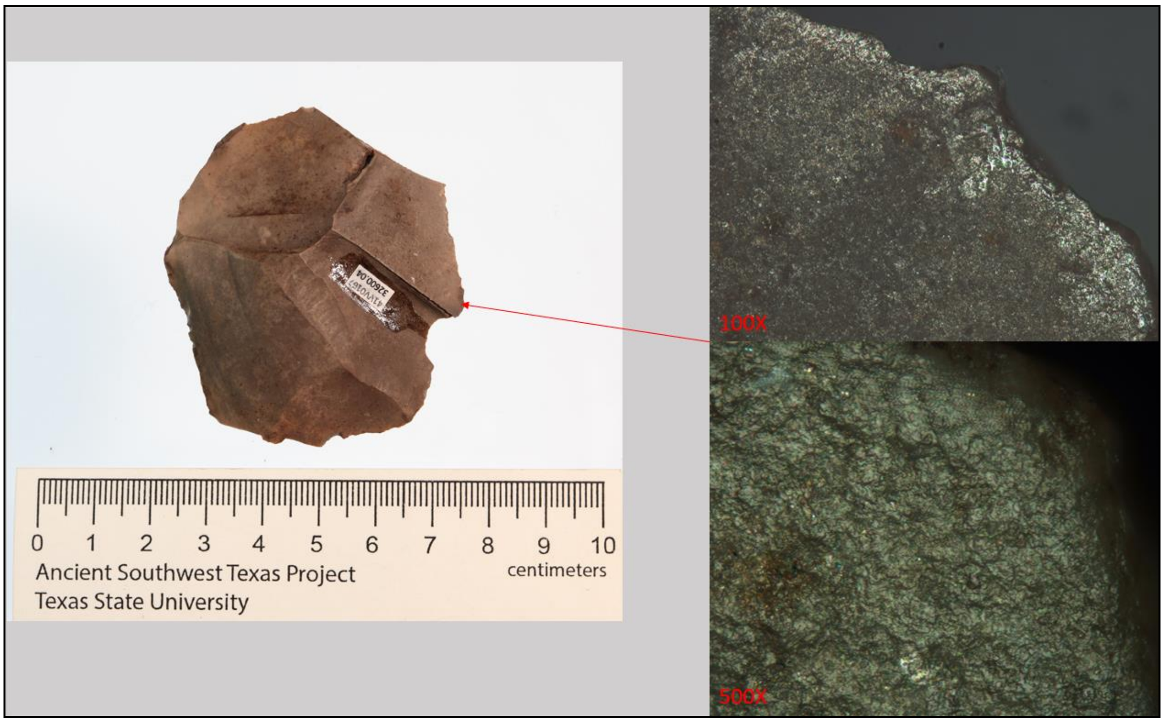

Figure 6.18. Eagle Cave specimen 32600.4 dorsal artifact photo and photomicrographs.

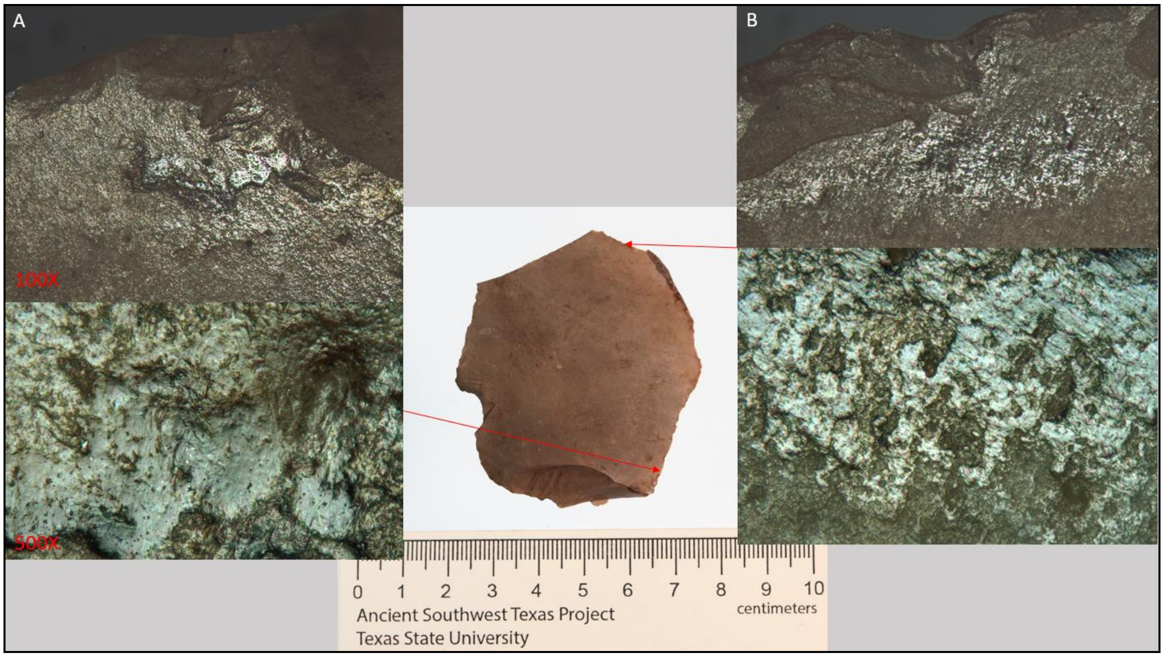

Figure 6.19. Eagle Cave specimen 32600.4 ventral artifact photo and photomicrographs.

31956.15

Eagle Cave specimen 31956.15 is a modified flake tool made from grayish brown chert with cortex on the distal edge of the tool. A slight amount of polish was noted macroscopically on the left dorsal/ right ventral lateral edges of the tool. When analyzed microscopically under low-power magnification, these edges show very little polish in these locations which indicates that this tool was not used for very long (Figure 6.20A-C). Due to this fact, the contact material is largely undetermined. However, this tool could have been used to process plants.

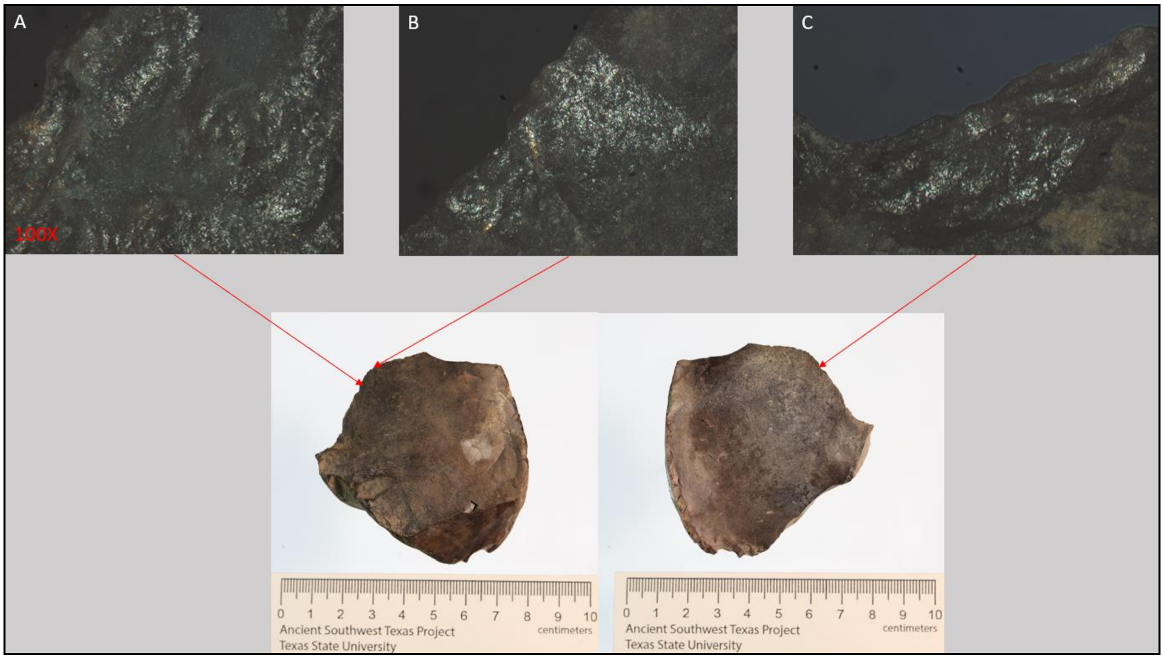

Figure 6.20. Eagle Cave specimen 31956.15 artifact photo and photomicrographs.

32457.26

Eagle Cave specimen 32457.26 is a small flake tool with cortex on the dorsal face, made from a light pink and brown colored chert. Macroscopically, slight polish and edge damage was noted on the tool. Two photomicrographs from the low-power microscopic analysis show edge damage and intermittent abrasive polish on the right dorsal lateral edge (Figure 6.21A) and the ventral distal edge (Figure 6.21B). This type of abrasive polish is thought to be indicative of hafting (Shoberg 2010:139). The lack of well-developed continuous polish suggests this tool was used for a short amount of time on the contact material. This tool may have been used on wood.

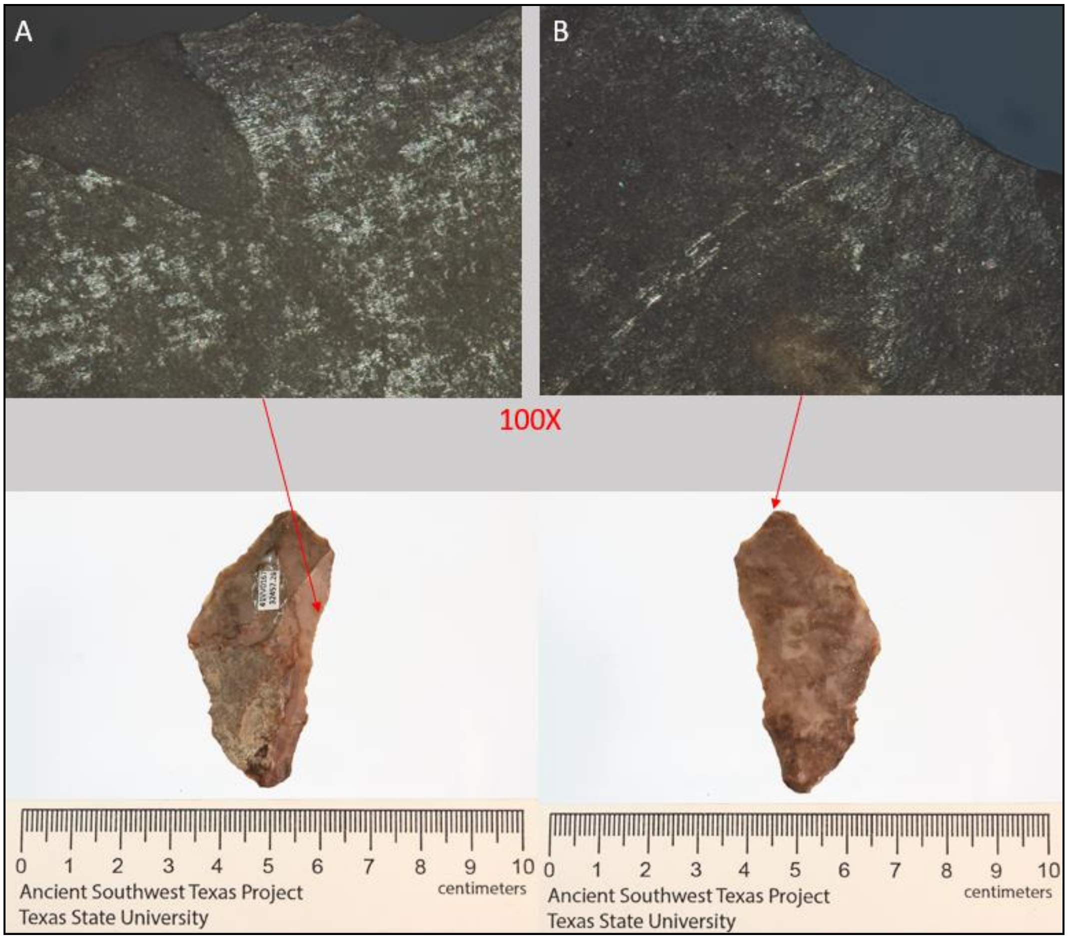

Figure 6.21. Eagle Cave specimen 32457.26 artifact photo and photomicrographs.

34173.2

Eagle Cave specimen 34173.2 is a modified flake made from a brown colored chert with a finely worked edge. Though my methodology in Chapter 6 states that I selected complete tools for this study when possible, this tool fragment shows evidence of well-developed polish (both macroscopically and microscopically) across the entirety of the working edge and is therefore an exception to this rule. Macroscopically, heavy gloss was observed on both sides which can be seen in the macroscopic photograph (Figure 6.22 and 6.23). Microscopic analysis under low- and high-magnification shows bright polish and several parallel striations that are parallel to the worked edge (Figure

6.22). Figure 6.23A shows well-developed, bright, and continuous polish with distinctive micropitting. Figure 6.23B also shows this, in addition to a striation at an oblique angle to the edge. The combination of these is characteristic of "sickle gloss" and is indicative of plant-processing (Jensen 1993:29; Shoberg 2010:150).

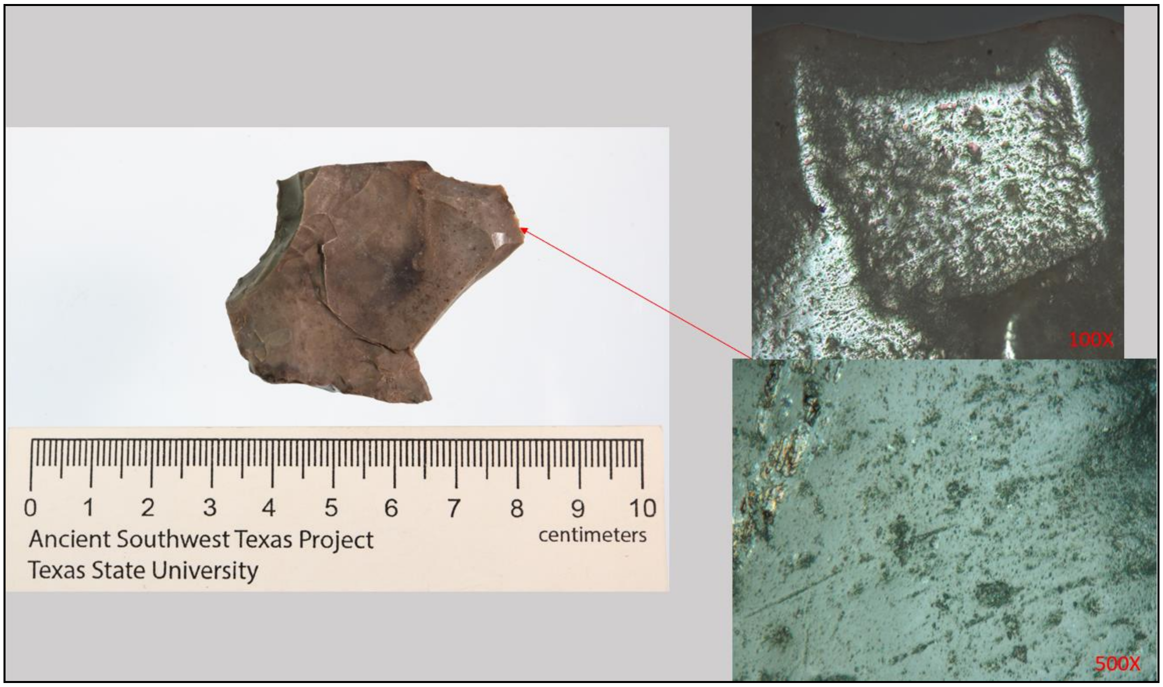

Figure 6.22. Eagle Cave specimen 34173.2 artifact photo and photomicrographs.

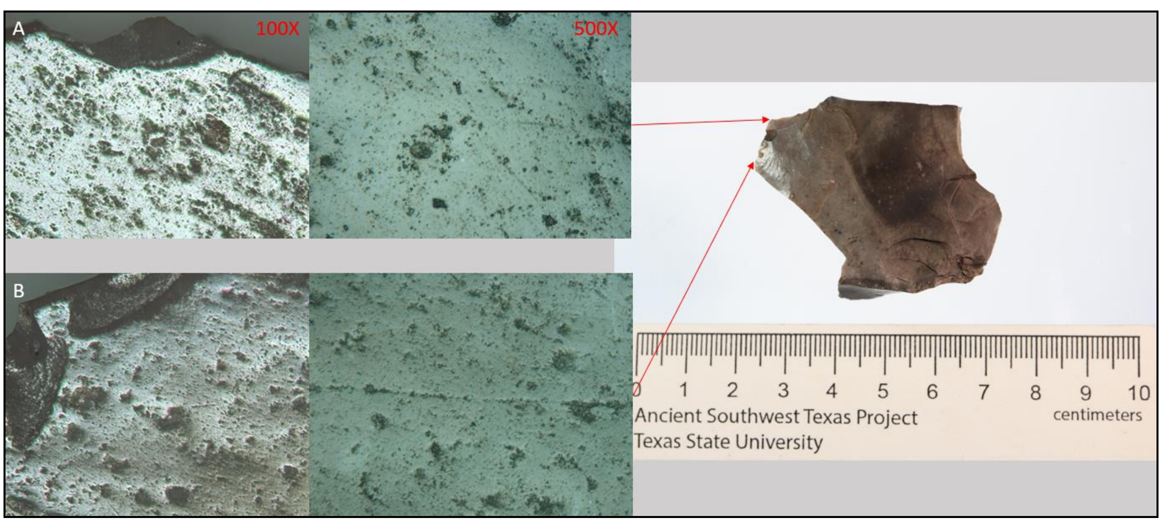

Figure 6.23. Eagle Cave specimen 34173.2 artifact photo and photomicrographs.

31084.3

Eagle Cave specimen 31084.3 is a large, modified flake tool made from dark gray chert with visible polish on the dorsal right lateral edge. Evidence of burning can be seen macroscopically on this tool such as discoloration and potlid features on the ventral face This tool was analyzed microscopically under low- and high-power magnification. The dorsal right lateral edge shows bright polish microscopically, with striations perpendicular to the edge and micropitting (Figure 6.24). The ventral right lateral edge shows discontinuous polish and overlapping striations (Figure 6.25A-B). The right ventral lateral edge also shows parallel striations at an oblique angle to the edge (Figure 6.26C-E). These wear patterns are characteristic of plant-processing.

Figure 6.24. Eagle Cave specimen 31084.3 dorsal artifact photo and photomicrographs.

Figure 6.25. Eagle Cave specimen 31804.3 ventral artifact photo and photomicrographs.

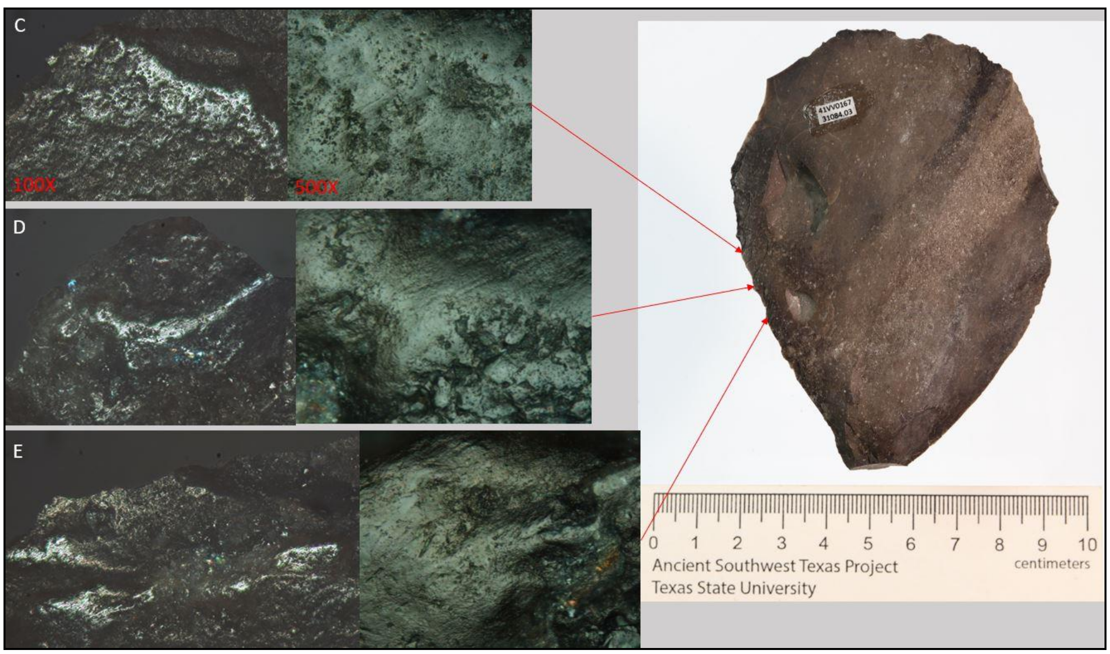

Figure 6.26. Eagle Cave specimen 31804.3 ventral artifact photo and photomicrographs.

30904.7

Eagle Cave specimen 30904.7 is a modified flake tool (Figure 6.27). As discussed in Chapter 4, during initial analysis of the site "polish/sheen" was noted in the specimen inventory of the tool and is visible macroscopically. However, microscopic analysis showed no traces of use wear and therefore no photomicrographs were taken of this tool. Post-depositional surface modification (PDSM) is the alteration of tool surfaces that occurs after the tool was discarded, such as patination, erosion from water/wind/sand, soil chemistry, and archaeological cleaning protocols (Odell 2003:138; Semenov 1985: 11; Vaughan 1985:42-43). This tool could have visible polish due to PDSM instead of evidence of use-wear.

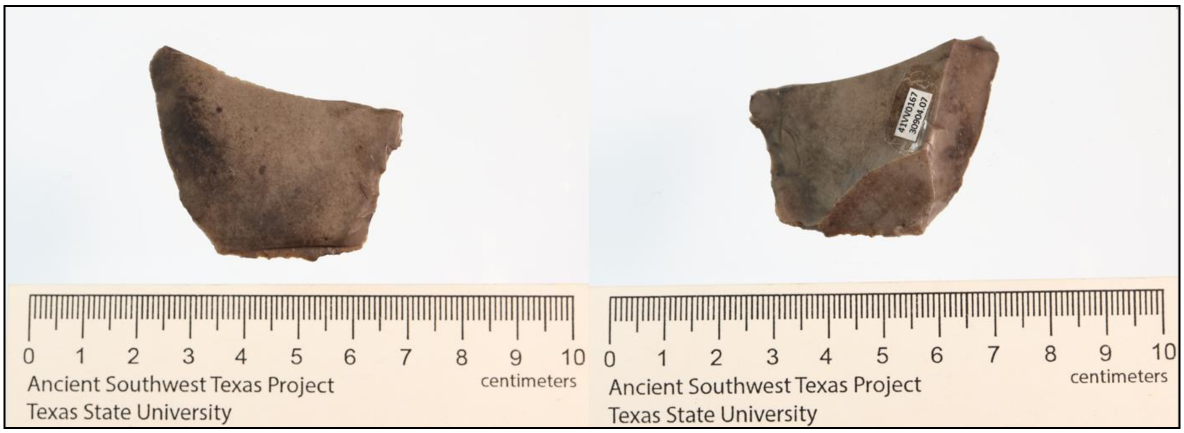

Figure 6.27. Eagle Cave specimen 30904.7 artifact photo.

30904.8

Eagle Cave specimen 30904.8 is a modified flake tool (Figure 6.28). Similar to the above tool, during initial analysis of the site “polish/sheen” was noted in the specimen inventory. However, microscopic analysis was conducted, and no traces of use wear was observed. Therefore, no photomicrographs were taken. This tool could have visible polish due to PDSM instead of evidence of use-wear, as with Specimen 30904.7 from the same provenience.

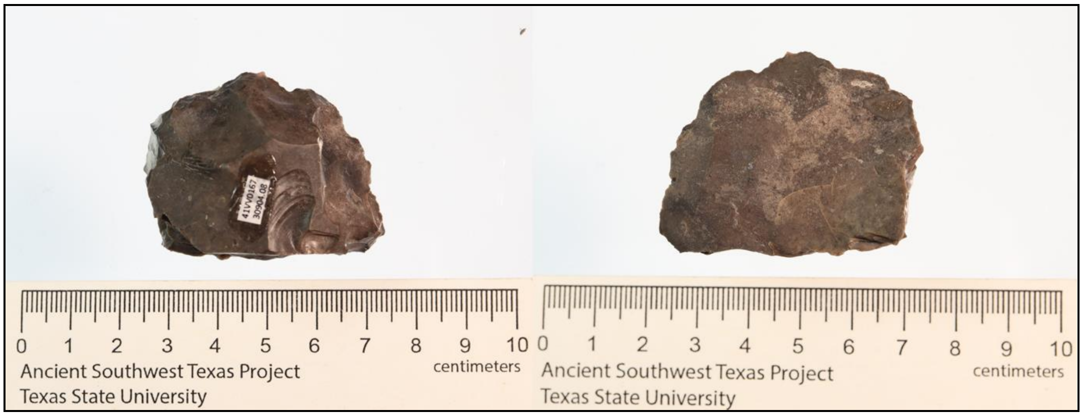

Figure 6.28. Eagle Cave specimen 30904.8 artifact photo.

34758.3

Eagle Cave specimen 34758.3 was entered in the specimen inventory as an adze fragment (Figure 6.29). This tool was made from a high-quality chert; the distal portion of the tool was broken off in a snap fracture that may have occurred prehistorically during manufacturing of the tool. A reddish color (likely ochre) was observed macroscopically on the dorsal face of this tool, though during analysis, no use-wear was observed microscopically on this tool; therefore, no photomicrographs were taken. The lack of observable use-wear could be due to PDSM or that the utilized distal end of the tool is missing; no wear traces could be inferred from this fragment.

Figure 6.29. Eagle Cave specimen 34758.3 artifact photo.

36029.7

Eagle Cave specimen 36029.7 is a flake tool made from a very high-quality black chert with a single white band on the proximal portion of the tool; the distal edge is broken in a snap fracture. Figure 6.30A-B show moderate polish with some linkage along the lateral edges of the ventral side. The right dorsal lateral edge shows slight polish on the higher points of the tool's topography with invasive polish following the microtopography of the chert surface (Figure 6.31). The use-wear evidence is characteristic of soft animal tissue as the contact material, which suggests butchering.

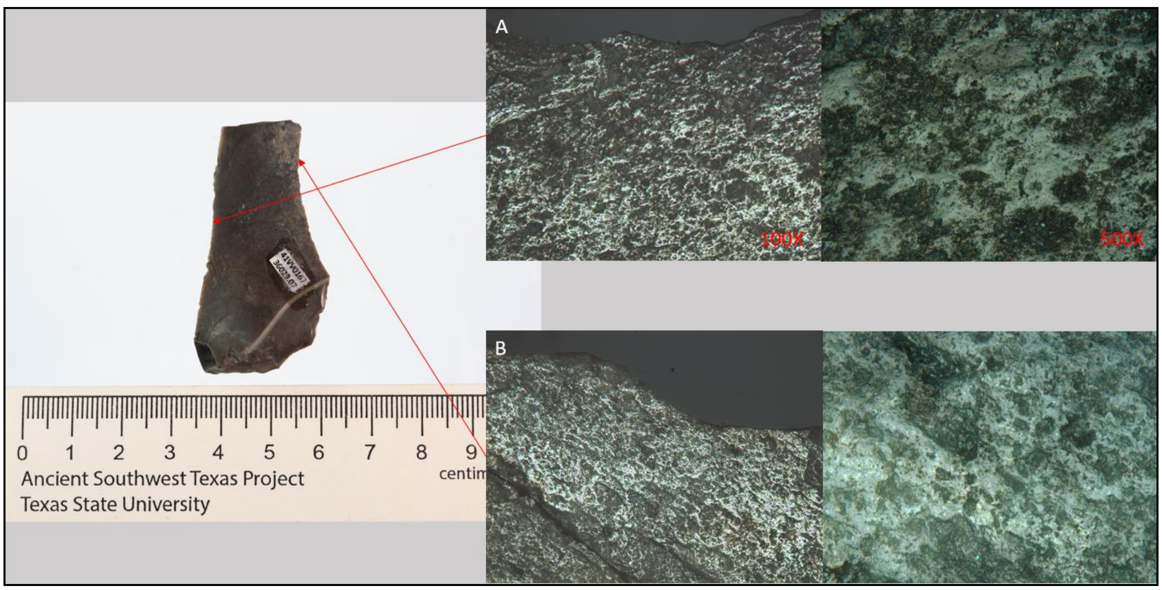

Figure 6.30. Eagle Cave Specimen 36029.7 ventral artifact photo and photomicrographs.

Figure 6.31. Eagle Cave Specimen 36029.7 dorsal artifact photo and photomicrographs.

30835.15

Eagle Cave specimen 30835.15 is a biface tool with polish visible macroscopically (Figure 6.32). As discussed in Chapter 4, during initial analysis of the site “polish/sheen” was noted in the specimen inventory of the tool. However, microscopic analysis showed no traces of use wear and therefore no photomicrographs were taken of this tool. This tool could have visible polish due to PDSM instead of evidence of use-wear.

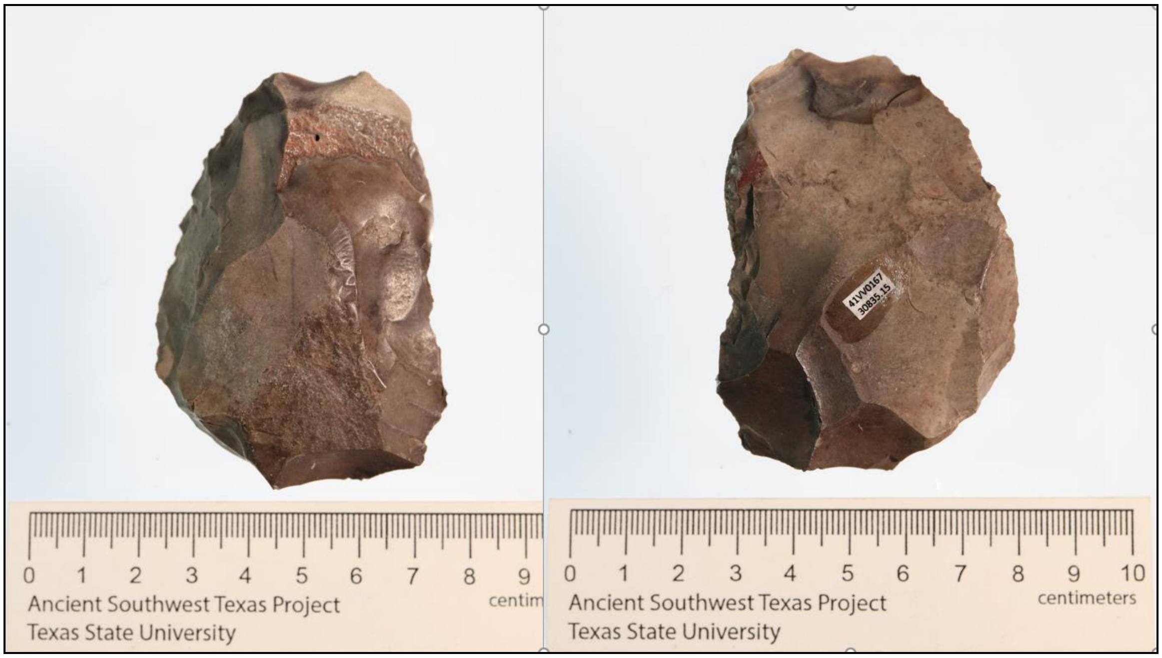

Figure 6.32. Eagle Cave Specimen 30835.15 artifact photo.

33411.16

Eagle Cave specimen 33411.16 is a small, modified flake tool made out of a high-quality brown chert. This tool was analyzed microscopically under low-power magnification and shows very little polish along the lateral edges (Figure 6.33A-C). This polish could be due to PDSM instead of evidence of use-wear, or this tool was used for too short a time for interpretable wear traces to form. It's possible this tool was used for processing plant materials, but this cannot be confirmed with the observable use-wear evidence.

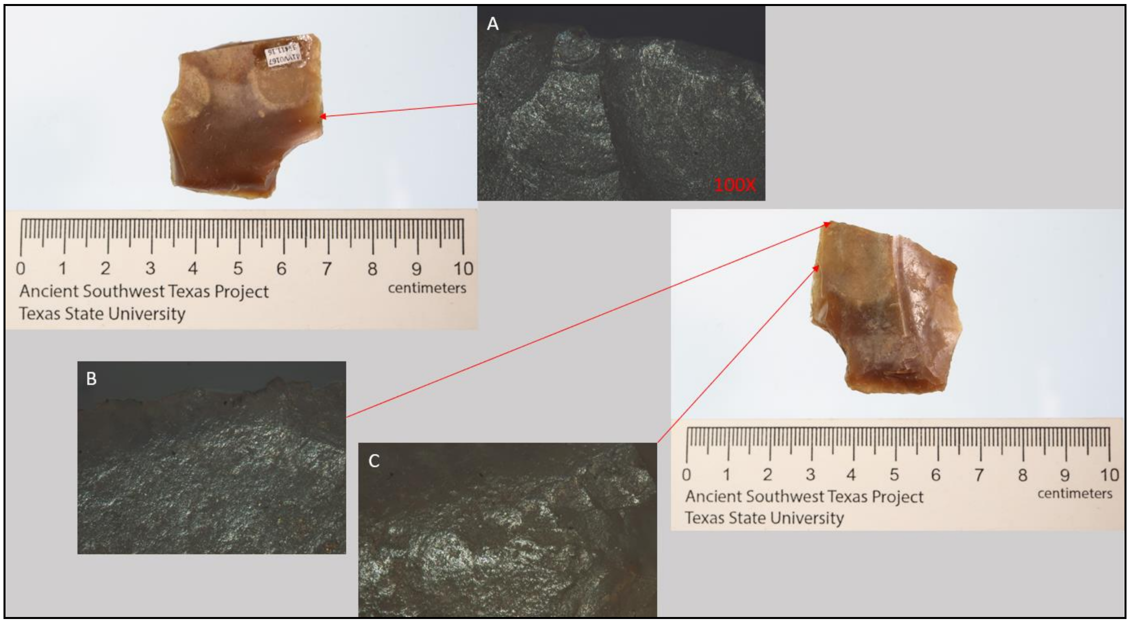

Figure 6.33. Eagle Cave Specimen 33411.16 artifact photo and photomicrographs.

33986.8

Eagle Cave specimen 33986.08 is a modified flake tool (Figure 6.34**)**. Macroscopically, the dorsal side of this tool was cracked and blackened as though it had been burned. This tool was analyzed microscopically under low- and high-power magnification, however, no evidence of use wear was observed; therefore, no photomicrographs were taken.

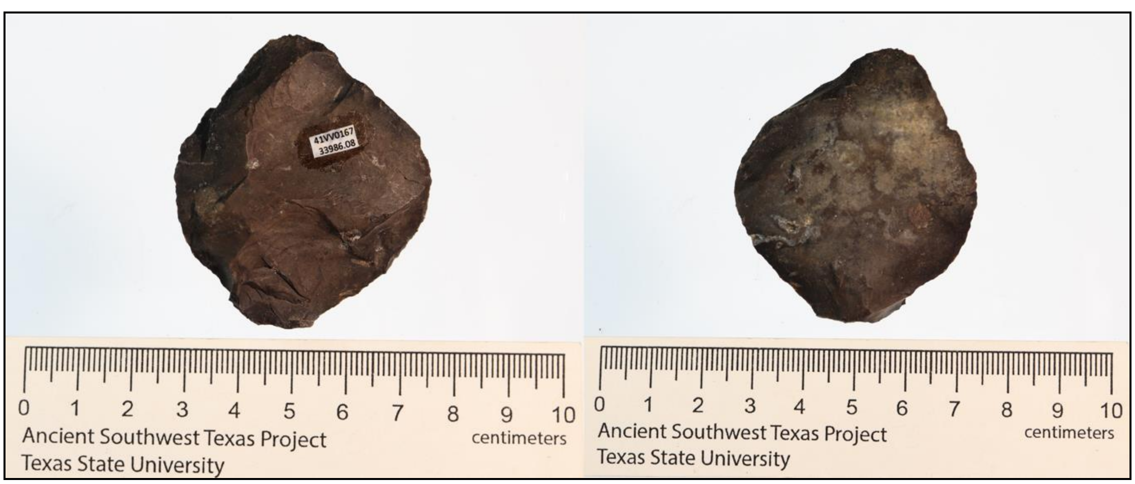

Figure 6.34. Eagle Cave Specimen 33986.08 artifact photo.

35761.3

Eagle Cave specimen 35761.3 is a very thin and small flake tool made from a golden-brown chert. Not much use wear observed, but one photomicrograph was taken showing polish on one area of the right ventral lateral edge (Figure 6.35). Due to the small portion of polish in only one area, the contact material could not be determined. This tool may have been used for plant-processing, but the lack of well-developed polish makes this difficult to confirm.

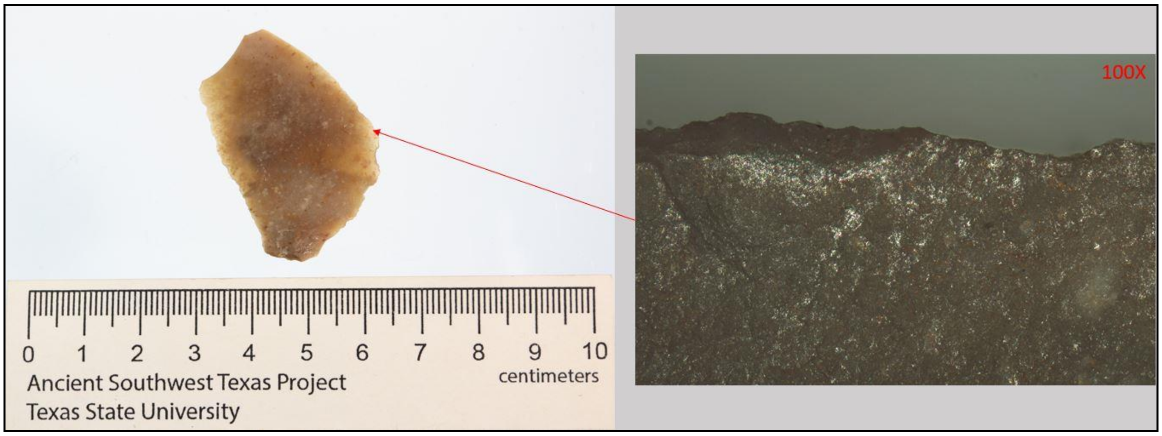

Figure 6.35. Eagle Cave Specimen 35761.3 artifact photo and photomicrographs.

32054.6

Eagle Cave specimen 32054.6 is a modified flake tool made from a white and pink chert Figure (6.36). As discussed in Chapter 4, during initial analysis of the site “polish/sheen” was noted in the specimen inventory of the tool. Microscopic analysis showed no traces of use wear and therefore no photomicrographs were taken of this tool. This tool could have visible polish due to PDSM instead of evidence of use-wear.

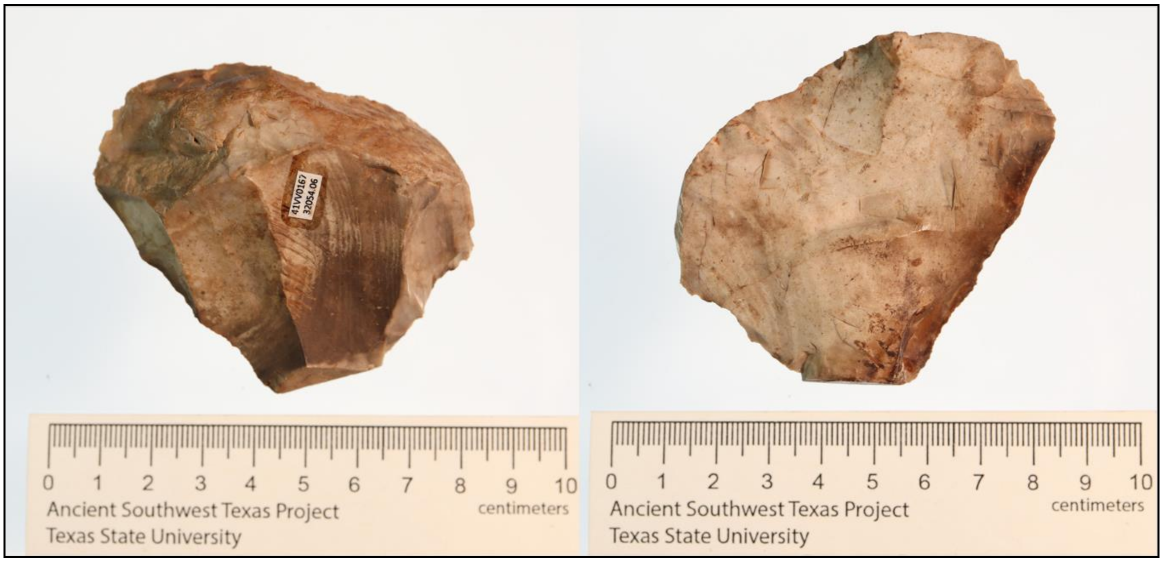

Figure 6.36. Eagle Cave Specimen 32054.6 artifact photo.

33263.13

Eagle Cave specimen 33263.13 is a tertiary flake tool made from a high-quality tan colored chert with the distal tip broken in a snap fracture (Figure 6.37). No use wear evidence was observed during microscopic analysis; therefore, no photomicrographs were taken. This tool may have been a drill/perforator that was broken at the distal edge, which is why no use-wear was observed from this fragment.

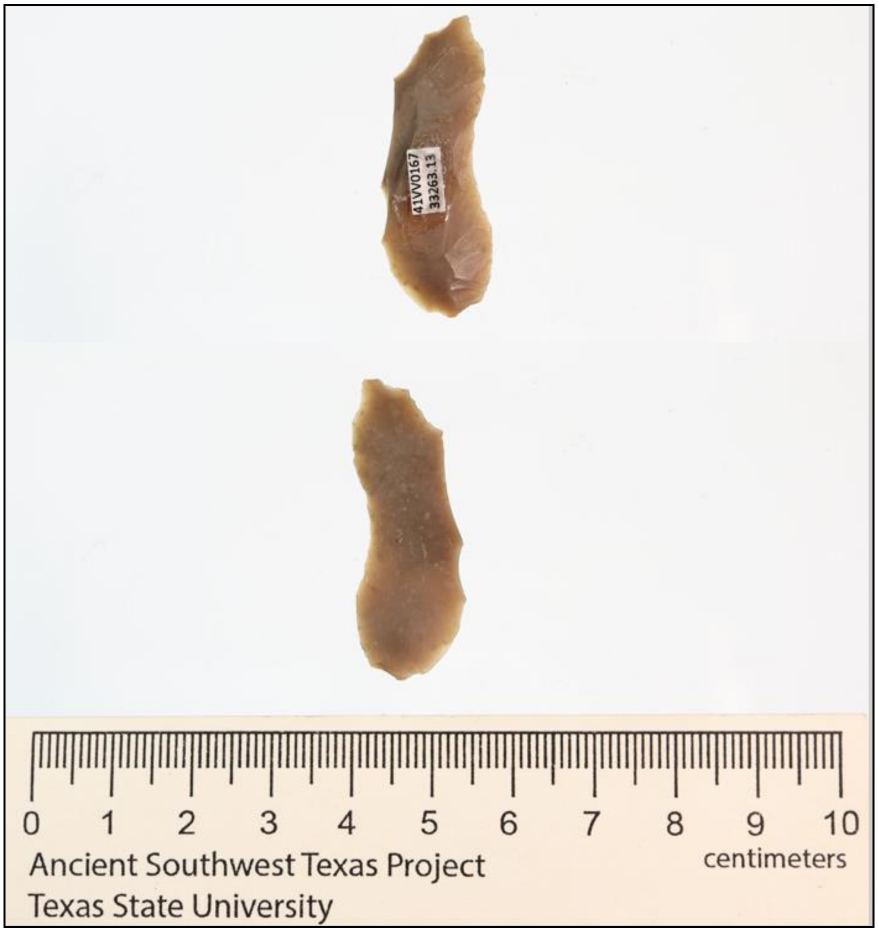

Figure 6.37. Eagle Cave Specimen 33263.13 artifact photo.

33770.2

Eagle Cave specimen 33770.2 is a large primary flake tool made from a brownish orange-colored chert (Figure 6.38). During initial analysis of the site, polish was noted in the specimen inventory. However, no use wear evidence was observed during microscopic analysis; therefore, no photomicrographs were taken.

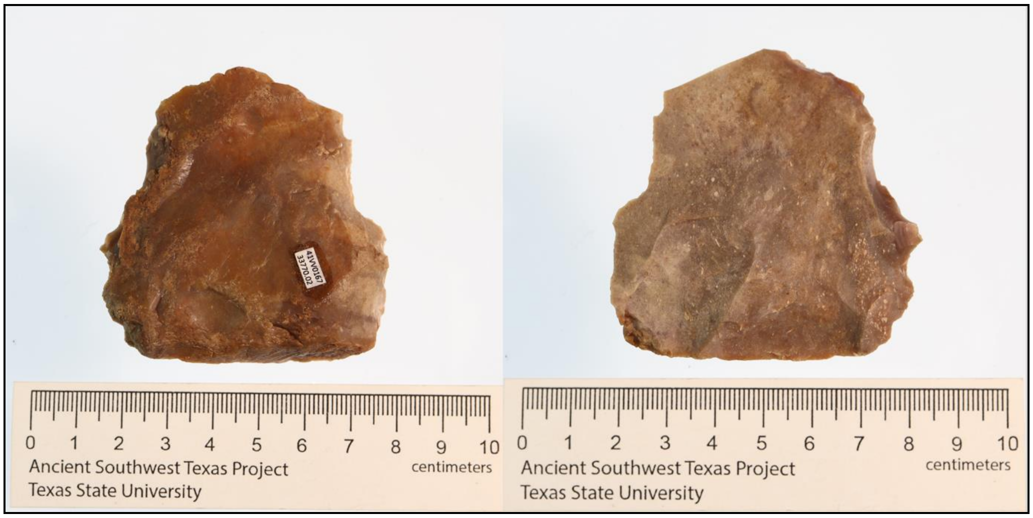

Figure 6.38. Eagle Cave Specimen 33770.2 artifact photo.

31224.9

Eagle Cave specimen 31224.9 is a modified flake made from a brown colored-chert. Macroscopically, edge damage is visible on the distal edge of this tool in addition to a slight sheen. Microscopic analysis under low-power magnification shows slight polish along the distal edge (Figure 6.39A-C). This discontinuous polish could indicate processing wood as the contact material.

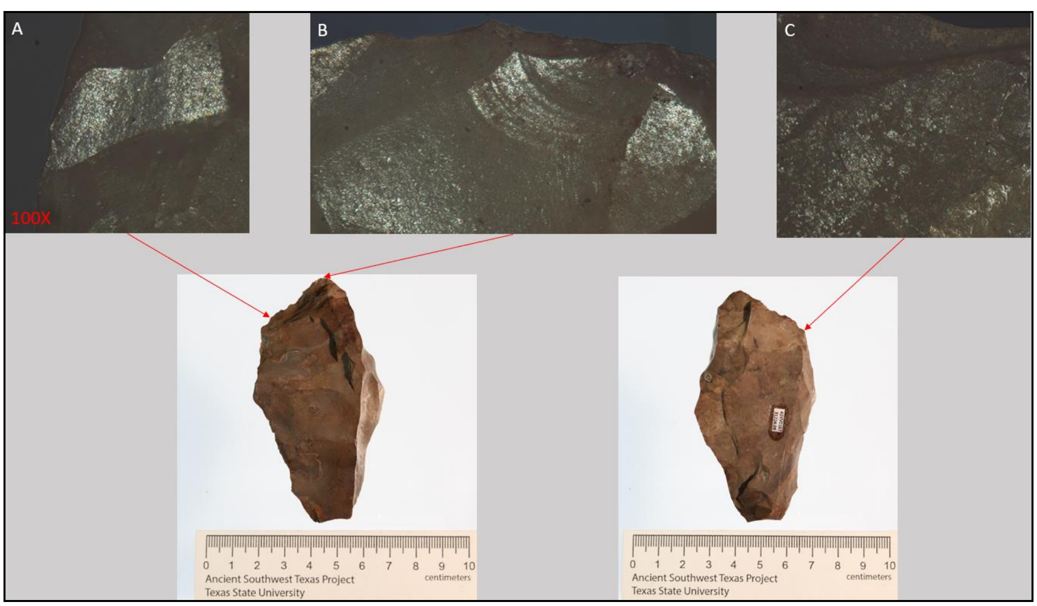

Figure 6.39. Eagle Cave Specimen 31224.9 artifact photo and photomicrographs.

32088.16

Eagle Cave specimen 32088.16 is a modified flake made from a brown colored-chert. Macroscopically, polish is visible on the dorsal side of the tool. When analyzed microscopically under low- and high-power magnification, moderate polish is visible that is mostly linked together in a patchy pattern (Figure 6.40A-C). These wear characteristics could indicate that the contact material was hide or animal flesh, but not plants.

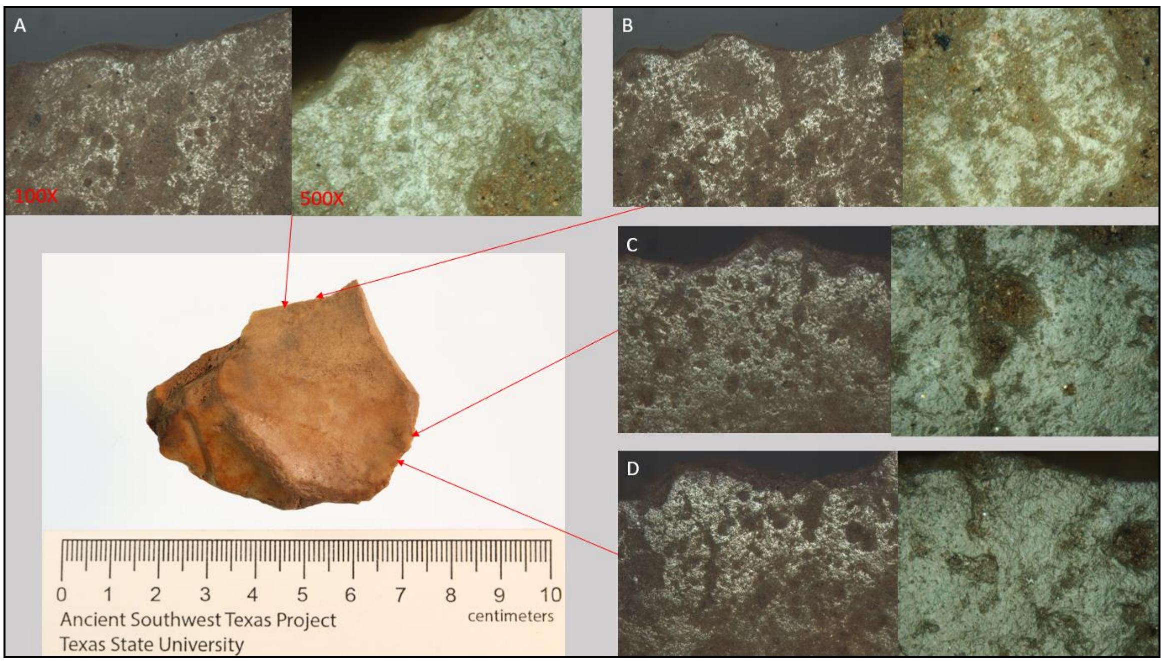

Figure 6.40. Eagle Cave Specimen 32088.16 artifact photo and photomicrographs.

32398.11

Eagle Cave specimen 32398.11 is a modified flake made from a dark brown colored-chert. This tool was analyzed microscopically under low-power magnification. The ventral left lateral and distal edges show a small portion of intermittent, abrasive polish (Figure 6.41A-B). No other areas of polish were observed. Though not well-developed, the wear characteristics show evidence that this tool could have been used on plant material.

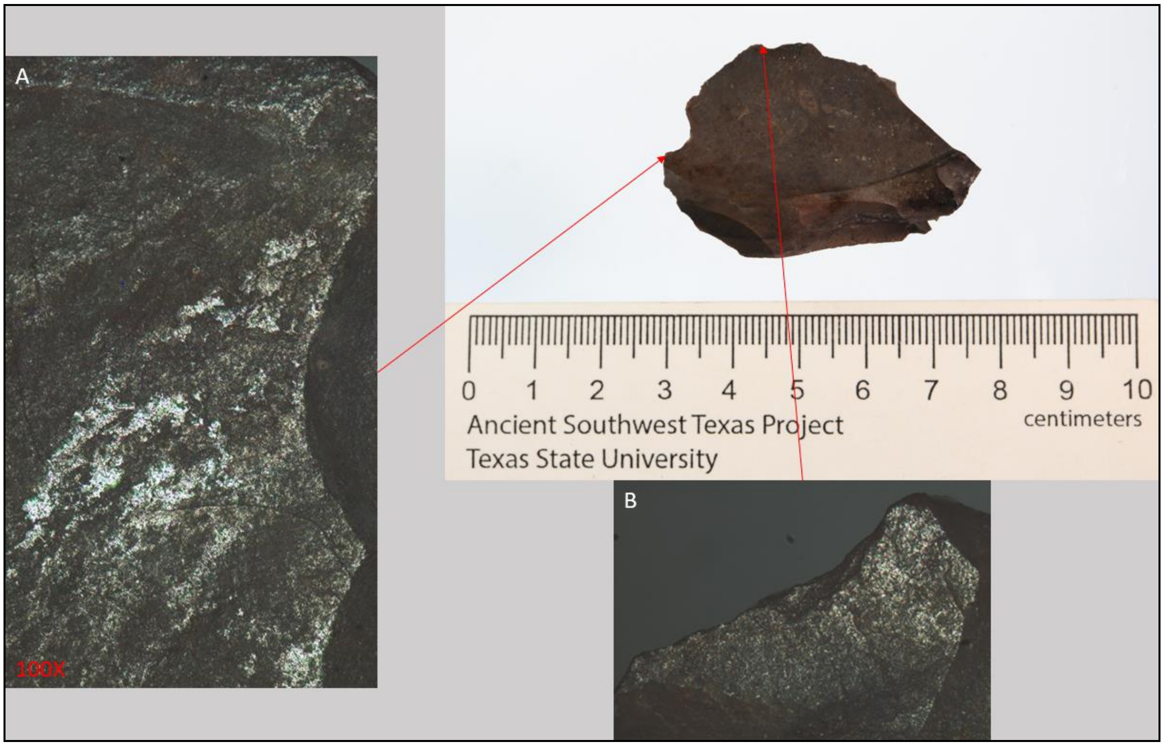

Figure 6.41. Eagle Cave Specimen 32398.11 artifact photo and photomicrographs.

34092.4

Eagle Cave specimen 34092.4 is a modified flake made from a brownish orange colored-chert. Reddish residue is encrusted all over tool's surface observed macroscopically and microscopically during analysis, even after washing thoroughly as detailed in Chapter 5. This residue could be ochre but further testing is required to confirm this. Figure 6.42A-B shows this residue on the left lateral edge under low-power magnification when analyzed microscopically. Figure 6.42C shows very slight, intermittent polish on the right lateral edge. No other areas of use-wear were observed on this tool. This may be a result of PDSM as opposed to use-wear. However, it is clear that this tool was not used to process plants.

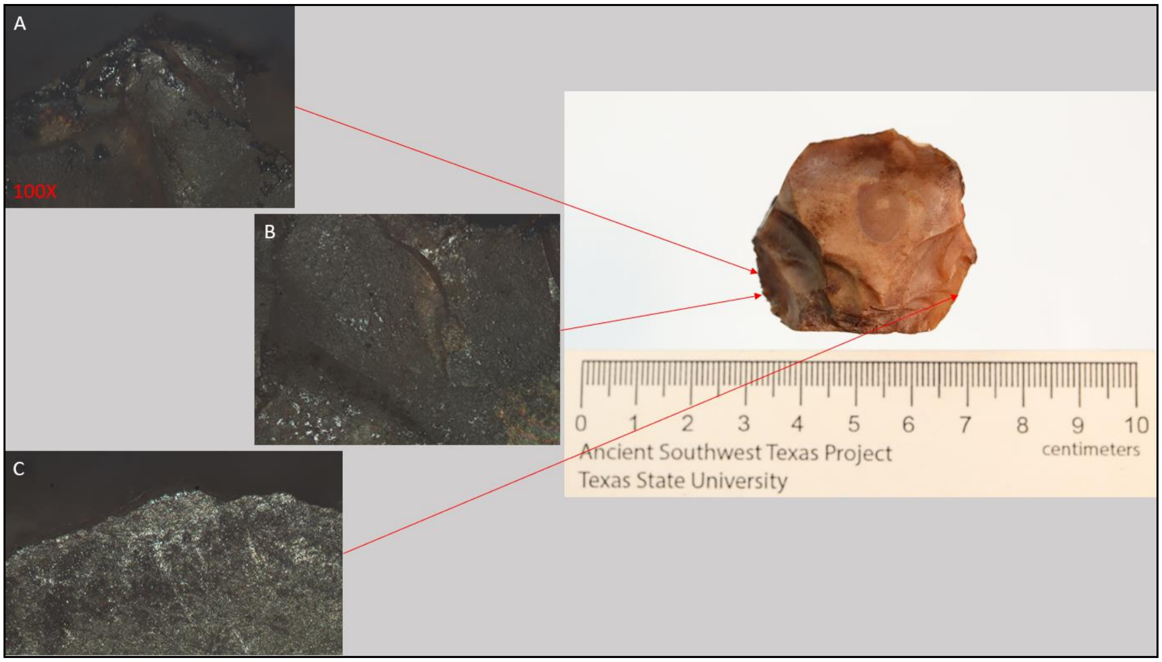

Figure 6.42. Eagle Cave Specimen 34092.4 artifact photo and photomicrographs.

Skiles Shelter

The descriptive statistics of the Skiles Shelter tools analyzed for this thesis are detailed in Table 4.3. The Skiles Shelter archaeological sample included in this study is comprised of edge-modified flakes, unifaces, sequent flake tools, and bifaces. There are a total of twenty tools from this site that were analyzed site from collections excavated by the ASWT Project.

20107.5

Skiles Shelter specimen 20107.5 is a small edge-modified flake tool made from a light-gray colored chert with cortex on the dorsal face; the dorsal side of the flake has multiple flake scars. As described in Chapter 4, plant epidermis and fiber were noted on the tools edge during initial analysis of the site. This tool was analyzed microscopically under low-power magnification. The dorsal lateral edges (Figure 6.43A-D) and ventral lateral edges (Figure 6.44E-H) have patchy, discontinuous polish along the entirety of the working edge. Though plant fibers were noted adhering to the tools edge, the use-wear evidence suggests this tool was used to process hide.

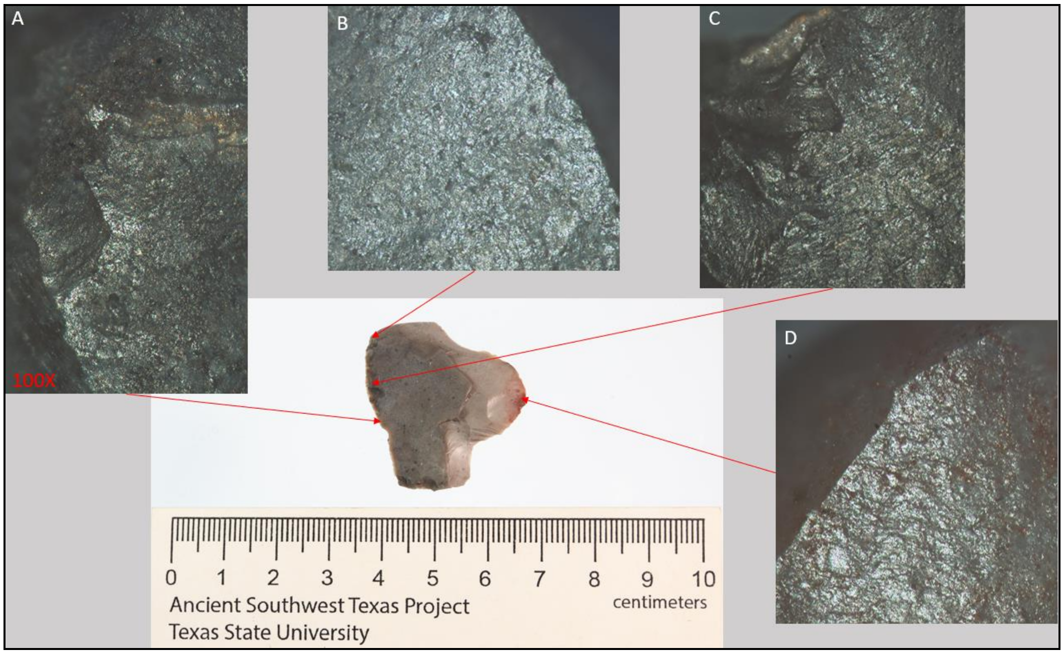

Figure 6.43. Skiles Shelter Specimen 20107.5 dorsal artifact photo and photomicrographs.

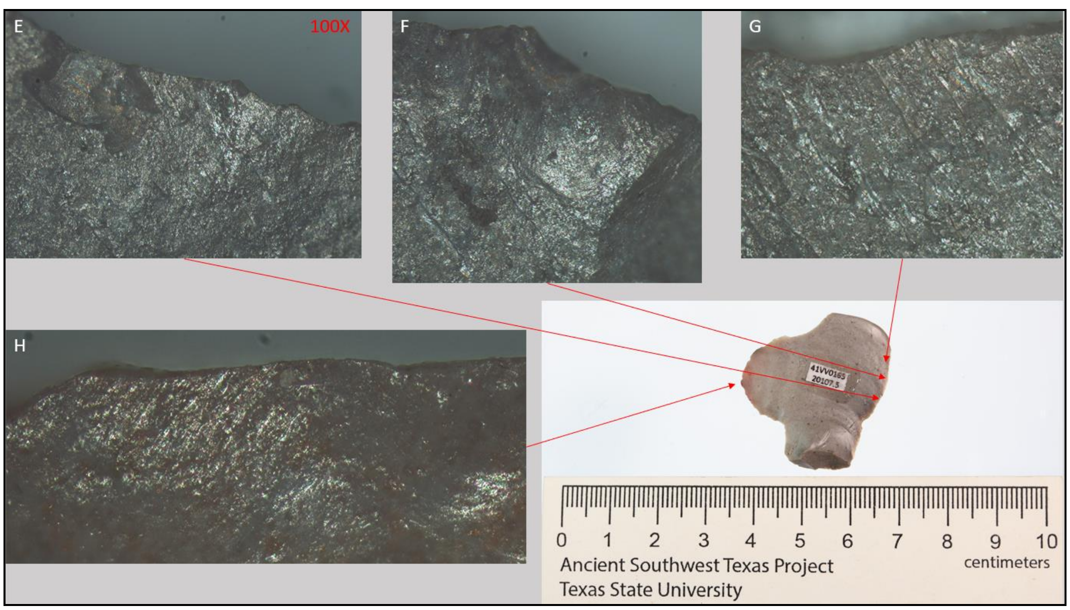

Figure 6.44. Skiles Shelter Specimen 20107.5 ventral artifact photo and photomicrographs.

20121.4

Skiles Shelter specimen 20121.4 is an edge-modified flake made from a light brown chert, unifacially worked on the dorsal side, with cortex on the proximal edge (Figure 6.45). It appears to be snapped in half along the mid-section. No evidence of use-wear was observed; therefore, no photomicrographs were taken. Described in Chapter 4, "animal product or plant residue" was observed on the platform during initial analysis of the site; though after washing in the ultrasonic cleaner, this was not observed macroscopically or microscopically during my analysis.

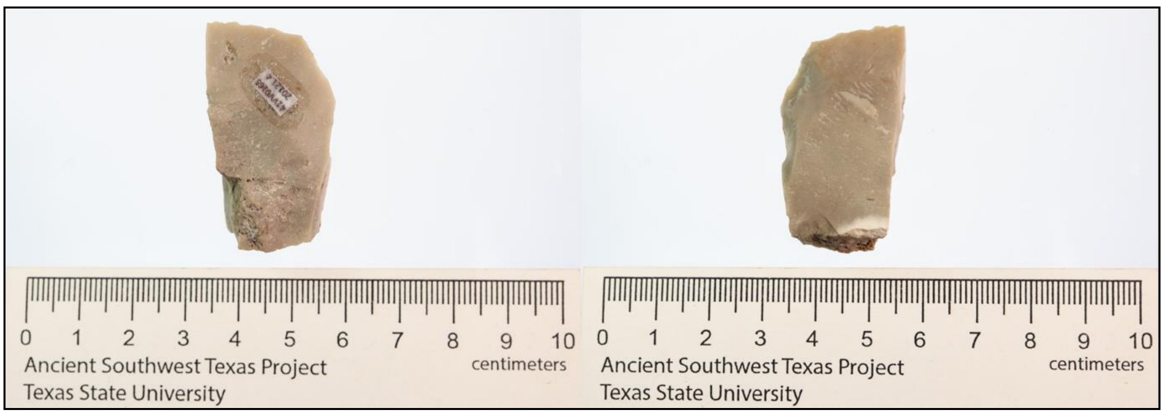

Figure 6.45. Skiles Shelter Specimen 20121.4 artifact photo.

20018.15

Skiles Shelter specimen 20018.15 is a uniface made from a light brown chert, unifacially worked on the dorsal side lateral edges. As described in Chapter 4, polish was noted during initial macroscopic analysis. This tool was analyzed microscopically under low- and high-power magnification. The left dorsal lateral edge shows polish on the arrises but not within the flake scars, suggesting multiple uses (Figure 6.46). The entirety of the right ventral lateral edge has polish and striations (at an oblique angle to the edge) indicative of plant-processing (Figure 6.47A-C). This tool was used to process plant materials, and furthermore, the use-wear evidence is comparable to experimental tools used to process lechuguilla.

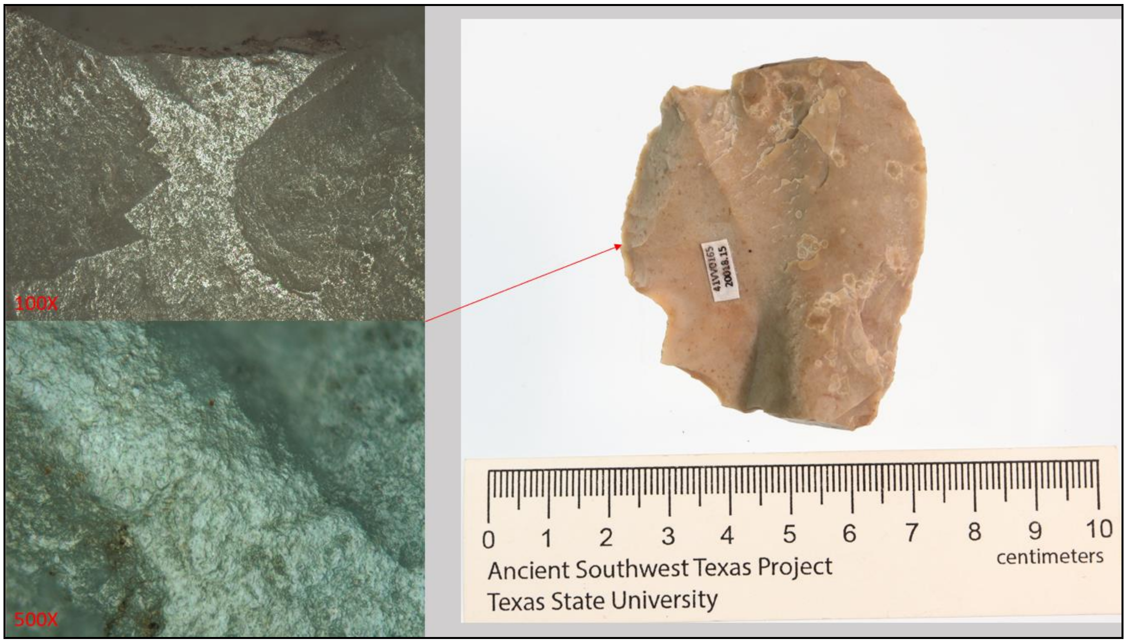

Figure 6.46. Skiles Shelter Specimen 20018.15 dorsal artifact photo and photomicrographs.

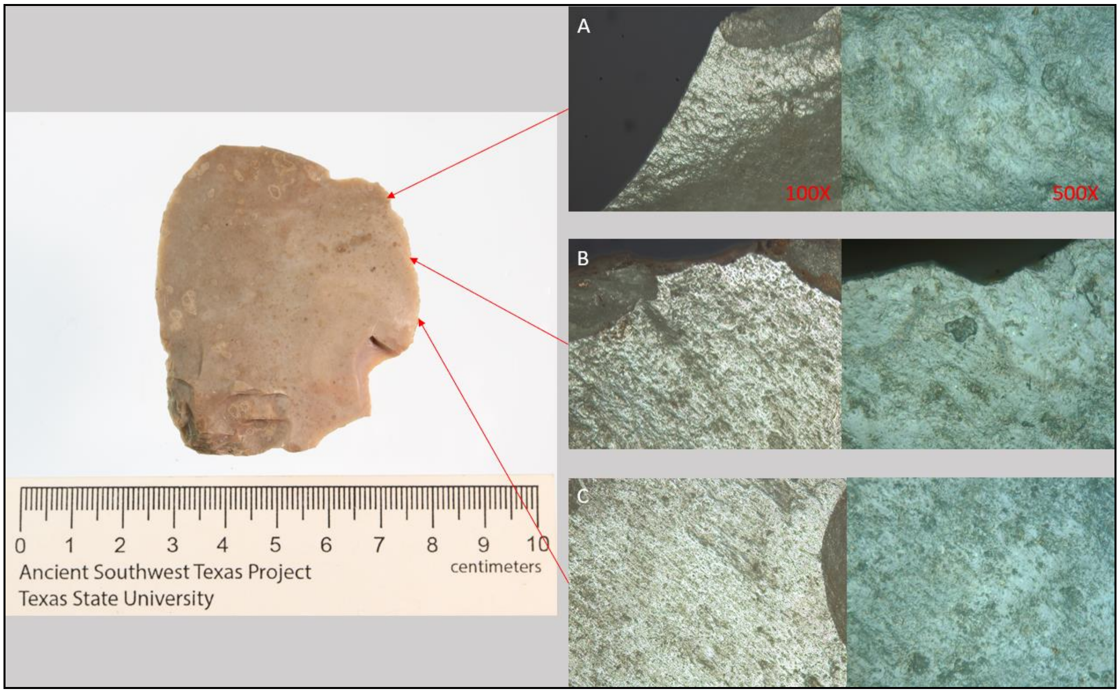

Figure 6.47. Skiles Shelter Specimen 20018.15 ventral artifact photo and photomicrographs.

20018.7

Skiles Shelter specimen 20018.7 is a sequent flake tool made from a brown chert, unifacially worked on the dorsal side. Cortex is present along the distal edge of the tool. As described in Chapter 4, polish was noted during initial macroscopic analysis. This tool was analyzed microscopically under low-power magnification and a moderate amount of polish was observed. Discontinuous polish was observed all along the ventral lateral edges (Figure 6.48A-C) and dorsal lateral edges (Figure 6.49D-F). The wear evidence is characteristic of this tool being used to process wood.

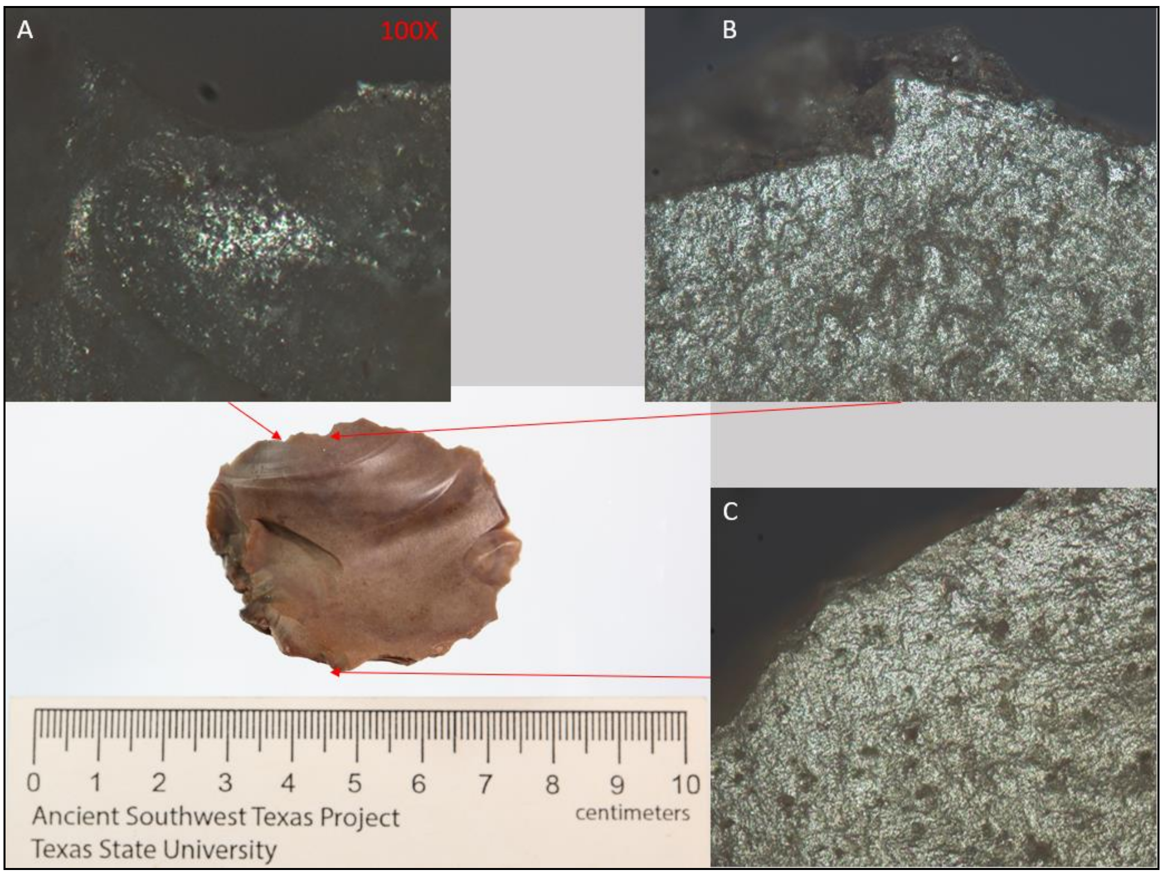

Figure 6.48. Skiles Shelter Specimen 20018.7 ventral artifact photo and photomicrographs.

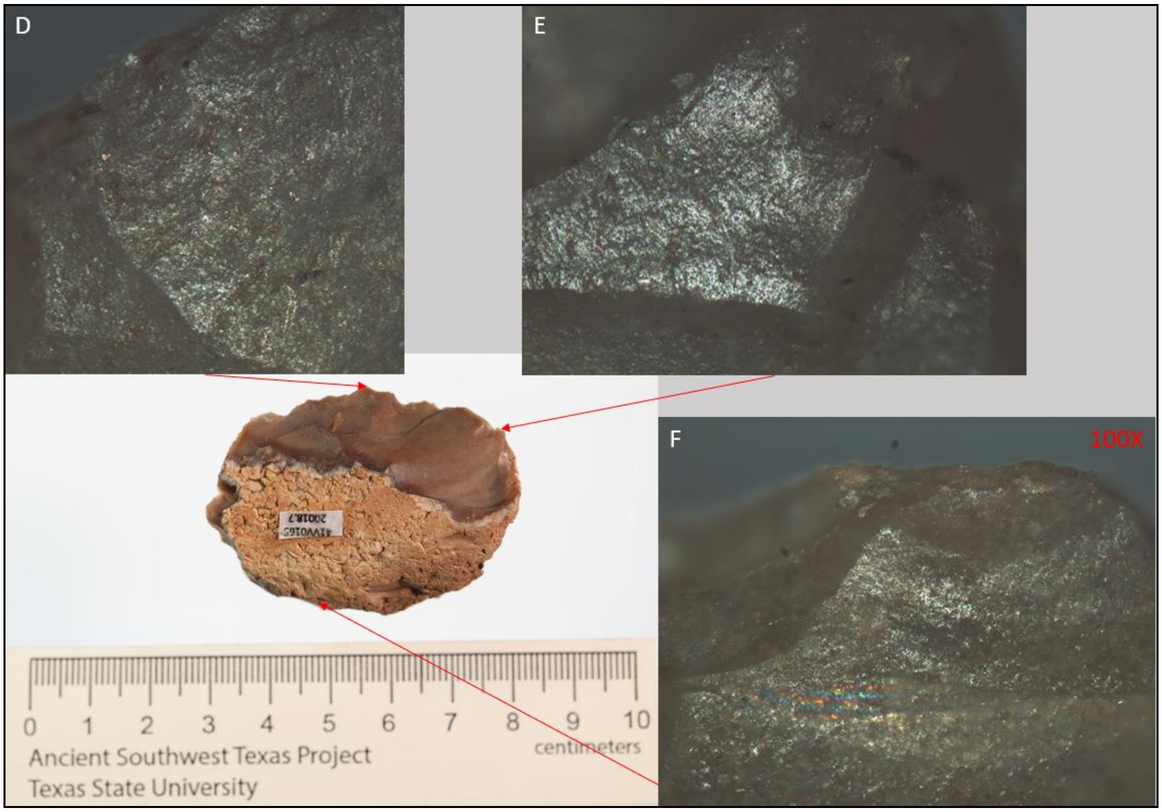

Figure 6.49. Skiles Shelter Specimen 20018.7 dorsal artifact photo and photomicrographs.

20018.17

Skiles Shelter specimen 20018.17 is a sequent flake tool made from a light brown chert, unifacially worked on the ventral side with right lateral and distal edges broken off as snap fractures. Cortex is present along the proximal edge of the tool by the platform and bulb. As described in Chapter 4, polish was noted during initial macroscopic analysis. This tool was analyzed microscopically under low-power magnification. Though very little polish present (Figure 6.50A-C), this use-wear could be indicative of processing hide. This tool was likely not used to process plants.

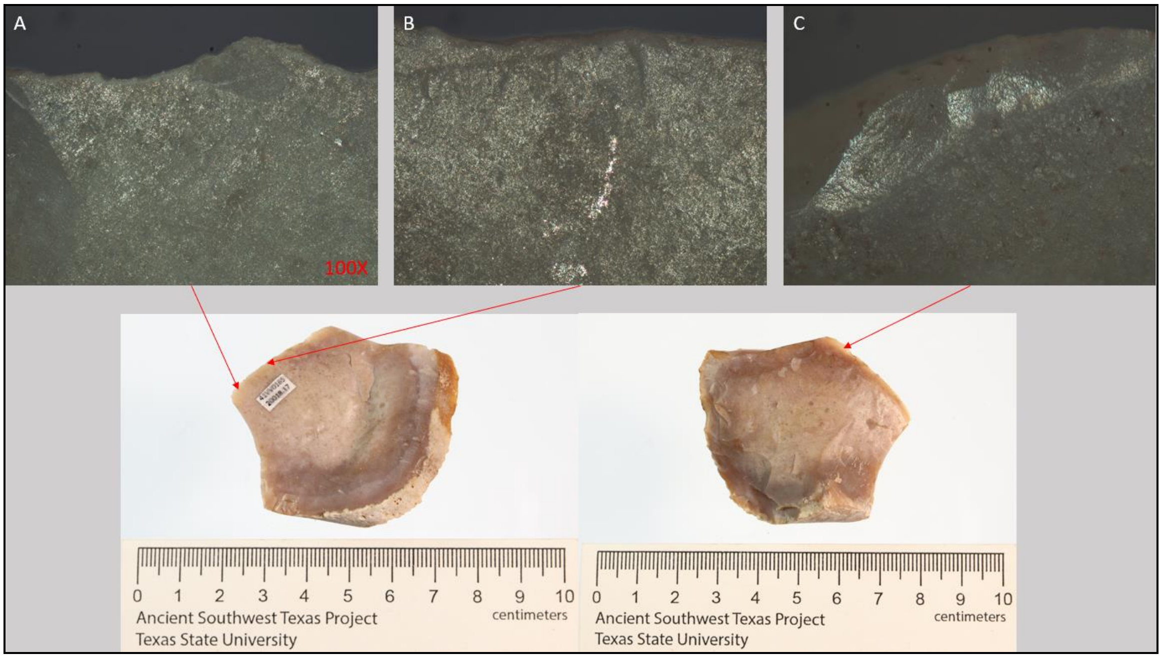

Figure 6.50. Skiles Shelter Specimen 20018.17 artifact photo and photomicrographs.

20073.4

Skiles Shelter specimen 20073.4 is a sequent flake tool made from a light tan colored chert with cortex framing the bulb fracture; it is worked on both ventral and dorsal sides. No evidence of hafting was observed, however, there may be evidence of burning from the discoloration of the surface. This tool was analyzed microscopically under low-power magnification and one area of polish was shown in the same location on both the ventral and dorsal side of the tool (Figure 6.51A-B). Though little polish is visible microscopically, this tool could have been used on plant materials.

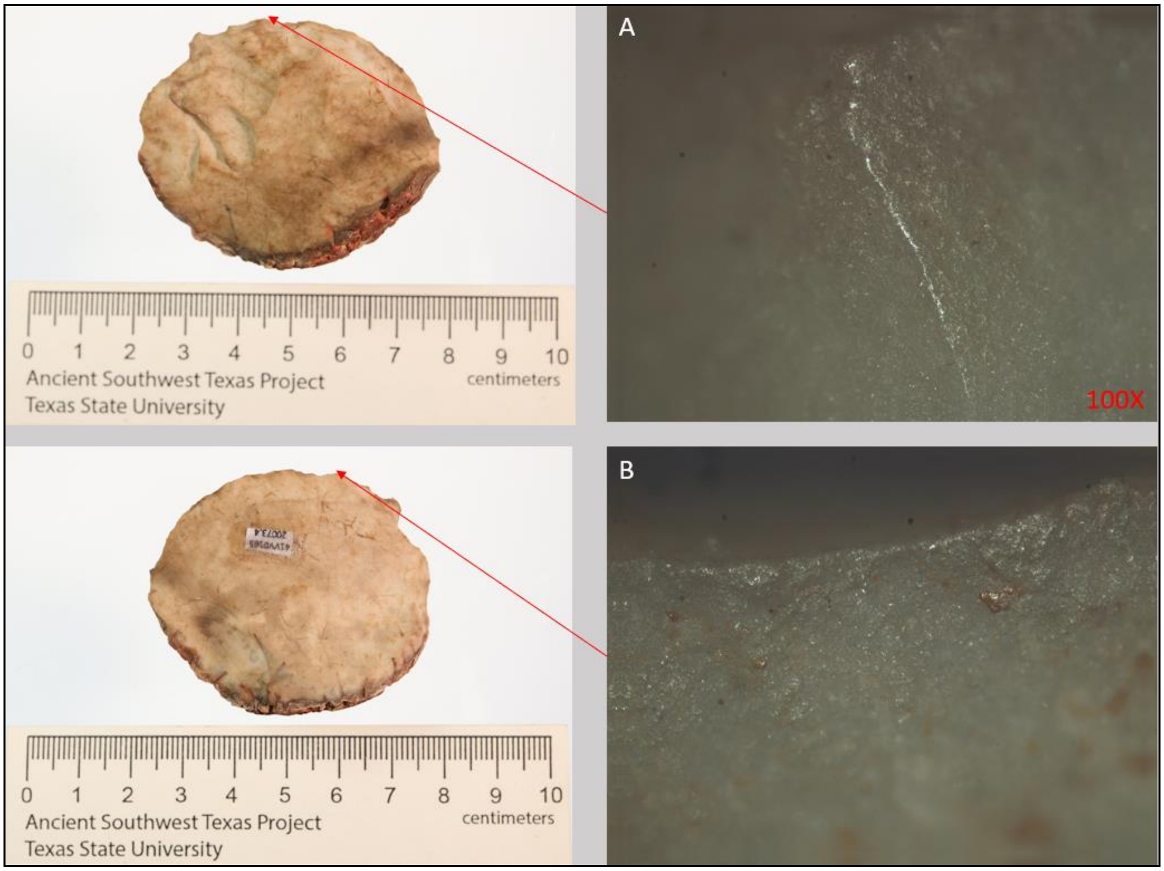

Figure 6.51. Skiles Shelter Specimen 20073.4 artifact photo and photomicrographs.

20029.9

Skiles Shelter specimen 20029.9 is a sequent flake tool made from a gray-colored chert with cortex framing the bulb fracture and is worked on the dorsal distal edge at a steep angle (Figure 6.52). During initial analysis, as detailed in Chapter 4, epidermis/fiber fragments were observed adhering to the edges. No evidence of use-wear was observed; therefore, no photomicrographs were taken.

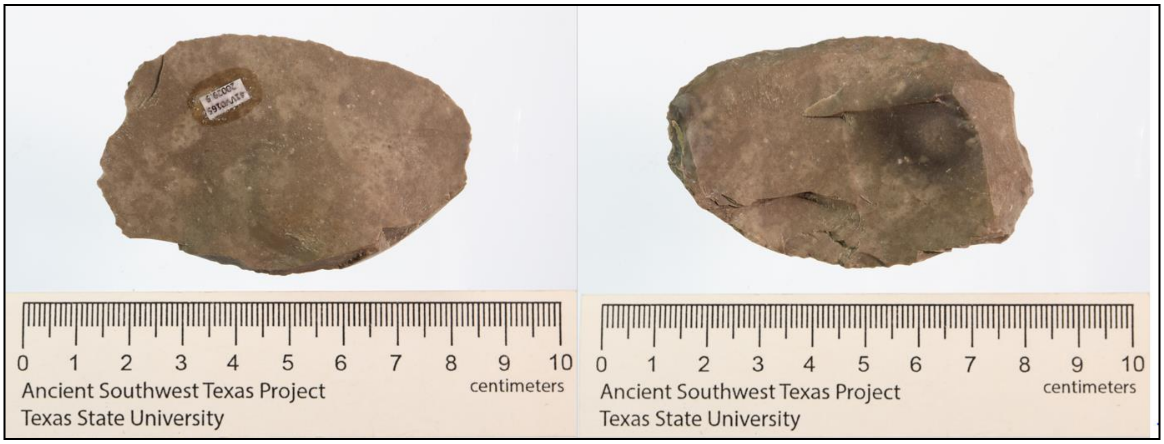

Figure 6.52. Skiles Shelter Specimen 20029.9 artifact photo.

20082.7

Skiles Shelter specimen 20082.7 is an edge-modified flake tool made from a dark brown chert, unifacially worked on the dorsal side lateral edges with cortex in the center. During initial analysis, as detailed in Chapter 4, unburned epidermis and white reside (potential fat) were observed on the dorsal distal edge of the tool. This tool was analyzed microscopically under low-power magnification. Hardly any polish except a small portion of the right dorsal lateral edge was observed (Figure 6.53). This use-wear evidence is characteristic of wood being the contact material.

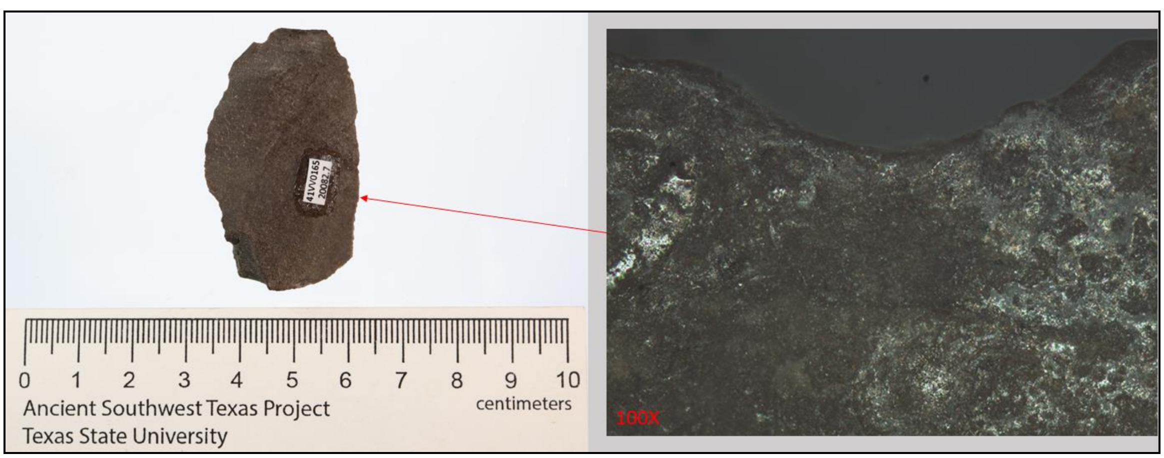

Figure 6.53. Skiles Shelter Specimen 20082.7 artifact photo and photomicrographs.

20063.15

Skiles Shelter specimen 20063.15 is an early-stage biface made from a light gray/brown chert, bifacially worked but with more investment to flaking on the dorsal surface. Polish was noted during initial analysis, as described in Chapter 4. This tool was analyzed microscopically under low-power magnification. The right ventral lateral and distal edge shows patchy, partially linked polish (Figure 6.54A-B). A very slight amount of polish was noted in one small area on the left dorsal lateral edge (Figure 6.55). This use-wear evidence is characteristic of processing hide, and not plant materials.

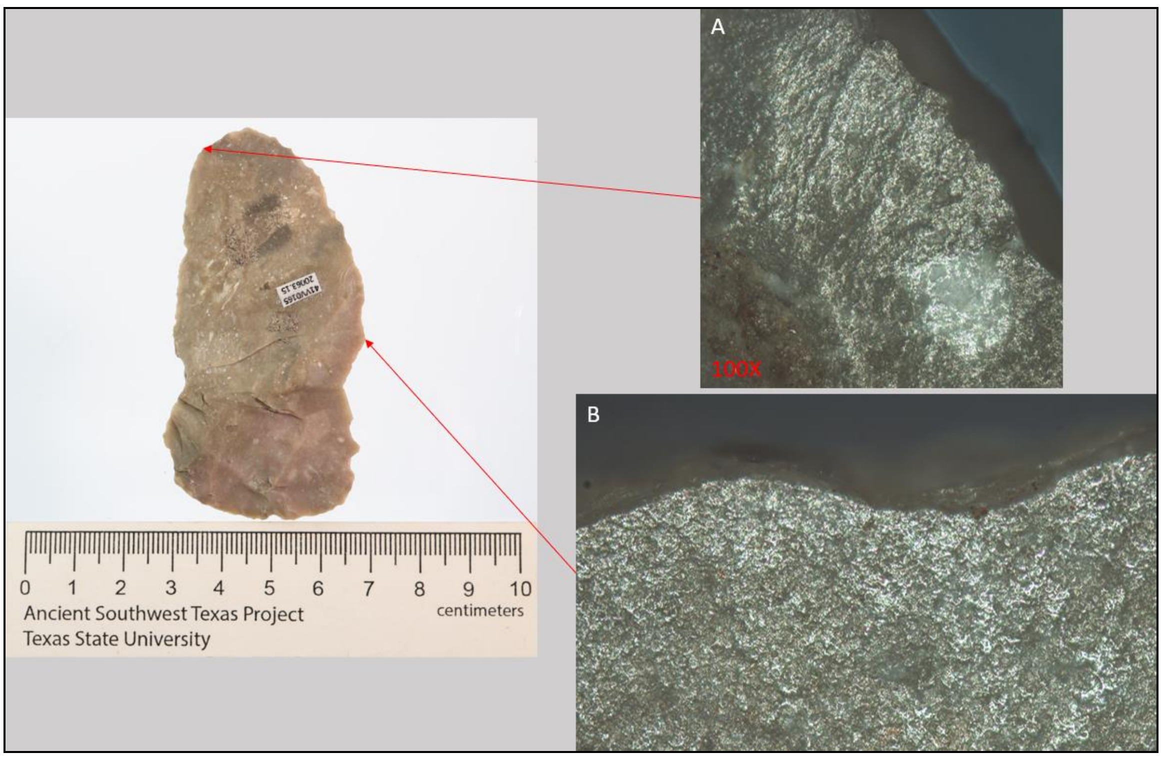

Figure 6.54. Skiles Shelter Specimen 20063.15 ventral artifact photo and photomicrographs.

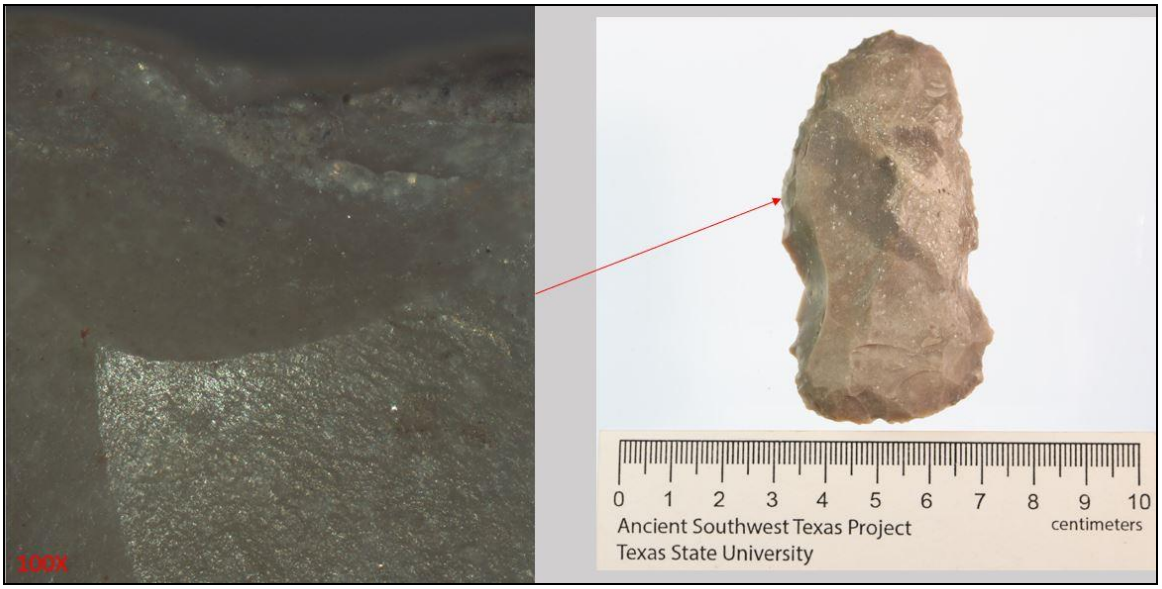

Figure 6.55. Skiles Shelter Specimen 20063.15 dorsal artifact photo and photomicrographs.

20063.9

Skiles Shelter specimen 20063.9 is triangular-shaped, early-stage biface made from a light brownish orange chert, bifacially worked but with more investment to flaking on the dorsal surface. A small spot of cortex is present on the left dorsal corner of the biface. Polish was noted during initial analysis, as described in Chapter 4. The right dorsal lateral edge has one small area of polish that was observed. The working edge is slightly rounded, with abrasive and discontinuous dull polish (Figure 6.56). These characteristics suggest that the contact material for this tool was wood.

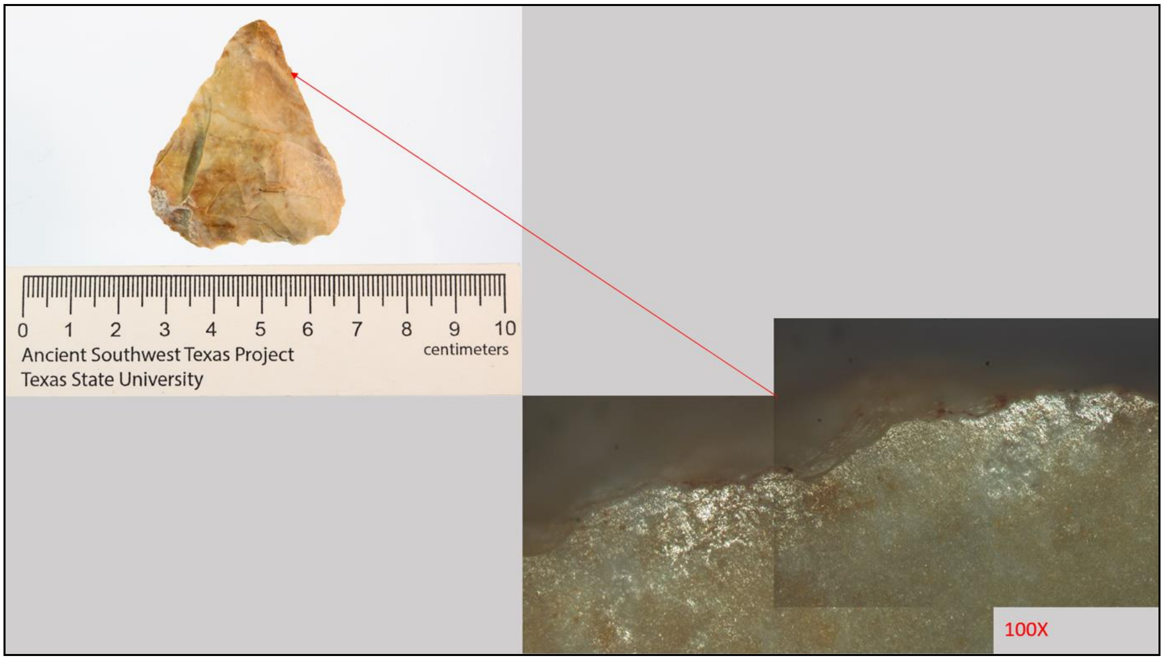

Figure 6.56. Skiles Shelter Specimen 20063.9 artifact photo and photomicrographs.

20054.5

Skiles Shelter specimen 20054.5 is a segmented portion of an edge-modified flake tool made from a light tan colored chert; only a partial lateral edge remains, unifacially worked on the dorsal side of the tool, with snap fractures on every other edge. Polish was noted during initial analysis, as described in Chapter 4. This tool was analyzed microscopically under low-power magnification. The left ventral lateral edge had one area with bright, moderately developed polish at the highest point of the microtopography (Figure 6.57) The right dorsal lateral edge has several areas where an unidentified reddish-brown residue was observed which could be ochre (Figure 6.58A-C). Though this tool is quite fragmented, the wear evidence suggests that this tool may have been used to process wood.

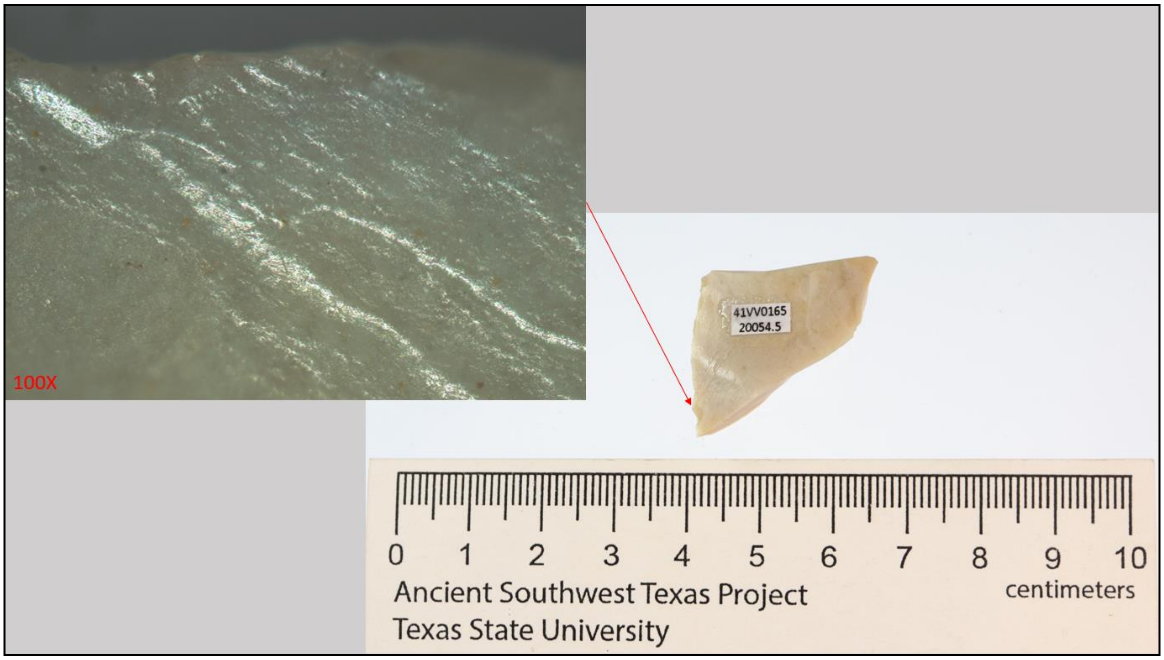

Figure 6.57. Skiles Shelter Specimen 20054.5 ventral artifact photo and photomicrographs.

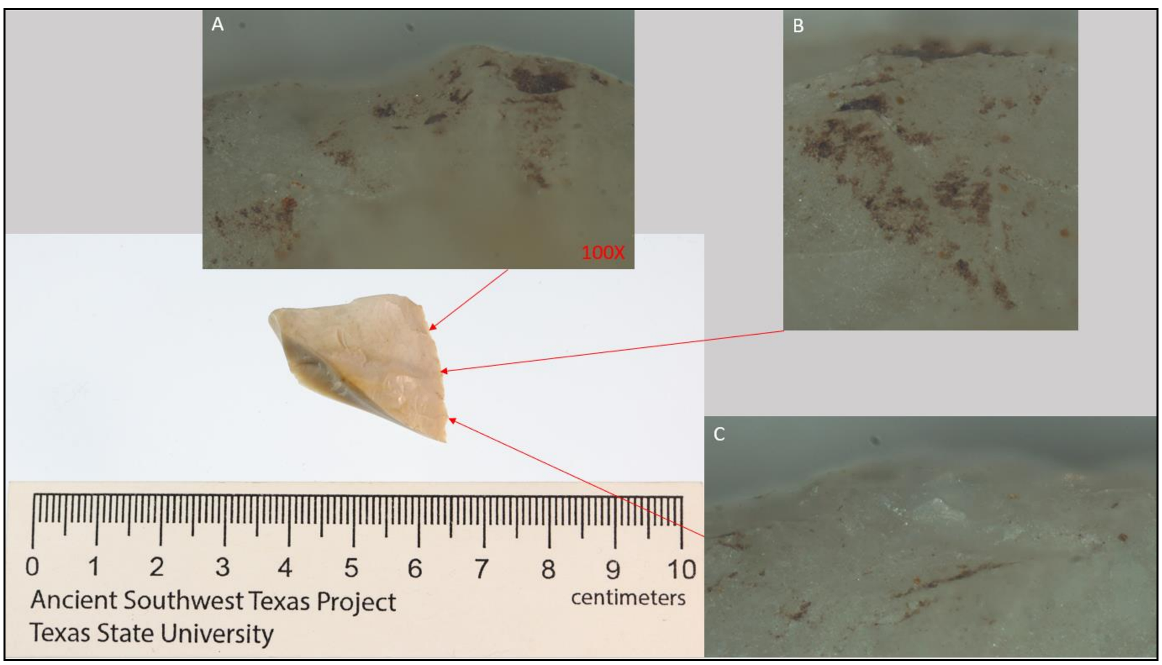

Figure 6.58. Skiles Shelter Specimen 20054.5 dorsal artifact photo and photomicrographs.

20078.3

Skiles Shelter specimen 20078.3 is an edge-modified flake made from a dark brown/black colored chert. The proximal portion of the tool is broken off with a snap fracture, leaving the distal portion showing worked lateral edges on both the dorsal and ventral sides. The center of the tool has a matte finish while the lateral edges are glossy; this may just be the structure of the material, but this could be evidence of hafting. As described in Chapter 4, polish was noted during initial analysis. During low-power magnification microscopic analysis, polish was noted on the arrises but not within the flake scars themselves; this could indicate re-sharpening, which may have resulted in the snap fracture. Both the dorsal (Figure 6.59A-D) and ventral edges of the tool (Figure 6.60E-F) had several areas of patchy, discontinuous polish. These wear traces suggest that this tool was used to process hide.

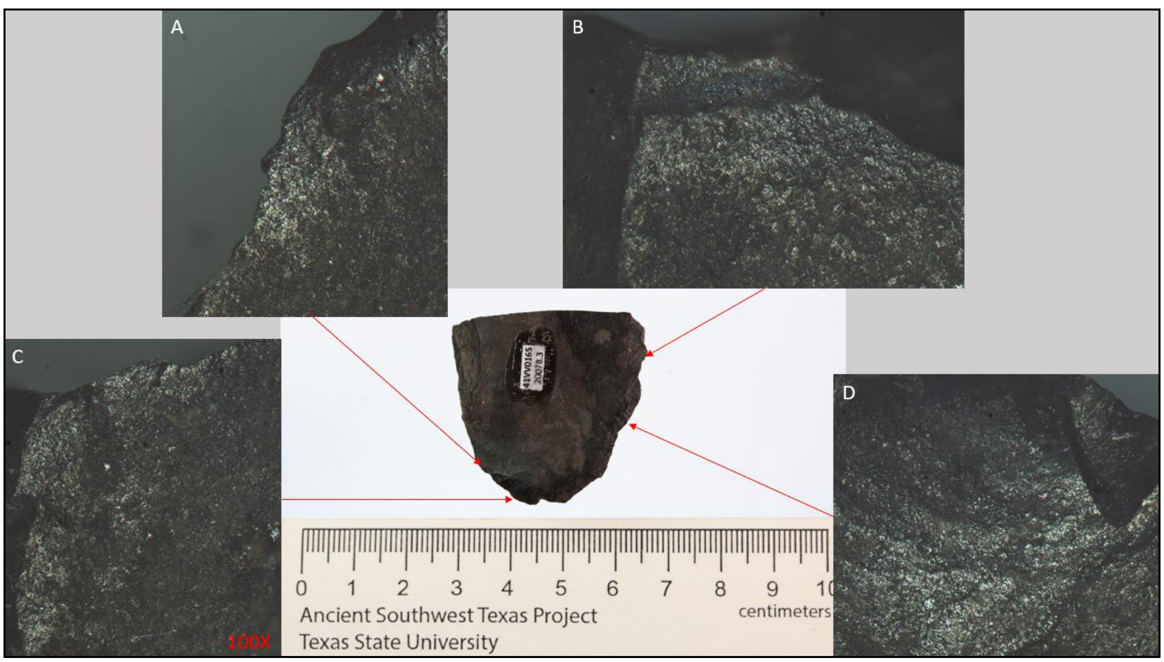

Figure 6.59. Skiles Shelter Specimen 20078.3 dorsal artifact photo and photomicrographs.

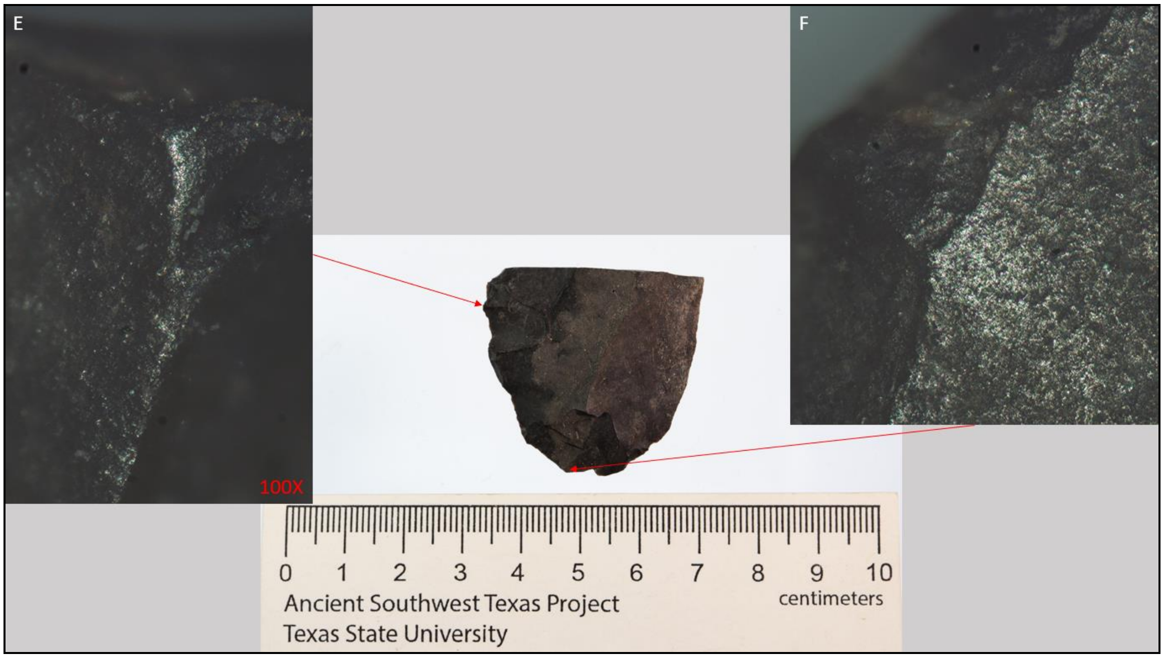

Figure 6.60. Skiles Shelter Specimen 20078.3 ventral artifact photo and photomicrographs.

20003.1

Skiles Shelter specimen 20003.1 is a uniface made from a light tan-colored chert and is a complete flake tool with lateral edges worked on the dorsal side of the tool. During initial analysis, epidermis/fiber fragments were observed adhering to the edge of the tool, as detailed in Chapter 4. Extensive polish along the entirety of the right ventral lateral edge was observed microscopically under low- and high-power magnification. This polish is bright and well developed, and just started to link together (Figure 6.61). This wear is characteristic of using this tool to process hide rather than plants. Perhaps the "fiber fragments" were actually animal instead.

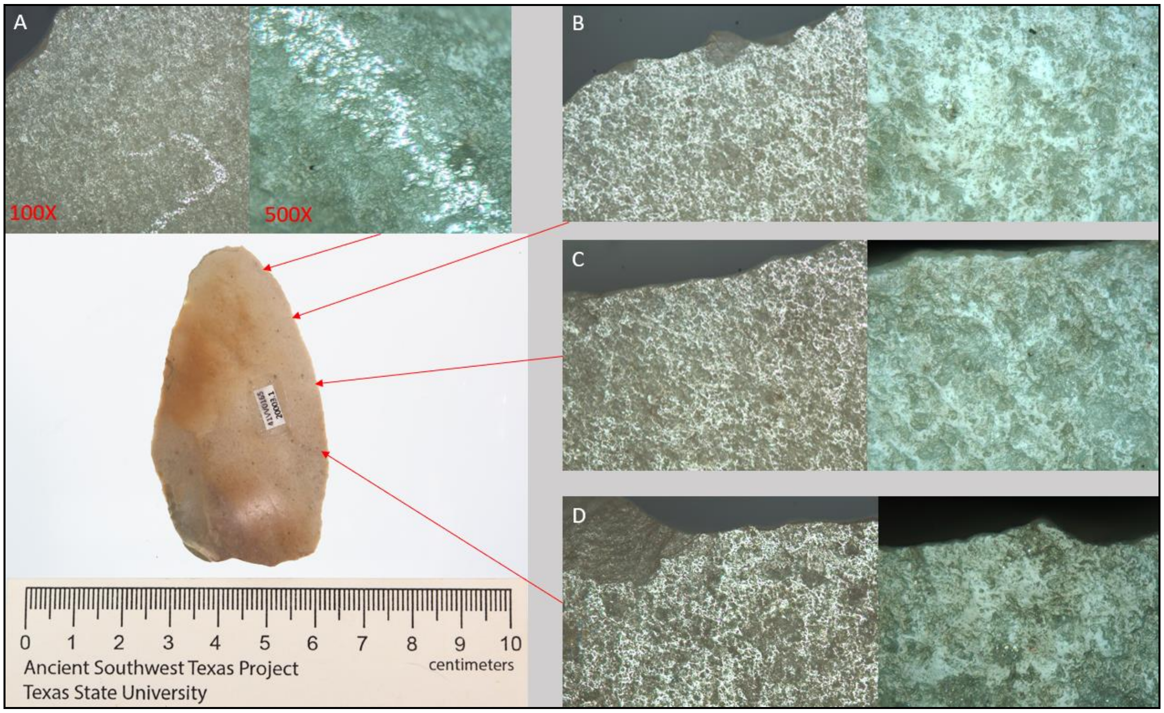

Figure 6.61. Skiles Shelter Specimen 20003.1 artifact photo and photomicrographs.

20040.5

Skiles Shelter specimen 20040.5 is a sequent flake made from a dark grayish brown-colored chert worked on the ventral lateral edges, with one edge broken off as a snap fracture. This tool was analyzed microscopically under low-power magnification. The dorsal (Figure 6.62A-B) and ventral (Figure 6.63C-F) edges of the tool show multiple locations of dull, intermittent polish. These wear traces are characteristic of plant processing, though the lack of well-developed polish suggests it was used for a short amount of time.

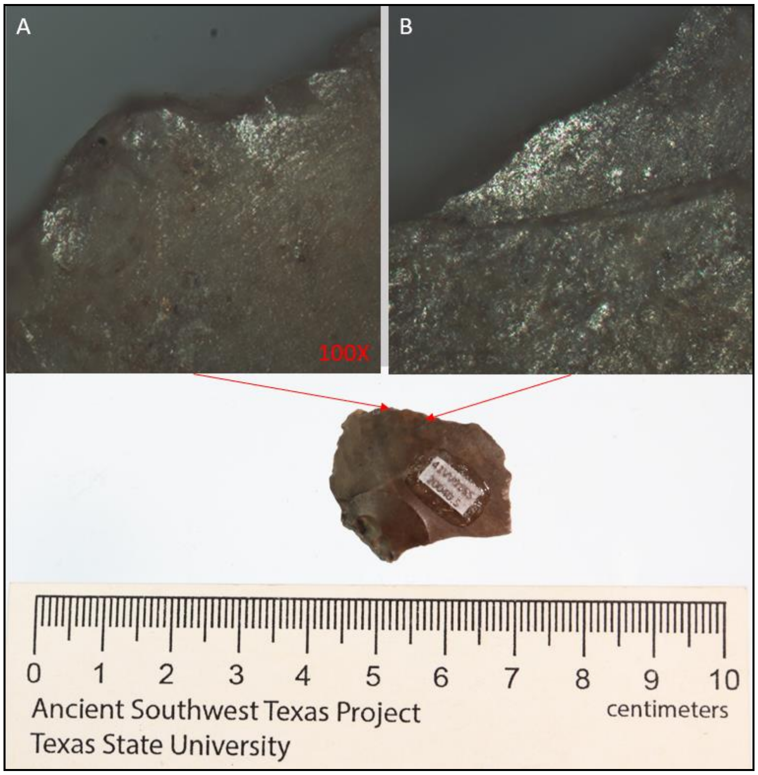

Figure 6.62. Skiles Shelter Specimen 20040.5 dorsal artifact photo and photomicrographs.

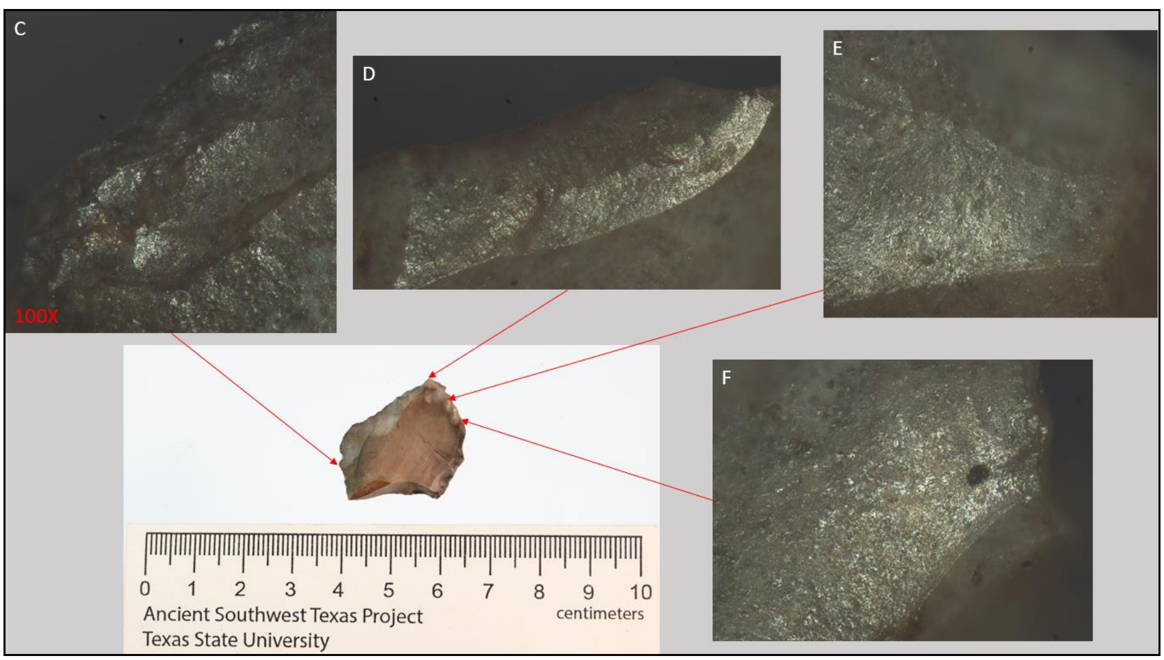

Figure 6.63. Skiles Shelter Specimen 20040.5 ventral artifact photo and photomicrographs.

20073.1

Skiles Shelter specimen 20073.1 is a uniface made from a light brown colored chert with light gray spherules and is a mostly complete, aside from the dorsal right lateral edge broken off as a snap fracture. As described in Chapter 4, unburned epidermis was observed on the dorsal right modified edge during initial analysis. This tool was analyzed microscopically under low- and high-power magnification. The lateral edges show evidence of extensive polish that wrap from the ventral around onto the dorsal edges; this polish is visible macroscopically and microscopically. The entirety of the ventral lateral edges shows well-developed, linked polish, with striations at differing angles to the edge (Figure 6.64A-D); this suggests multiple uses and angles of processing. The left dorsal edge also shows well-developed polish (Figure 6.65E-F). These wear characteristics suggest this tool was used to process plant material.

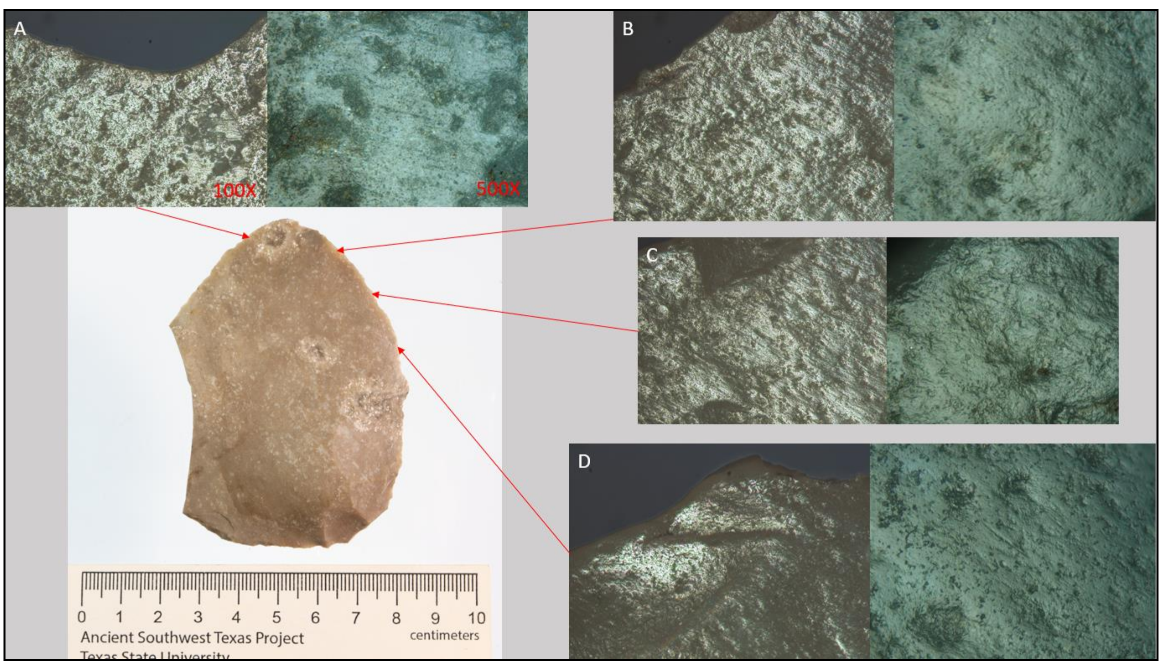

Figure 6.64. Skiles Shelter Specimen 20073.1 ventral artifact photo and photomicrographs.

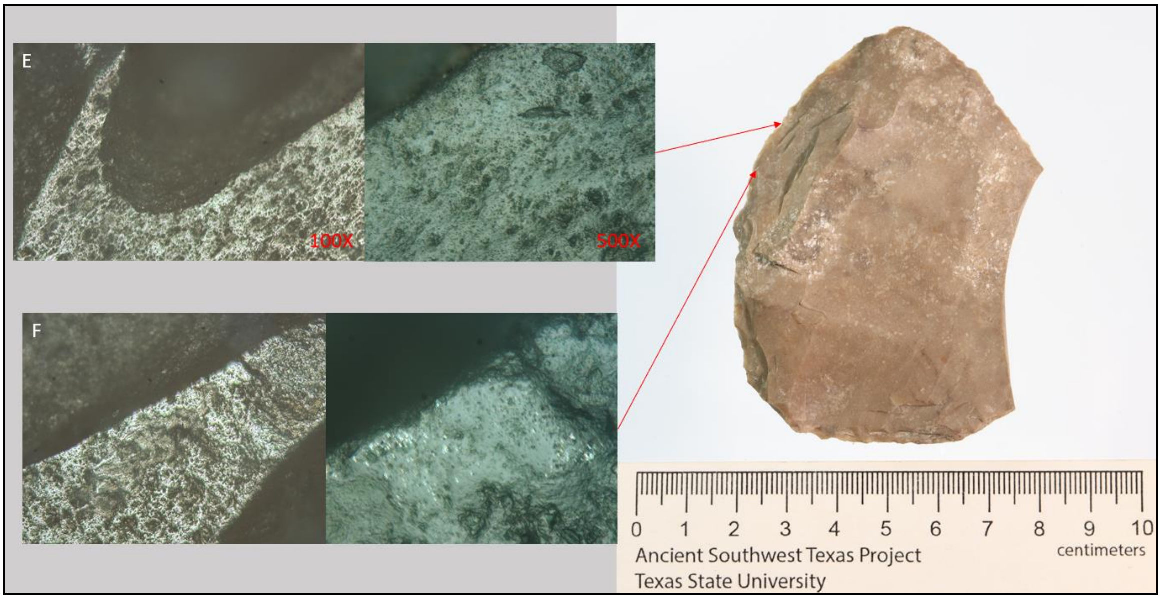

Figure 6.65. Skiles Shelter Specimen 20073.1 dorsal artifact photo and photomicrographs.

20020.2

Skiles Shelter specimen 20020.2 is an edge-modified flake made from a light tan and pinkish colored chert and is a complete flake tool with lateral edges worked on the ventral lateral edges of the tool. During initial analysis, epidermis/fiber fragments were observed adhering to the edge of the tool, as detailed in Chapter 4. This tool was analyzed microscopically under low- and high-power magnification. The left ventral and right dorsal lateral edges have bright, well-developed polish indicative of plant processing (Figure 6.66A-C).

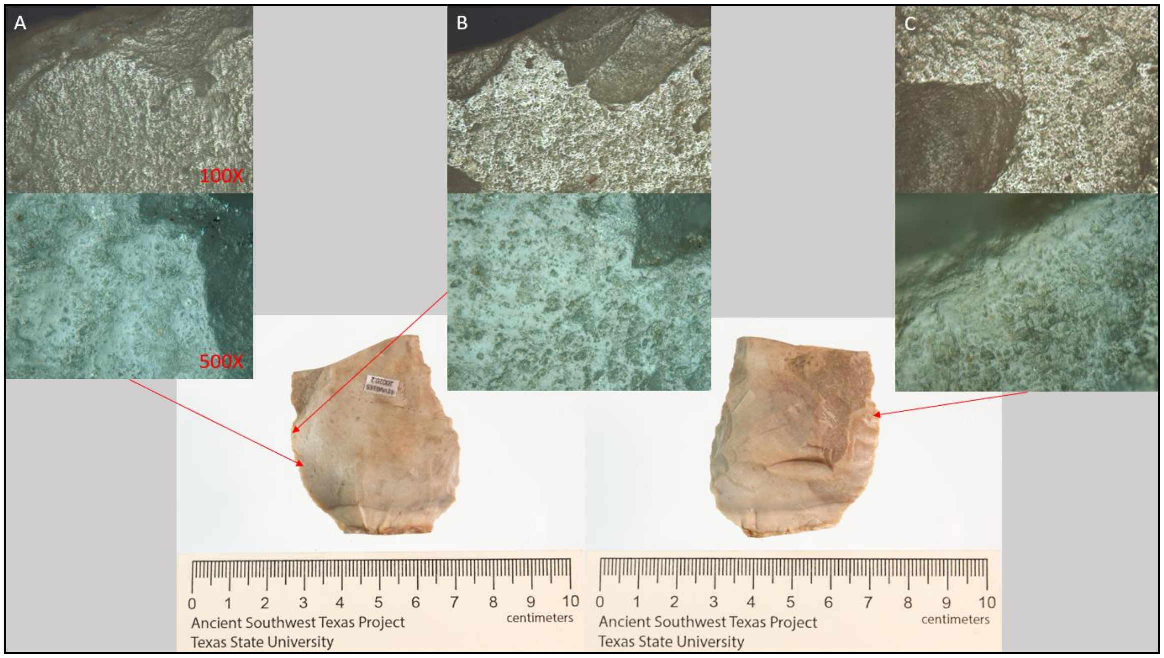

Figure 6.66. Skiles Shelter Specimen 20020.2 artifact photo and photomicrographs.

20056.8

Skiles Shelter specimen 20056.8 is made from a light tan and pinkish colored chert. It is a complete flake tool with lateral edges worked on both the dorsal and ventral sides of the tool (Figure 6.67). Cortex is present across the majority of the dorsal side. During initial analysis, as detailed in Chapter 4, epidermis/fiber fragments were observed adhering to the edges. No evidence of use-wear was observed; therefore, no photomicrographs were taken.

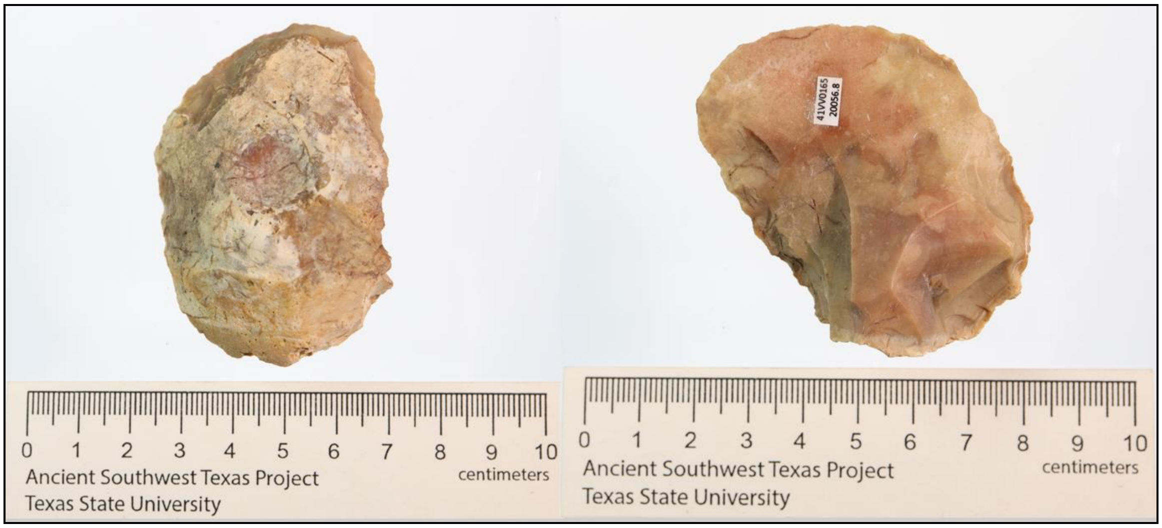

Figure 6.67. Skiles Shelter Specimen 20056.8 artifact photo.

20105.10

Skiles Shelter specimen 20105.10 is a unifacial scraper made from a light brown colored chert, with cortex on the left lateral edge and heavy flaking on the right lateral edge of the dorsal side. The proximal edge of the uniface is broken off with a snap fracture. As described in Chapter 4, during initial analysis polish was noted. This tool was analyzed microscopically under low-power magnification. Polish is visible macroscopically on the ventral side of the tool. Microscopically, the ventral lateral edge has a few areas of dull polish with deep striations at perpendicular and oblique angles to the edge (Figure 6.68A-B). These wear traces are characteristic of processing bone as the contact material.

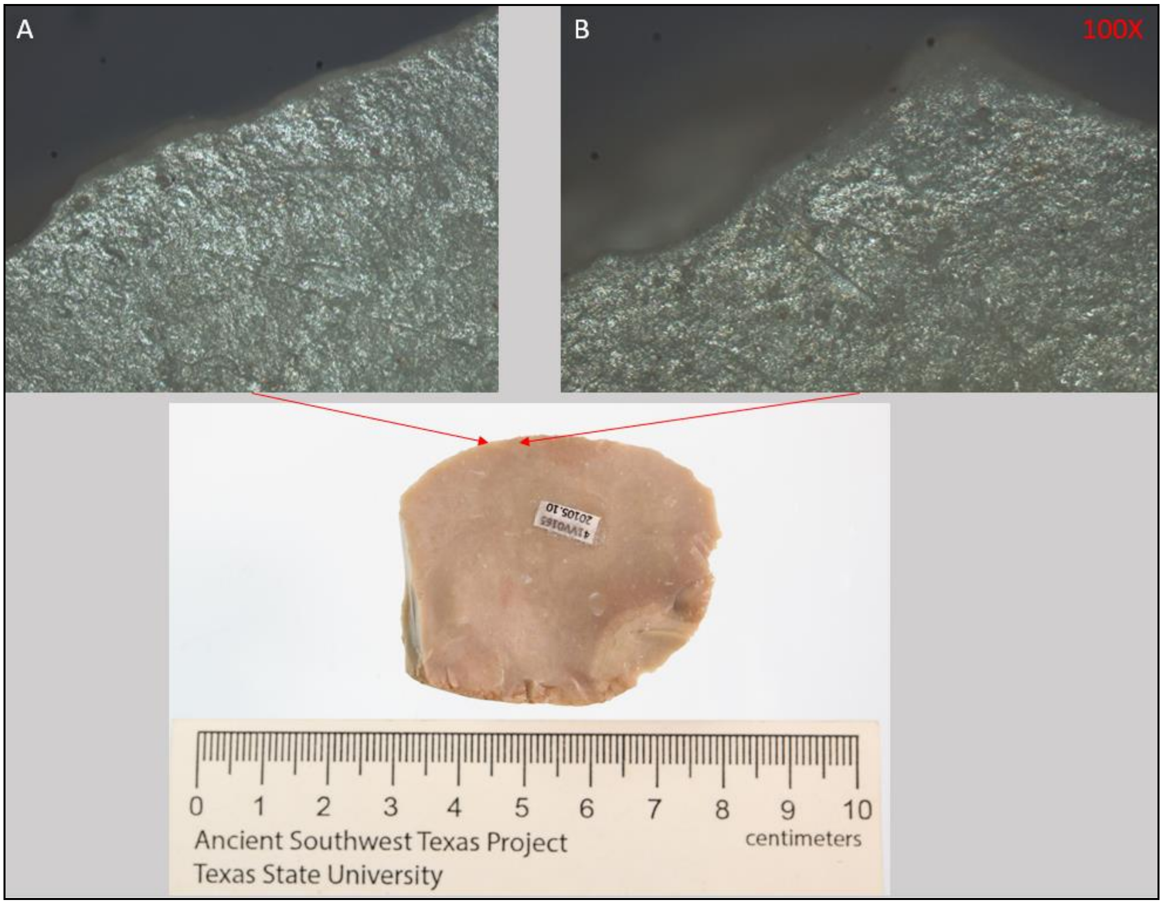

Figure 6.68. Skiles Shelter Specimen 20105.10 artifact photo and photomicrographs.

20062.1

Skiles Shelter specimen 20062.1 is a complete steep-angled unifacial scraper made from a tan-colored chert with pinkish-orange spherules dotted throughout, with no cortex. During initial analysis, epidermis/fiber fragments were observed adhering to the edge of the tool, as detailed in Chapter 4. Polish is visible macroscopically. This tool was analyzed microscopically under low-power magnification. The right ventral lateral edge is rounded with weak, dull polish (Figure 6.69A-B). This is characteristic use-wear evidence for wood processing.

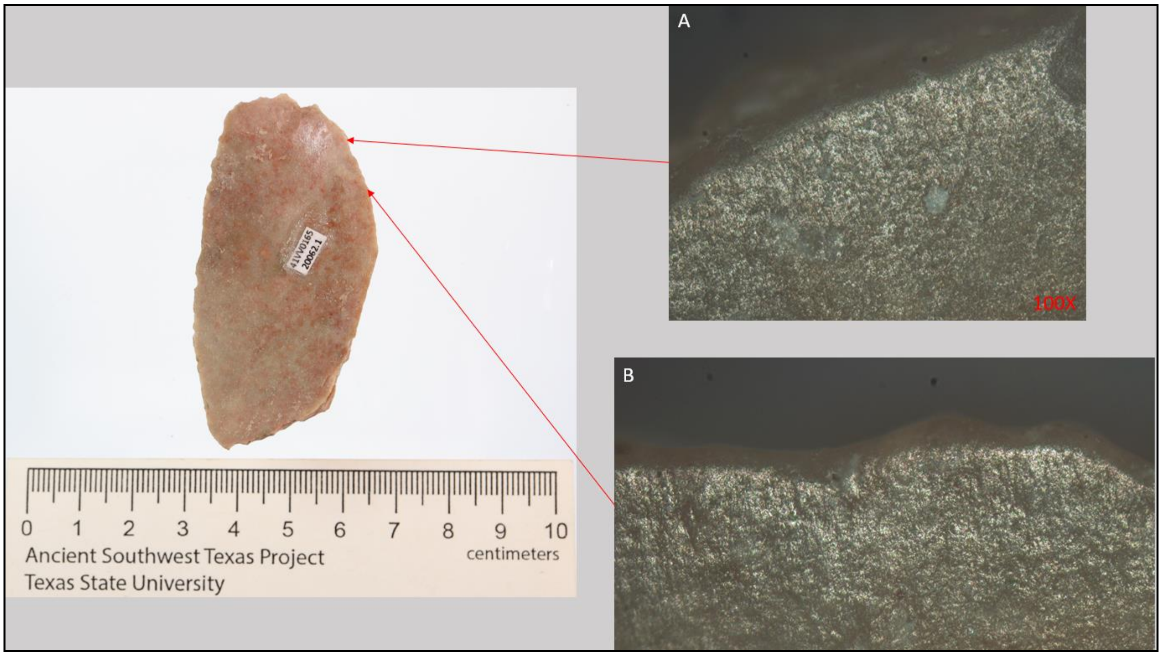

Figure 6.69. Skiles Shelter Specimen 20062.1 artifact photo and photomicrographs.

20031.4

Skiles Shelter specimen 20031.4 is a complete steep-angled unifacial scraper made from a light brown colored chert. During initial analysis, epidermis/fiber fragments were observed adhering to the edge of the tool, as detailed in Chapter 4. All lateral edges of this tool are heavily polished which was observed both macroscopically and microscopically. A lack of polish on the medial portion of both sides of the tool suggests evidence of hafting. This tool was analyzed microscopically under low- and high-power magnification. The ventral side of the tool has bright, well-developed polish all along the entirety of the lateral edges (Figure 6.70A-C). This wear evidence is indicative of processing plant material.

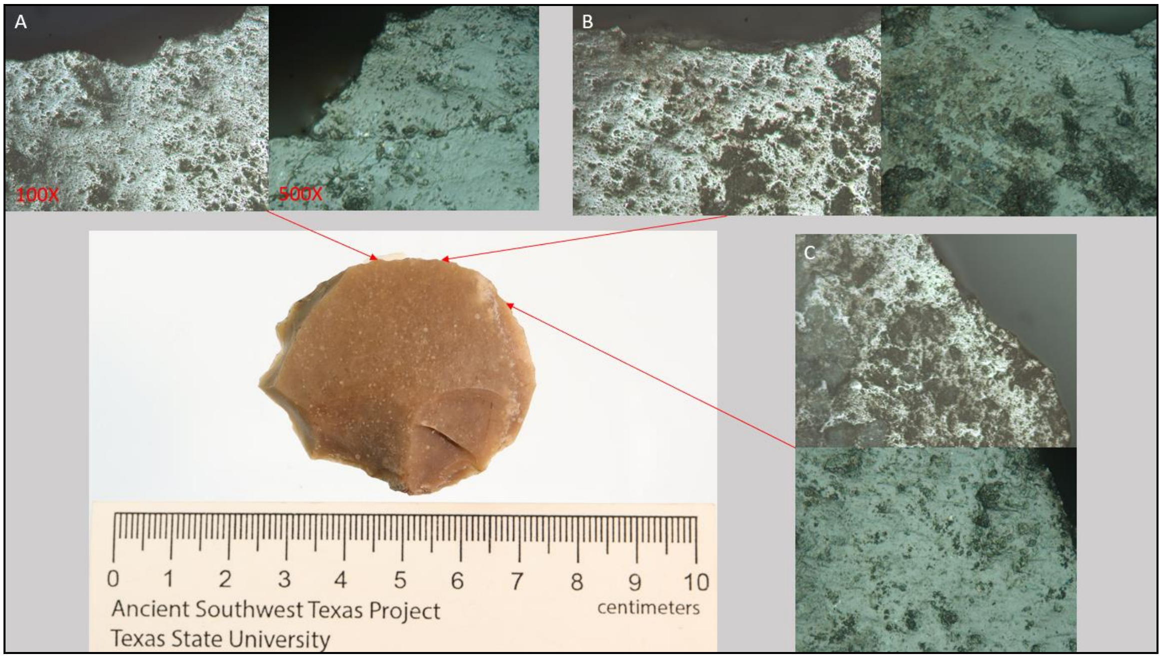

Figure 6.70. Skiles Shelter Specimen 20031.4 artifact photo and photomicrographs.

Little Sotol

The descriptive statistics of the Little Sotol tools analyzed for this thesis are detailed in Table 4.1. The Little Sotol archaeological sample included in this study is comprised of a chopper, unifaces, flake tools, and bifaces with contexts described in Chapter 4. There are a total of twenty tools from this site that were analyzed site from collections excavated by the ASWT Project.

12.2

Little Sotol specimen 12.2 is a large uniface made from a high-quality brown chert with cortex on the dorsal side of the tool (Figure 6.71). During initial analysis of the site's chipped stone tool assemblage, Knapp describes this tool as an agave knife and notes that no use-wear was observed macroscopically (2015:120). This was also confirmed during this study's microscopic analysis; therefore, no photomicrographs were taken.

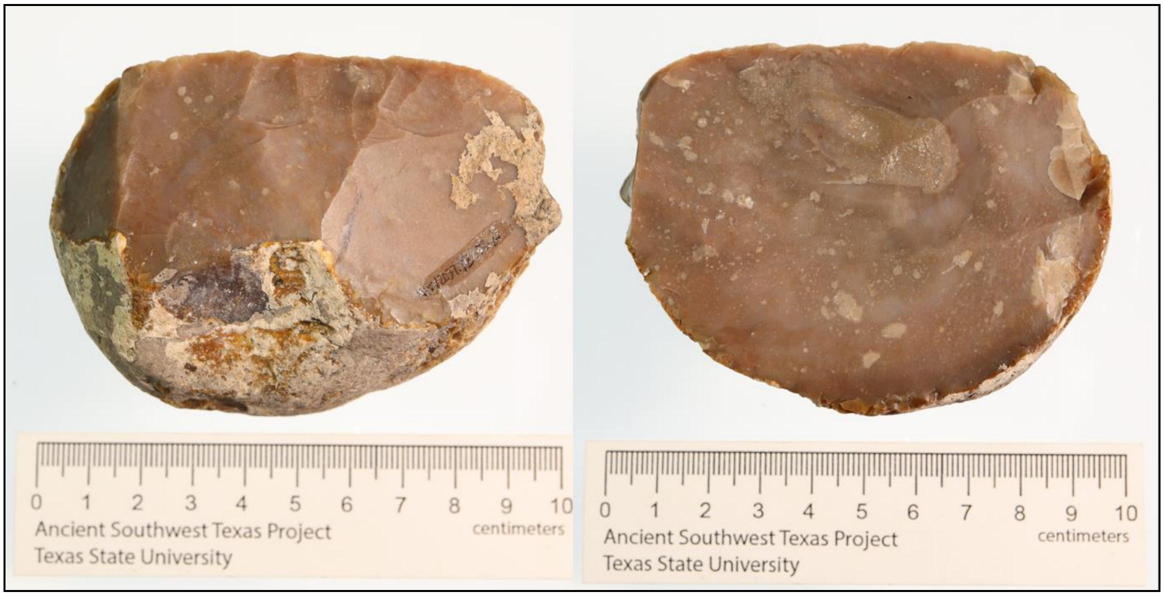

Figure 6.71. Little Sotol Specimen 12.2 artifact photo.

67.5

Little Sotol specimen 67.5 is a secondary flake tool made from a light brown chert. Polish is visible macroscopically and microscopically on the entirety of both ventral and dorsal lateral edges. Microscopic analysis under low-and high-power magnification shows bright, well-developed polish and striations at oblique angles from the tools edge (Figure 6.72A-C). The dorsal lateral edges also have extensive bright polish, though to a slightly lesser degree than the ventral side (Figure 6.73D-F). This is clear and characteristic evidence of plant-processing related use-wear.

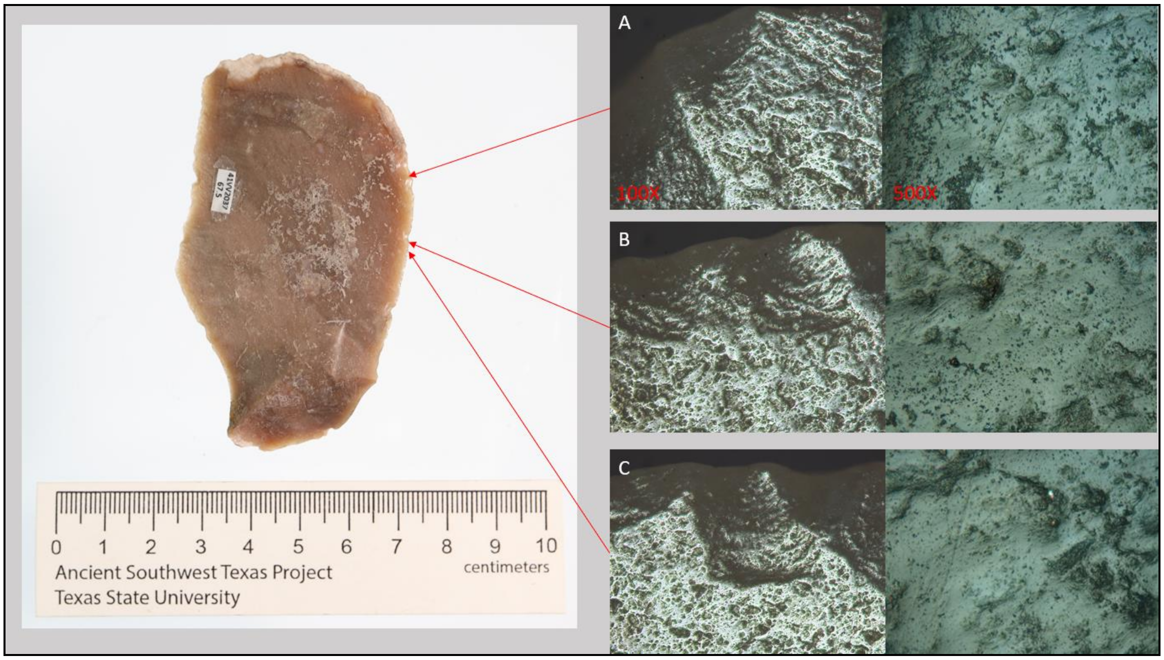

Figure 6.72. Little Sotol Specimen 67.5 ventral artifact photo and photomicrographs.

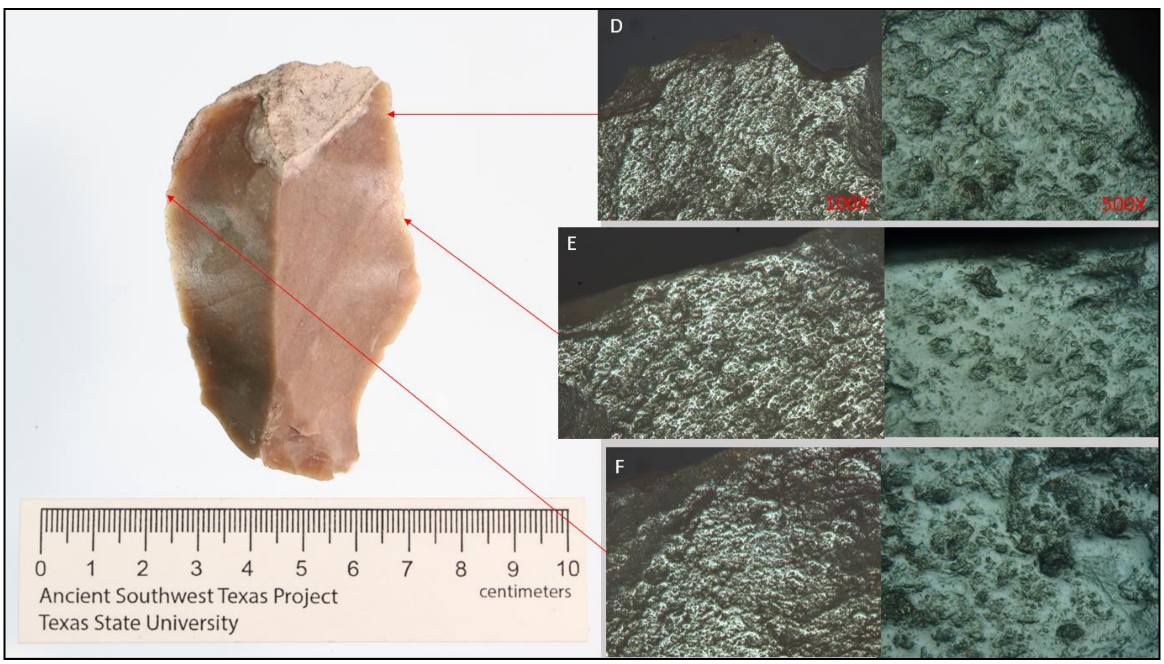

Figure 6.73. Little Sotol Specimen 67.5 dorsal artifact photo and photomicrographs.

64.2

Little Sotol specimen 64.2 is a tertiary flake tool made from tan chert. This tool was analyzed microscopically under low- and high-power magnification. On the dorsal right lateral edge, one area of polish was observed. The polish is smooth and very well-developed on the edge and lessens the further you go towards the center of the tool (Figure 6.74). On the ventral lateral edges of the tool plant, bright polish is observed on the high points of the microtopography (Figure 6.75A-C). This suggests this tool was used on plant material.

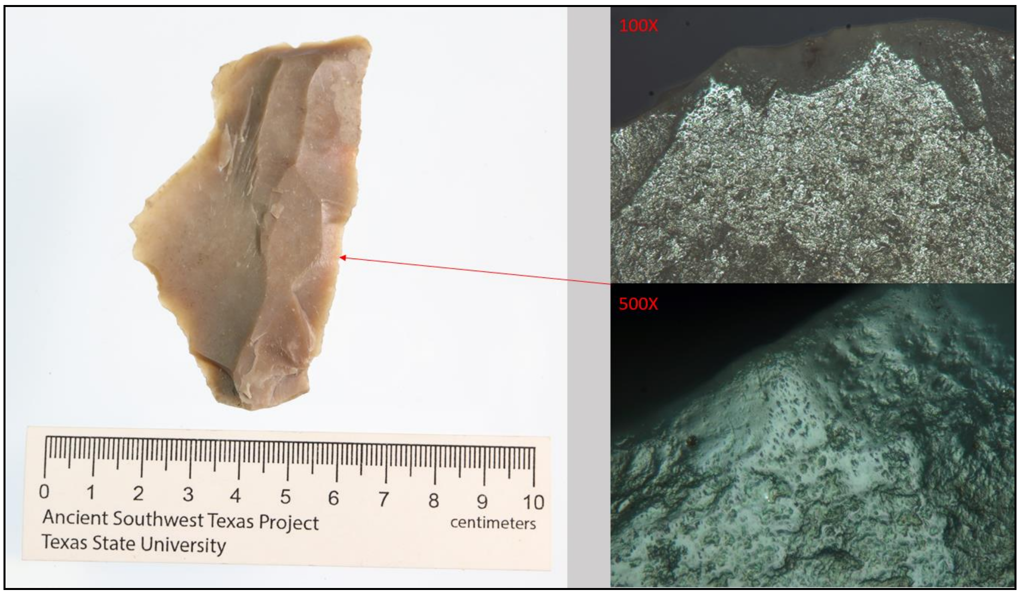

Figure 6.74. Little Sotol Specimen 64.2 dorsal artifact photo and photomicrographs.

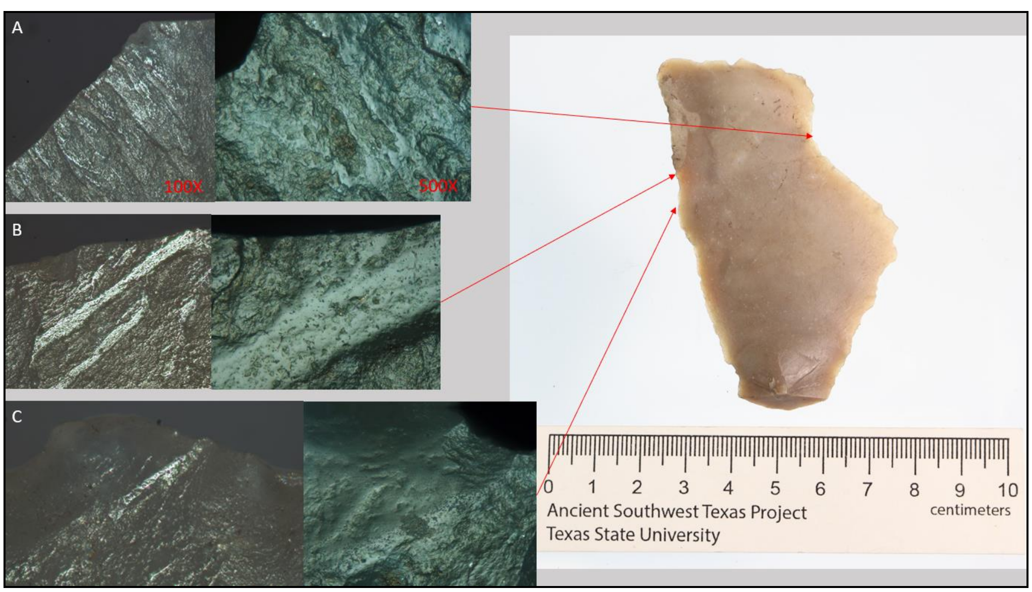

Figure 6.75. Little Sotol Specimen 64.2 ventral artifact photo and photomicrographs.

25.13

Little Sotol specimen 25.13 is a large secondary flake tool made from coarse-grained chert. Reddish residue could be ochre but further analysis needed. Calcium carbonate encrusted on the tools surface made use-wear analysis difficult, though a majority of the tool's edge was clear enough to still analyze. This tool was analyzed microscopically under low-power magnification. The photomicrograph shows an example of what the entirety of the lateral edge looks like, with reddish residue and calcium carbonate deposits on the tools surface (Figure 6.76). This reddish residue is very likely ochre, though further testing is be needed to confirm this. No other use-wear evidence was observed; this tool was definitively not used to process plants.

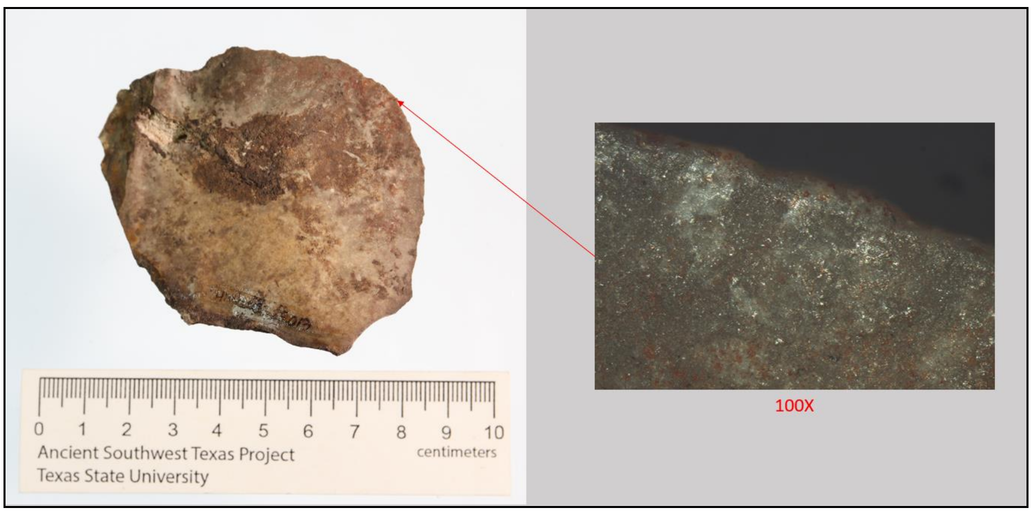

Figure 6.76. Little Sotol Specimen 25.13 artifact photo and photomicrographs.

58.52

Little Sotol specimen 58.52 is a sequent flake tool made from a high-quality pinkish, brown-colored chert with cortex on the proximal portion at the edge of the bulb (Figure 6.77). The dorsal side of this sequent flake tool is nicely worked, and it seems like it would make a decent usable tool. However, no use wear evidence was observed during microscopic analysis; therefore, no photomicrographs were taken.

Figure 6.77. Little Sotol Specimen 58.52 artifact photo.

57.5

Little Sotol specimen 57.5 is a large secondary flake tool made from a light brown chert. Polish is visible macroscopically and microscopically along the working edge. This tool was analyzed microscopically under low-power magnification. One location of the worked edge, on both the dorsal and ventral distal/lateral edge, has moderately developed bright, glassy polish (Figure 6.78A-C). This wear pattern is characteristic of plant-processing.

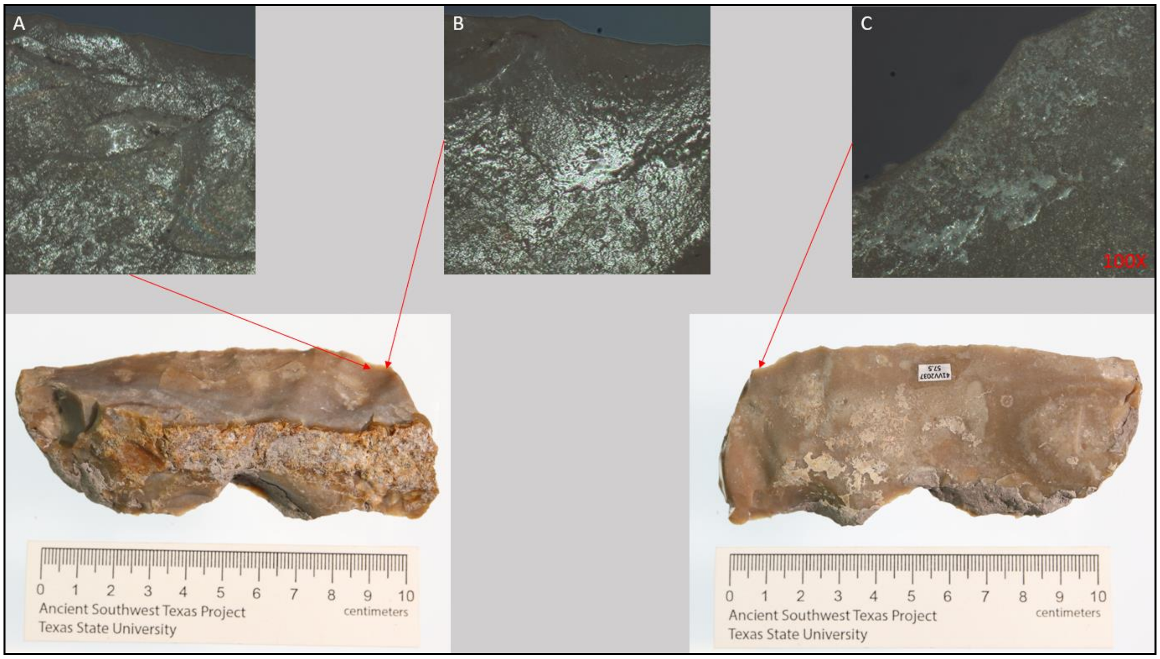

Figure 6.78. Little Sotol Specimen 57.5 artifact photo and photomicrographs.

56.1

Little Sotol specimen 56.1 is a tertiary flake tool made from a brown chert. Calcium carbonate encrusted to the tools surface is visible macroscopically and microscopically, affecting the visibility for use-wear analysis. This tool was analyzed microscopically under low-power magnification and one small area of potential use-wear was observed. The polish shown in the photomicrograph is dull, patchy, and abrasive (Figure 6.79). This type of use-wear pattern is characteristic of soft tissue butchering or hide processing; no evidence suggests this tool was used for processing plants.

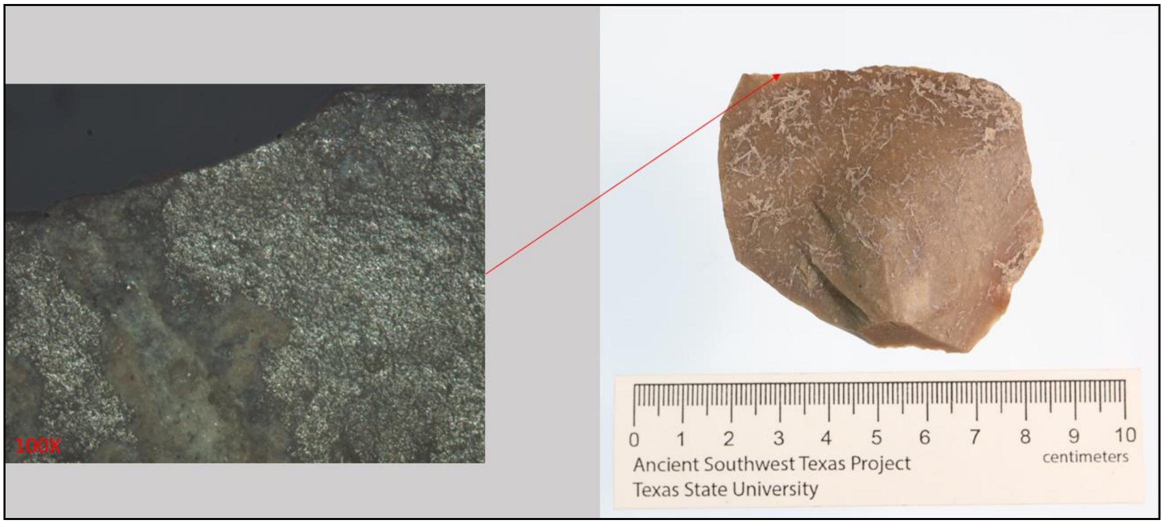

Figure 6.79. Little Sotol Specimen 56.1 artifact photo and photomicrographs.

4.4

Little Sotol specimen 4.4 is a secondary flake tool made from brown chert. This tool was analyzed microscopically under low-power magnification. The photomicrographs show bright, linked polish on both the dorsal and ventral distal edge (Figure 6.80A-C). This wear pattern is characteristic of plants being the contact material.

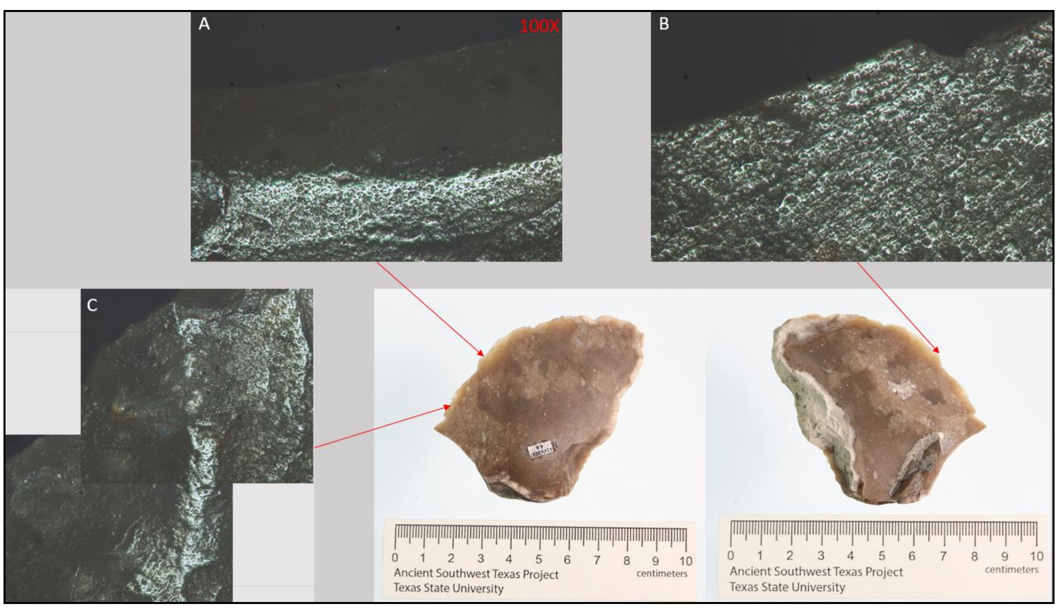

Figure 6.80. Little Sotol Specimen 4.4 artifact photo and photomicrographs.

93.6

Little Sotol specimen 93.6 is a modified flake tool with cortex on the right dorsal lateral edge (Figure 6.81). A slight sheen was observed macroscopically on both sides of the tool. No use wear evidence was observed during microscopic analysis; therefore, no photomicrographs were taken.

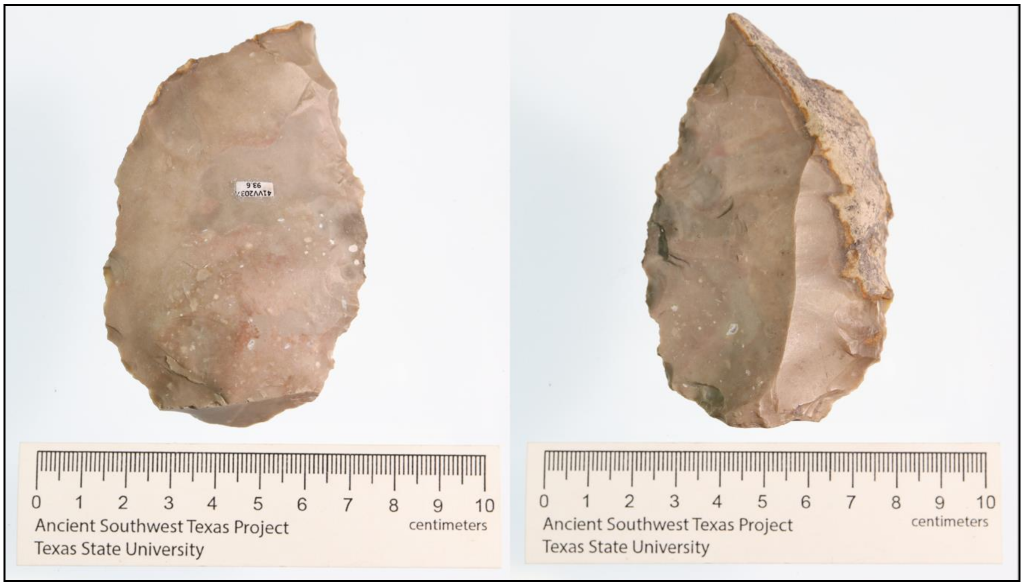

Figure 6.81. Little Sotol Specimen 93.6 artifact photo.

4.2

Little Sotol specimen 4.2 is a secondary flake tool made from a brownish orange, high-quality chert. Polish is visible macroscopically and microscopically on the entirety of lateral ventral edge. This tool was analyzed microscopically under low- and high-power magnification. Well-developed plant polish is present across the length of the ventral lateral edge; photomicrographic examples of this polish are shown in Figure 6.82A-C. The large areas of linked, smooth polish here are indicative of this tool being used on plant materials.

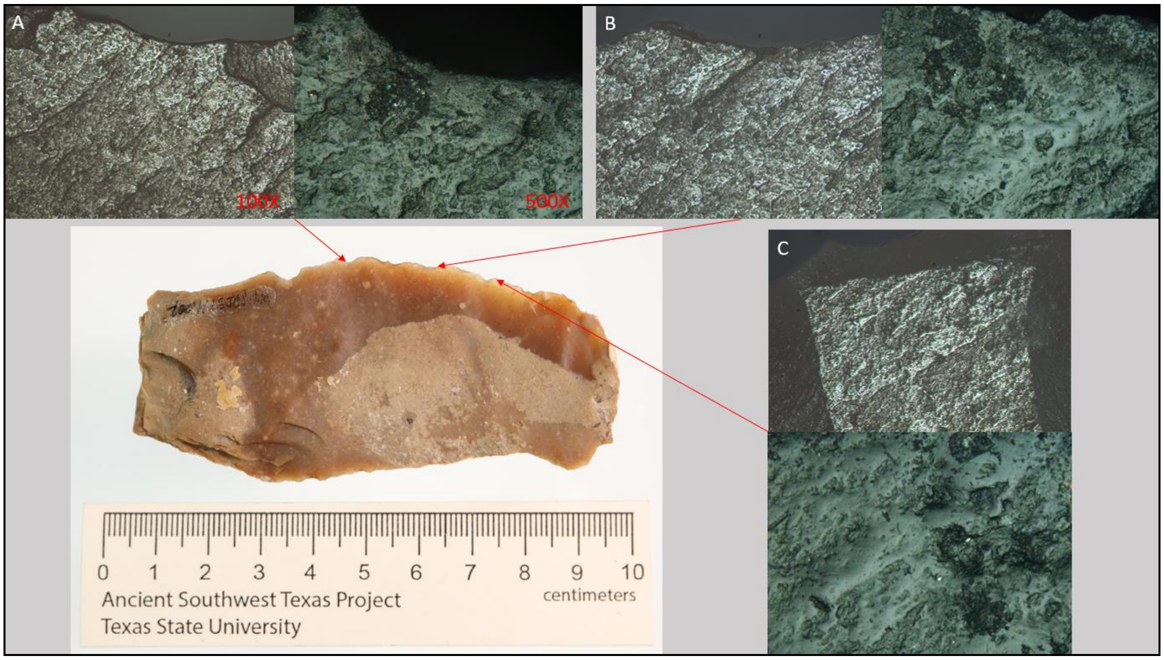

Figure 6.82. Little Sotol Specimen 4.2 artifact photo and photomicrographs.

2.7

Little Sotol specimen 2.7 is a secondary flake tool made from a light tan colored chert. Polish is visible macroscopically and microscopically on the entirety of lateral ventral edge. This tool was analyzed microscopically under low- and high-power magnification. Very bright, exceptionally well-developed glassy polish is present along the entire ventral working edge (Figure 6.83A-C). The photomicrographs in Figure 6.83A-B show striations are visible under high-power magnification, at oblique angles to the edge. This type of use-wear is clear and characteristic of plant-processing activities. The intensity of the polish speaks to how many times this tool was used prehistorically; this level of polish suggests this tool was used during multiple plant processing events.

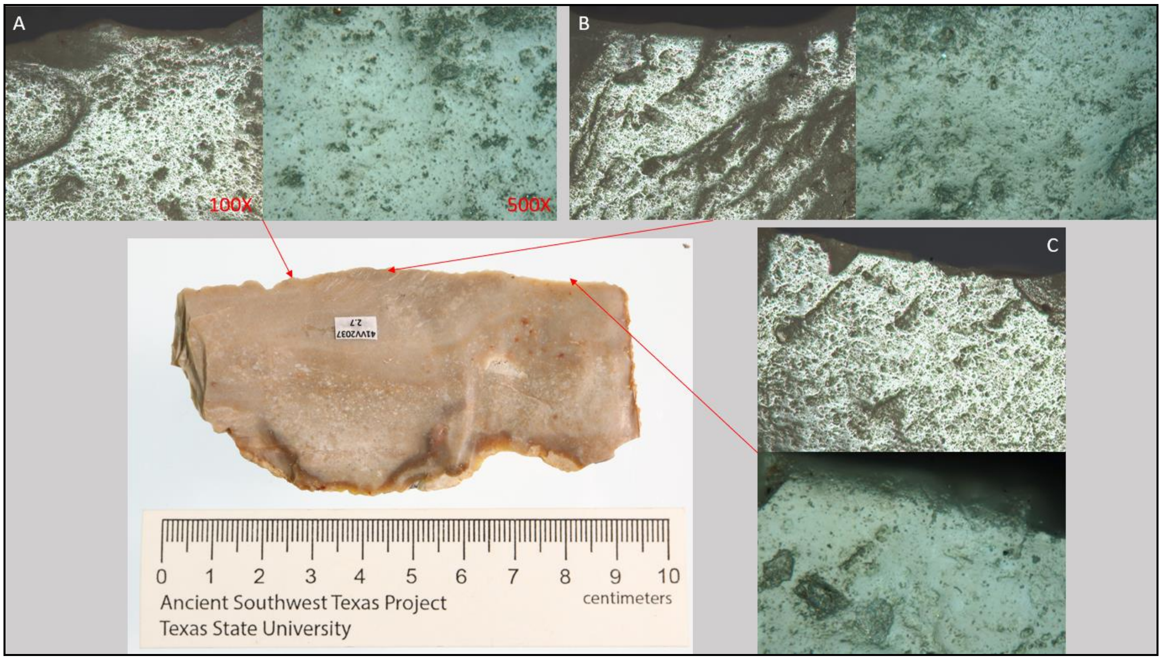

Figure 6.83. Little Sotol Specimen 2.7 artifact photo and photomicrographs.

8.4

Little Sotol specimen 8.4 is a secondary flake tool made from a light tan colored chert. This tool was analyzed microscopically under low-power magnification. The lateral edges of this flake tool are modified as if for hafting, though no evidence of such was seen under the microscope in these areas. Two photomicrographs were taken of slight polish present along the right ventral lateral edge; the polish is discontinuous and not well-developed, though bright (Figure 6.84A-B). This tool may have been used to process wood; however, the wear traces suggest it was not used on plant material.

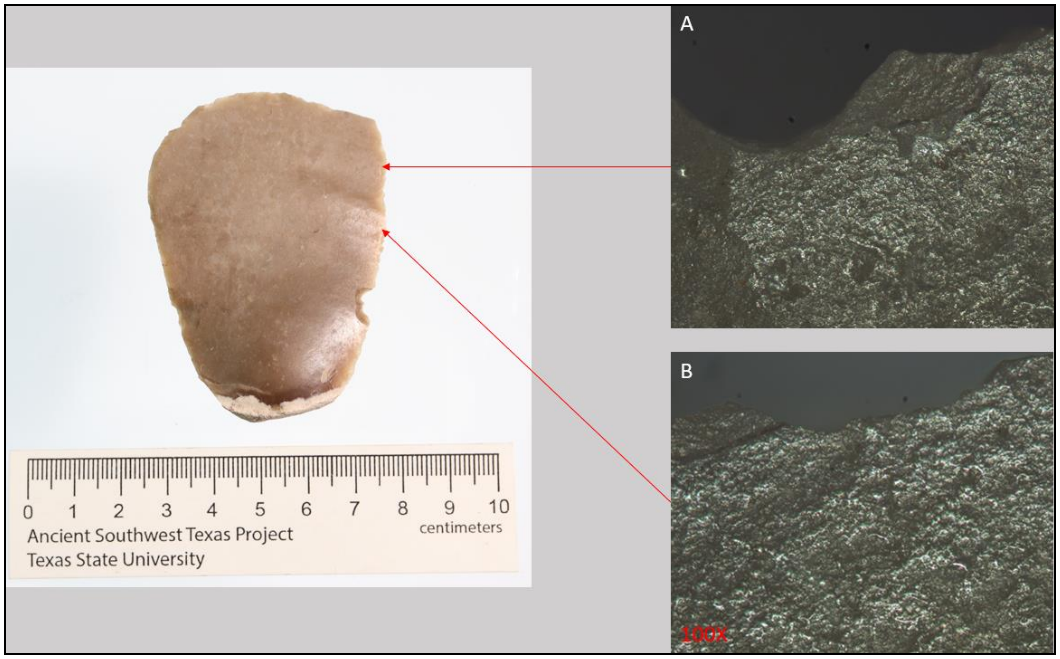

Figure 6.84. Little Sotol Specimen 8.4 artifact photo and photomicrographs.

2.5

Little Sotol specimen 2.5 is a large modified tertiary flake tool made from a tan chert. Polish is visible macroscopically and microscopically on the entirety of the lateral dorsal edge. This tool was analyzed microscopically under low- and high-power magnification. The photomicrographs show examples of the polish present across the entire worked edge. Figure 6.85A shows well-developed bright and smooth polish, with a large striation sub perpendicular to the edge. Figure 6.85B also shows this extensive polish. These wear traces are definitively characteristic of plant material as the contact.

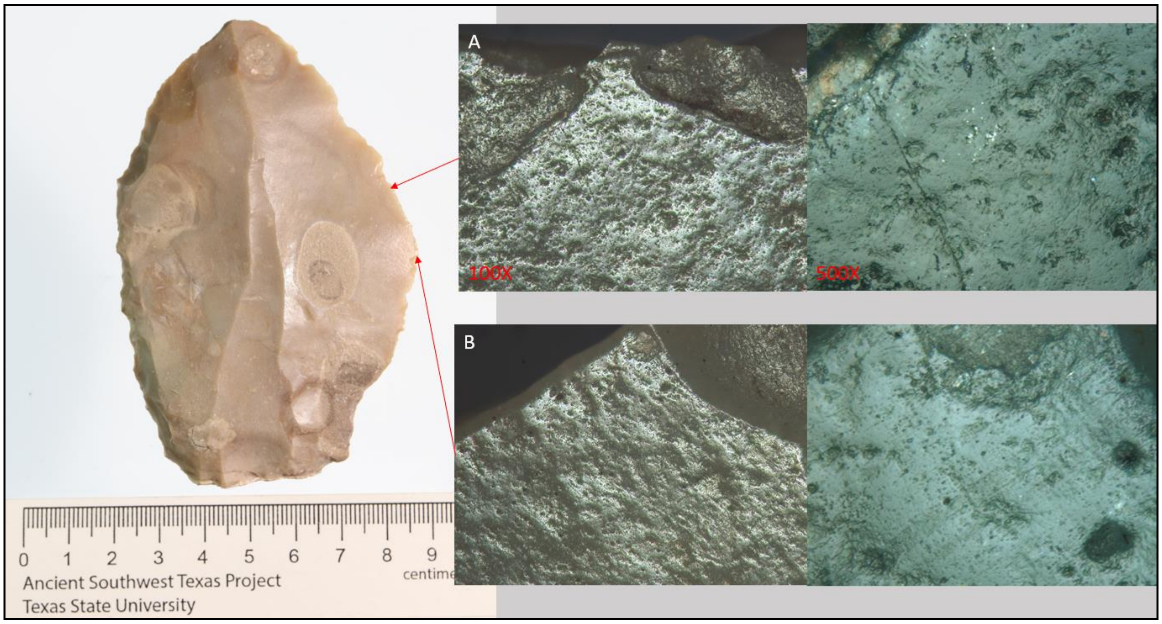

Figure 6.85. Little Sotol Specimen 2.5 artifact photo and photomicrographs.

23.4

Little Sotol specimen 23.4 is a unifacial scraper tool made from a banded brown/white-colored chert. This tool was analyzed microscopically under low-power magnification. A few areas were microphotographed showing very weak and inconsistent polish (Figure 6.86A-B). This does not appear to be associated with any use on a contact material, but instead could be evidence of pseudo-polish from patination (i.e., PDSM).

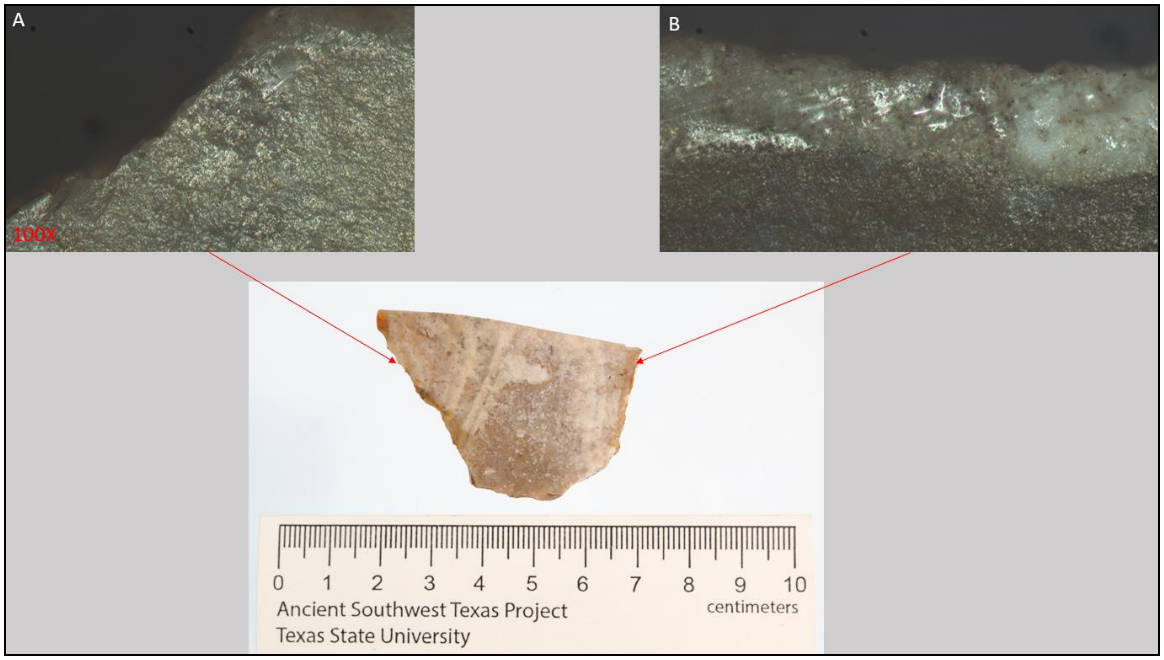

Figure 6.86. Little Sotol Specimen 23.4 artifact photo and photomicrographs.

20.11

Little Sotol specimen 20.11 is a secondary flake tool made from a tan-colored chert. This tool was analyzed microscopically under low-power magnification. On the left ventral lateral edge, a few areas of extremely bright, shimmering blotches along the very edge are present, which could be some sort of residue or leftover alcohol from the cleaning process (Figure 6.87A-C). It is clear that this tool was not used to process plants, if it was used at all.

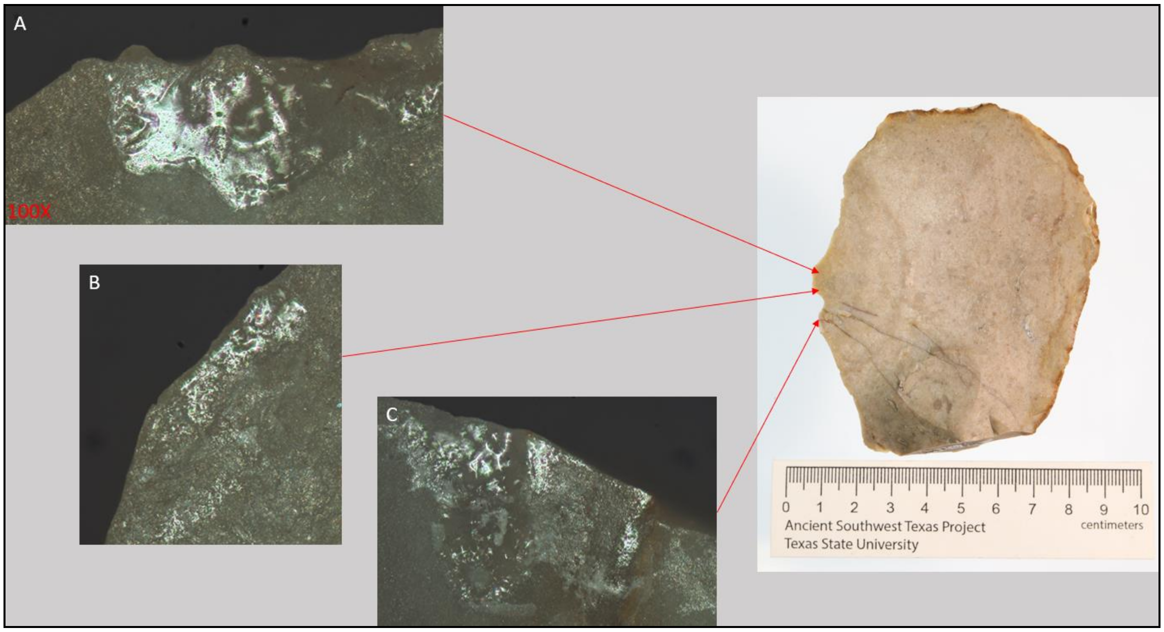

Figure 6.87. Little Sotol Specimen 20.11 artifact photo and photomicrographs.

81.9

Little Sotol specimen 81.9 is a large chopper tool made from a low-quality source of tan chert (Figure 6.88). This tool was too large to analyze under the Leica microscope. As described in Chapter 5, any tools that were not analyzed with the Leica were examined under the DynoLite with no photos taken. Analysis showed no observable use wear traces.

Figure 6.88. Little Sotol Specimen 81.9 artifact photo.

21.6

Little Sotol specimen 21.6 is a bifacial tool that looks like a blank that would have been reduced before use (Figure 6.89). There is some discoloration on the proximal edge that could be evidence of burning. During microscopic analysis, no use wear traces were observed therefore no photomicrographs were taken.

Figure 6.89. Little Sotol Specimen 21.6 artifact photo.

24.1

Little Sotol specimen 24.1 is an early-stage biface that may have been a drill, or a projectile point preform. Hardly any polish was noted during microscopic analysis under low-power magnification. One photomicrograph was taken that shows very little sheen in only one area on the tool (Figure 6.90). This pseudo-polish could be patination due to PDSM.

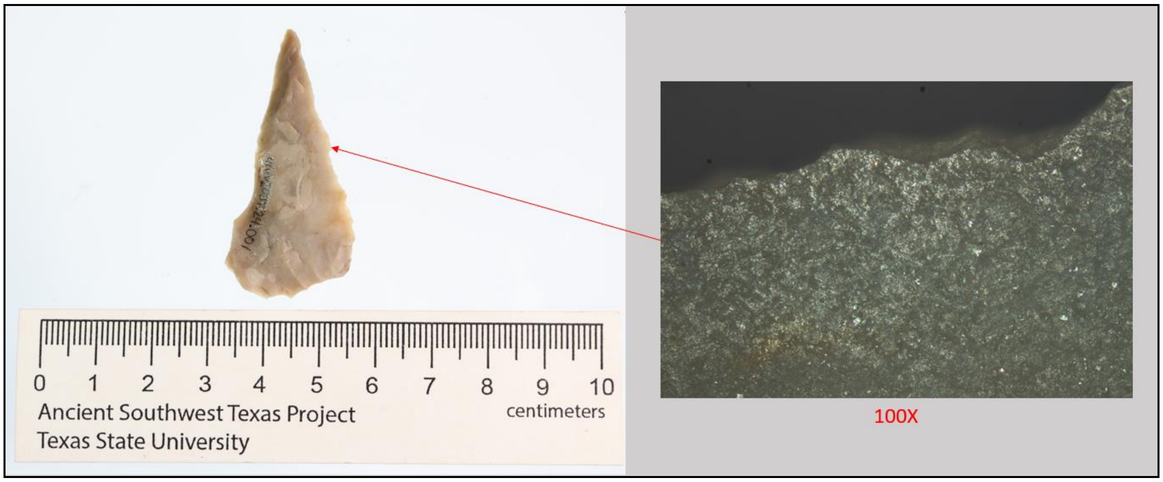

Figure 6.90. Little Sotol Specimen 24.1 artifact photo and photomicrographs.

20.5

Little Sotol specimen 20.5 is a large, tertiary flake tool made from pinkish brown chert. This tool was analyzed microscopically under low-power magnification. One area of patchy, abrasive polish was observed (Figure 6.91). This could be indicative of hafting; however, no other areas of wear traces were located in order to assess what the contact material was for this tool.

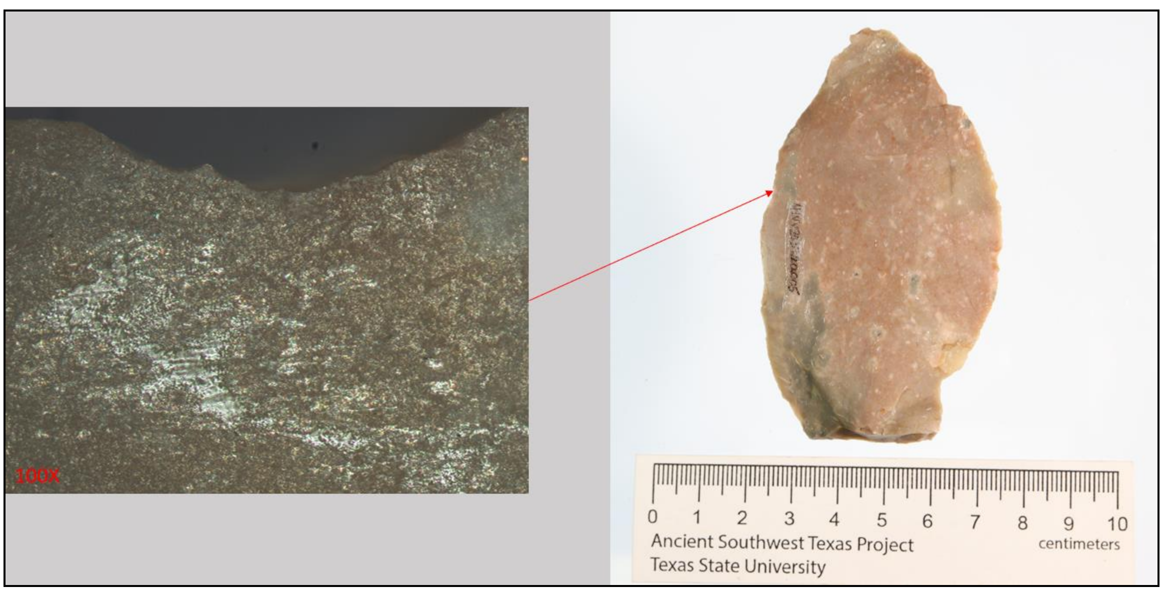

Figure 6.91. Little Sotol Specimen 20.5 artifact photo and photomicrographs.

46.2

Little Sotol specimen 46.2 is a biface made from a very high-quality banded white/brown chert, though it looks like an early-stage biface that would be further reduced/chipped down and not used in its current form. This tool was analyzed microscopically under low-power magnification. Some bright spots of polish were noted in two areas during analysis that could have resulted from use or PDSM (Figure 6.92A-B).

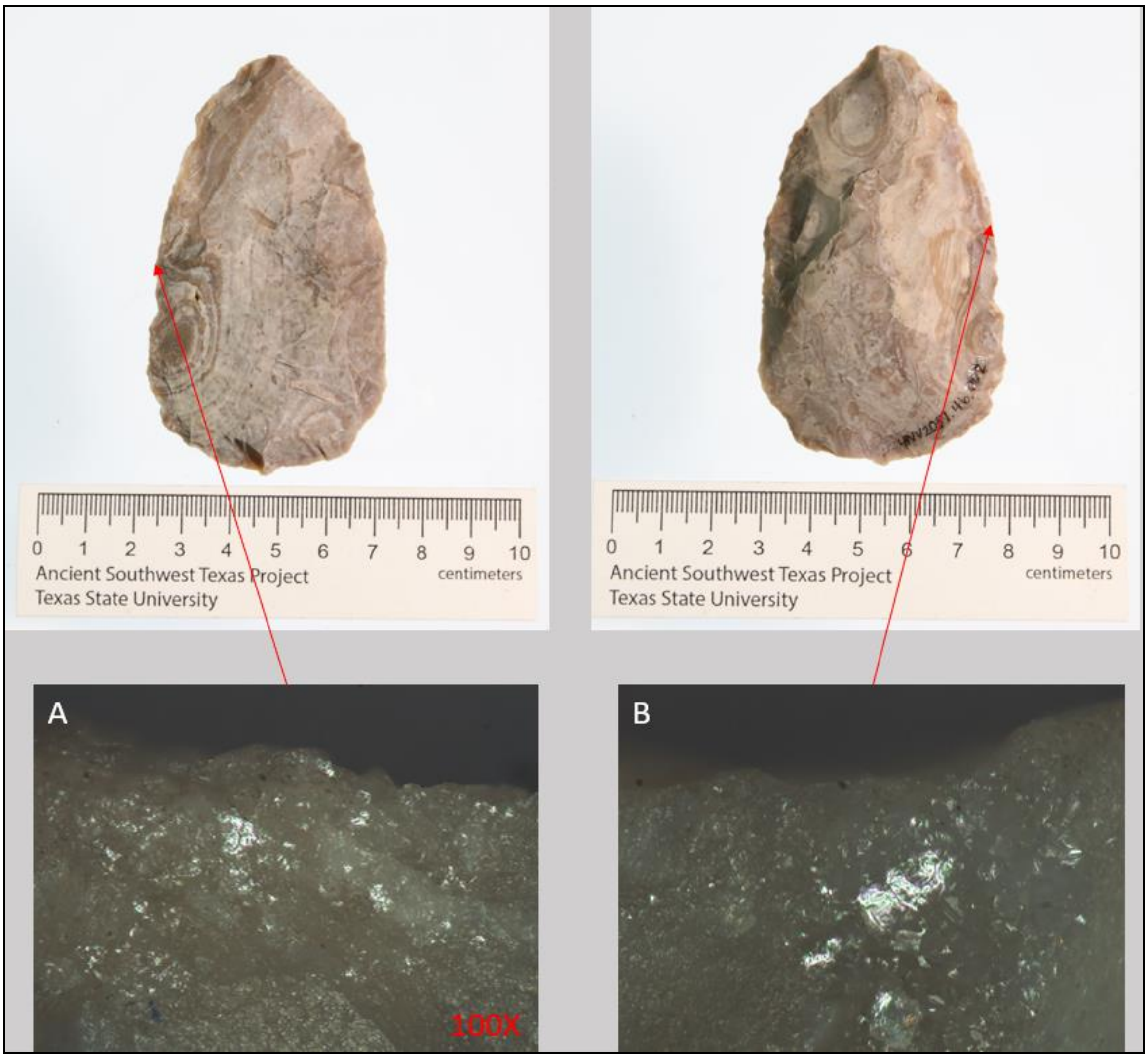

Figure 6.92. Little Sotol Specimen 46.2 artifact photo and photomicrographs.

Sayles Adobe

The Sayles Adobe site is located below Skiles Shelter in Eagle Nest Canyon in the LPC, which is further described in Chapter 2. As detailed in Chapter 4, only one unique tool from this site was selected for analysis from the Sayles Adobe site. The descriptive statistics of this tool are detailed in Table 4.4.

50158.1

Sayles Adobe specimen 50158.1 is an agave knife made from a dark brown chert. The distal edge is very thin and well-made and the thick "butted" proximal edge has cortex present. The entirety of this tool's surface is extremely glossy and polished which can be seen macroscopically. This tool was analyzed microscopically under low- and high-power magnification. Microscopically, the densest and most continuous polish is located on the left lateral edge shown in Figures 6.93 and 6.94. Even under low-power magnification, striations are visible. Figure 6.93A shows consistent polish with micropitting and striations at an oblique angle to the edge. Figure 6.93B-C show overlapping oblique and parallel striations through well-developed, continuous polish; this suggests multiple use-events.

Figure 6.94D shows bright polish and striations perpendicular to the edge and Figure 6.94E shows discontinuous polish. Figure 6.94F shows a high spot with well-developed polish but surrounding flake scars without polish, which suggests that this tool was re-sharpened and therefore used during multiple processing events. Figure 6.95 shows well-developed polish and striations parallel to the distal edge. The photomicrographs show a combination of use-wear characteristics that suggest the contact material was high in silica and therefore used to process plants. The subparallel striations overlapping at multiple angles show that this was a well-used plant-processing tool.

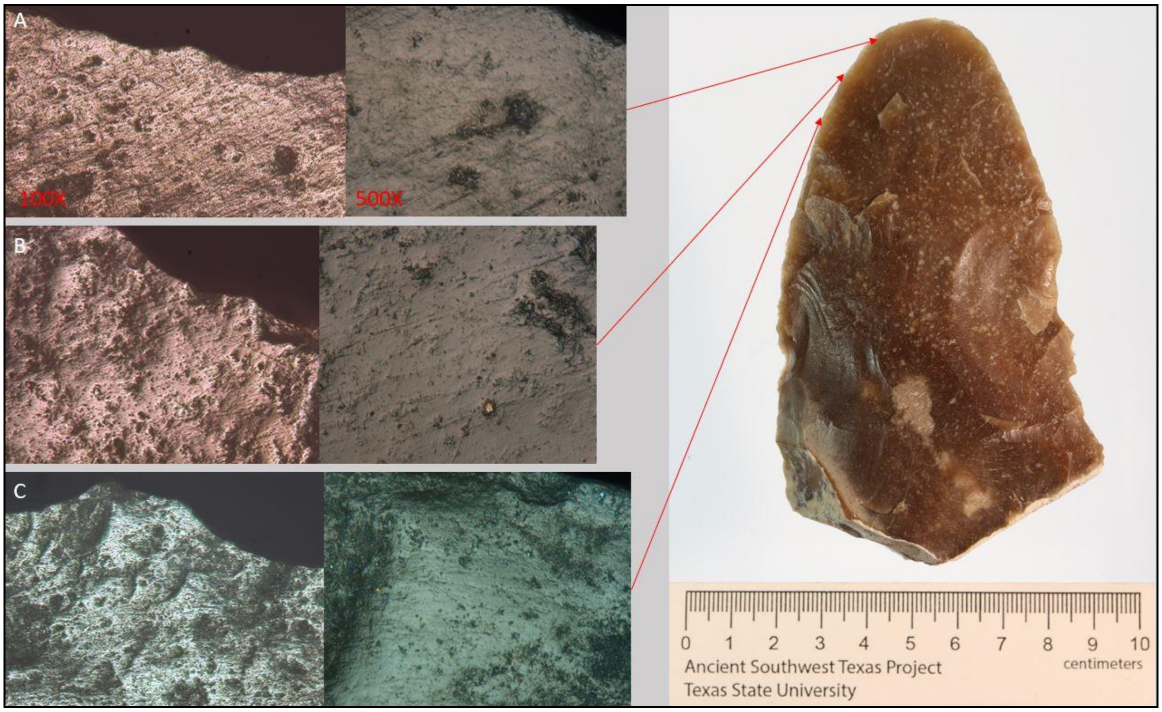

Figure 6.93. Sayles Adobe Specimen 50158.1 artifact photo and photomicrographs.

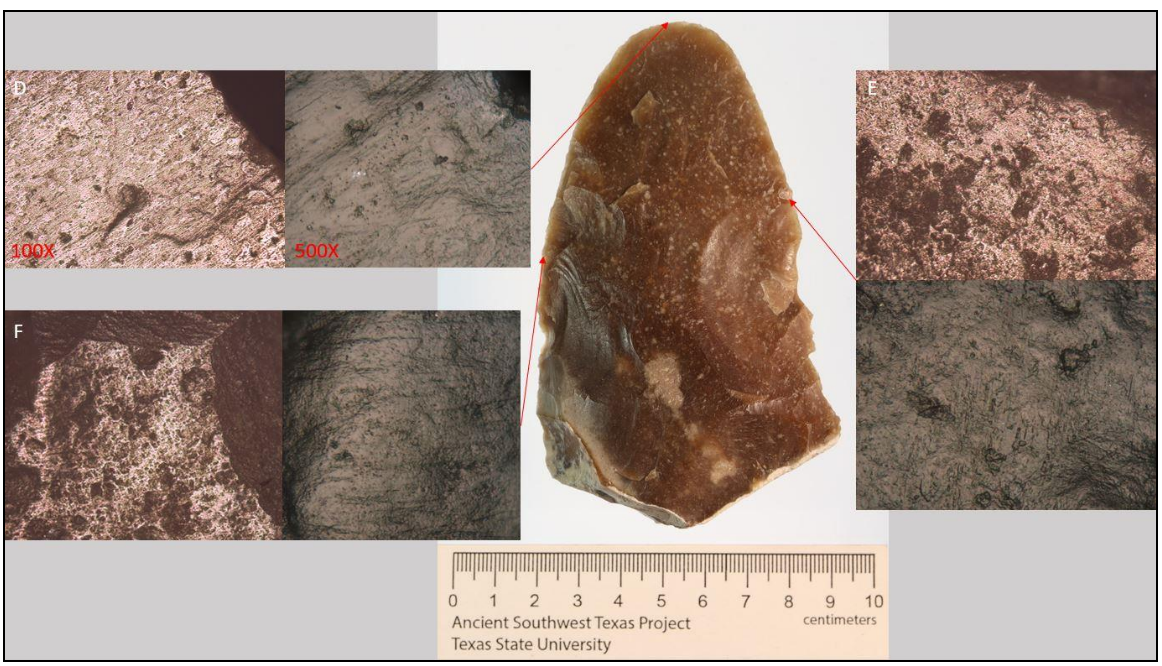

Figure 6.94. Sayles Adobe Specimen 50158.1 artifact photo and photomicrographs.

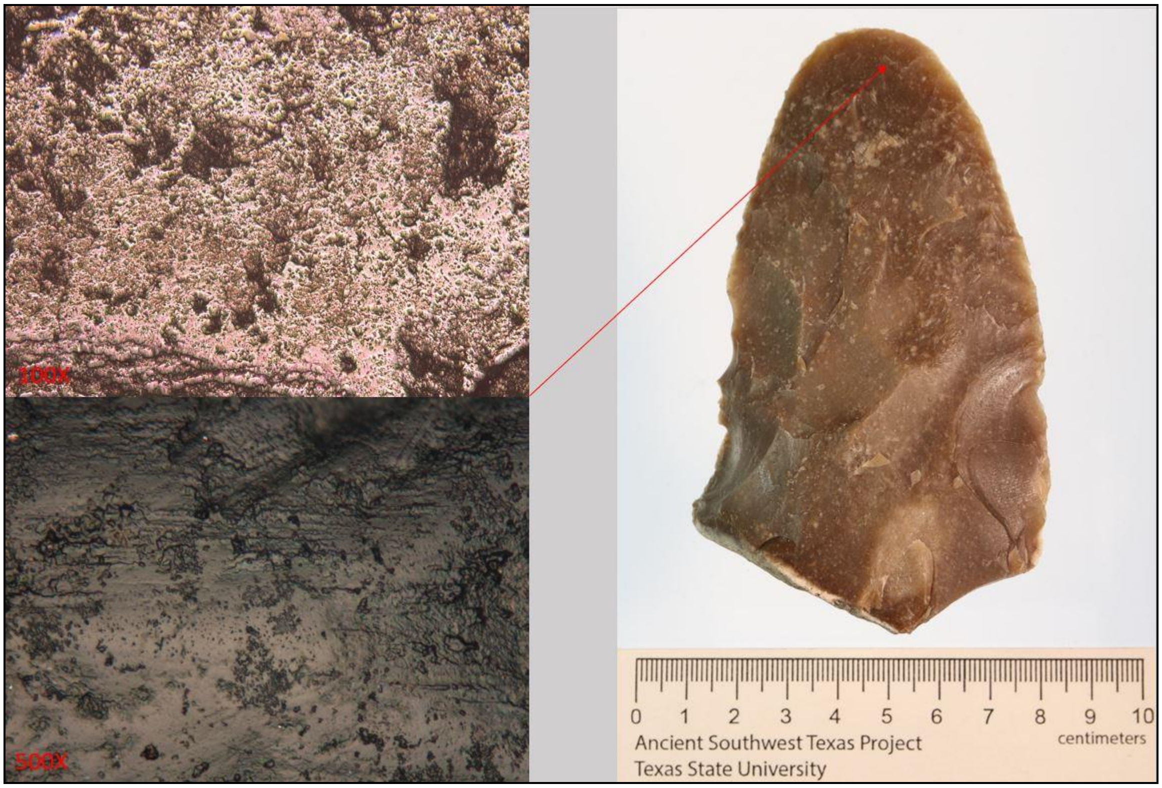

Figure 6.95. Sayles Adobe Specimen 50158.1 artifact photo and photomicrographs.

VII. DISCUSSION AND CONCLUSION

Most archaeological sites have a wide range of artifact types, though often preservation affects the types of perishable artifact materials that remain in the archaeological record. The xeric natural environment and dry rockshelters of the Lower Pecos Canyonlands afford a unique opportunity for the preservation of perishable materials that other areas are lacking. However, this is not true of all sites in the LPC where open sites abound. At open sites like the Little Sotol burned rock midden, artifacts of chipped stone often comprise the largest number of artifacts within an assemblage, simply because they do not decay and rot away like plant materials and animal materials. Use-wear analysis can provide insight into what kinds of materials prehistoric people were processing, even thousand years after organic materials have decayed.

Results and Interpretations

In this study, the goal of my research is to formulate an understanding of the use and variety of chipped stone tools needed to process plants, in order to correlate tool type with tool function; in other words, to identify the plant-processing toolkit in the LPC. With my research I identify which tool types were used for certain tasks and on what contact material, as well as whether tools were used during single or multiple events. I chose to analyze several different sites in the LPC because I wanted to see the difference in observable use-wear evidence on rockshelter sites versus open-air terrace sites.

Out of the 76 tools analyzed during this study, a total of three tools were not able to be analyzed under the Leica microscope due to the large size and/or steep edge angle and a total of 17 tools had no observable use-wear evidence present (Table 7.1). A high percentage of the tools within each site assemblage had observable use-wear evidence.

However, many of these tools only had slight polish on a small portion of the worked edge. A large number of minimally shaped tools that would be classified as “expedient” showed heavy plant polish. Identifying macroscopic polish on large flakes and formal tools is key to establishing potential plant processing tools for use-wear analysis. I was surprised that some of the more formal tools, such as the adze fragment from Eagle Cave (specimen 34758.3) and the “agave” knife from Little Sotol (specimen 12.2), had no use-wear traces. Perhaps these formal tools were just middle stage preforms that had not yet been completed for use or finished tools that had been resharpened after a previous use.

Table 7.1 Use-Wear Results from Experimental and Archaeological Tools.

Context	Total Number of Tools	Tools with Use-Wear	Not Analyzed Microscopically	No Use-Wear Present	Percentage of Sample with Observable Wear
Experimental	15	13	2	2	86.67%
Eagle Cave	20	12	0	8	60%
Skiles Shelter	20	17	0	3	85%
Little Sotol	20	15	1	4	75%
Sayles Adobe	1	1	0	0	100%

The type of use-wear observed had different characteristics based on the type of contact material that the tool was used on. Table 7.2 shows the pattern of polish, intensity of polish, occurrence of striations, and presence of microchipping along the tools worked edge for the contact materials: plant, animal flesh/hide, bone and wood. These minute variations in use-wear characteristics made it possible during my analysis to distinguish whether a tool was used on a certain contact material versus another.

Table 7.2 Contact Material Use-Wear Characteristics.

	Plant	**Animal Flesh/Hide**	**Bone**	**Wood**
Pattern of Polish	Continuous	Patchy/Discontinuous	Discontinuous	Discontinuous
Intensity of Polish	Bright/Glossy	Dull	Dull	Dull
Striations	Yes	Occasionally	Yes	Occasionally
Microchipping	Occasionally	Occasionally	Yes	Yes

The type of use-wear evidence observed on each tool in this study was divided into five categories of contact material: “Plant,” “Animal Butchering/Hide,” “Bone,” “Wood,” and “Undetermined” (Table 7.2). If a tool was categorized as having “Undetermined” use-wear, this means that while there is observable use-wear, it is so under-developed that clear/characteristic patterns for the type of contact material was impossible to discern; this should not be confused with tools that had no observable use-wear present and therefore had no photomicrographs taken.

Table 7.3 Categories of Use-Wear on Experimental and Archaeological Tools.

Contact Material	**Experimental**	**Eagle Cave**	**Skiles Shelter**	**Little Sotol**	**Sayles Adobe**
Plant	8	3	6	8	1
Animal Butchering/Hide	2	2	5	0	N/A
Bone	1	0	1	0	N/A
Wood	1	2	5	1	N/A
Undetermined	N/A	5	0	6	N/A

From each site, differences can be seen in how many tools were used on these various contact materials. As shown in Table 7.3, the most common use-wear traces across all sites were from the contact material: "Plant." The Eagle Cave sample use-wear analysis confirmed three tools had use-wear traces consistent with plant as the contact material, two tools used for animal butchering/hide processing, two tools used to process wood, and five tools used on an undetermined contact material. The Skiles Shelter sample use-wear analysis showed six tools had been used on plant as the contact material, five tools used for animal butchering/hide processing, one tool used on bone, and five tools used on wood. True to its evergreen rosette name, the Little Sotol sample had the highest number of identified plant-processing tools from the four targeted sites. There are eight tools showing evidence of plant as the contact material, one used on wood, and six tools were used on an undetermined contact material.

Undetermined contact materials on tools from Eagle Cave and Little Sotol could be affected due to preservation, archaeological cleaning protocols, and sampling strategies. These tools may have been used just once and discarded. Little Sotol is an open-air terrace site with an approximately 2-meter deep BRM (Pagano 2019), and as I had expected, many of the older and more deeply buried tools were covered in patina and carbonate encrustations which hindered use-wear analysis in certain areas of the tool which could have had wear traces.

The initial excavators and/or analysts working on these archaeological sites had attempted to identify plant-processing tools in the field and lab by noting the presence of polish and/or plant fibers adhering to the tool's edges. Bryan Heisinger and Ashley Knapp expounded upon this initial identification by analyzing Skiles Shelter and Little Sotol tools, respectively, for their theses (Heisinger 2019; Knapp 2015). This directly affected my research design, as I was largely basing my sample selection off their results and observations recorded in the specimen inventory during cataloging/curation of these artifacts. In some ways, our works complemented each other's in helpful and validating ways; however, there were some instances where our findings directly challenged and/or negated others'.

There were some tools that were documented during initial analysis as having polish that I did not observe under the microscope, as detailed in Chapter 6. For example, seven Eagle Cave tools (Specimens 30904.7, 30904.8, 34758.3, 30835.15, 33411.16, 32054.6, 33770.2) had macroscopic polish visible and noted in the specimen inventory, however my analysis showed no use-wear traces microscopically. Skiles Shelter specimens 20107.5, 20003.1, 20056.8 were documented as having plant fiber and polish, but my analysis shows the first two tools were more likely used to process hide rather than plants, and 20056.8 had no use-wear traces observed at all. During initial analysis, "animal product or plant residue" was noted on the platform of Skiles Shelter specimen 20121.4, however this was not observed during my analysis. Skiles Shelter specimen 20029.9 had epidermis/fiber noted adhering to the edge during initial analysis, but I saw no evidence of this.

Little Sotol specimen 12.2, as described in Chapter 6, was confirmed by Knapp and me as being morphologically consistent with an agave knife, but as not being used. Little Sotol specimen 93.6 had macroscopic polish noted in the specimen inventory, but no visible microscopic wear traces.

Contrastingly, many tools that were identified as plant-processing tools during initial were confirmed as such by my analysis. For example, as described in Chapter 6, Skiles Shelter specimens 20020.2 and 20031.4 had epidermis/fiber fragments observed on the edge during initial analysis and also during this study had bright, well developed microscopic use-wear traces indicative of plant-processing. Little Sotol specimens 67.5, 64.2, 57.5, 4.4, 4.2, 2.7, 8.4, 2.5 were identified plant-processing tools during initial analysis; this was confirmed by my use-wear analysis study. The agave knife from Sayles Adobe (specimen 50158.1) was also confirmed to be a well-used plant-processing tool by both the excavators and by my microscopic use-wear analysis.

I attempted to correlate tool type with tool function across all sites, by conducting a chi-square statistical analysis. My research hypothesis states there was a correlation of specific tool types being used preferentially on certain contact materials (e.g., agave knives were used more to process plants than modified flakes). My null hypothesis states there was no correlation between tool type and contact material it was used on. The results of this statistical analysis showed that the null hypothesis was true, and the research hypothesis was rejected; in other words, there was no significant correlation between tool type and contact material across all targeted sites (X^2=0.13 p=0.99). I also ran the test within each site individually but there was also no correlation (Eagle Cave: X^2=0.18 p=0.68; Skiles Shelter: X^2=0.05 p=0.99; Little Sotol: X^2=0.74 p=0.39). This lack of correlation is likely due to the insufficient sample sizes for statistical analysis. The number of tools would likely have to be in the hundreds to gain stronger statistical insight.

The Chipped Stone Tool Plant-Processing Toolkit

The chipped stone toolkit that was used for processing evergreen rosettes included at least flake tools, unifaces, and agave knives according to my use-wear analysis

(Figures 7.1-7.10). I only focus on the chipped stone tools, though as described in the ethnographic literature review in Chapter 3, the plant-processing toolkit would also include artifacts such as hammerstones, ground stone tools including bedrock features, and drying trays made from evergreen rosette stalks and fibers. The chipped stone plant-processing toolkit from the LPC included a variety of tool types. From Eagle Cave, two modified flake tools (Figures 7.1 and 7.2) were confirmed as extensively utilized plant-processing tools; three unifaces from Skiles Shelter (Figures 7.3-7.5); four flake tools from Little Sotol (Figures 7.6-7.9); and the pristine example of an agave knife from Sayles Adobe (Figure 7.10). The photomicrographs showing this extensive plant use-wear is detailed in Chapter 6.

While excavating at a site or doing chipped stone tool analysis, archaeologists should be on the lookout for these tool types with visible, glossy polish along the worked edges. Short of doing a use-wear analysis, excavators and analysts should document and identify the level/intensity of polish and specify the location of the polish/ possible use-wear on the tool within the specimen inventory.

Figure 7.1 Plant-processing toolkit: Eagle Cave Specimen 31084.3 modified flake tool.

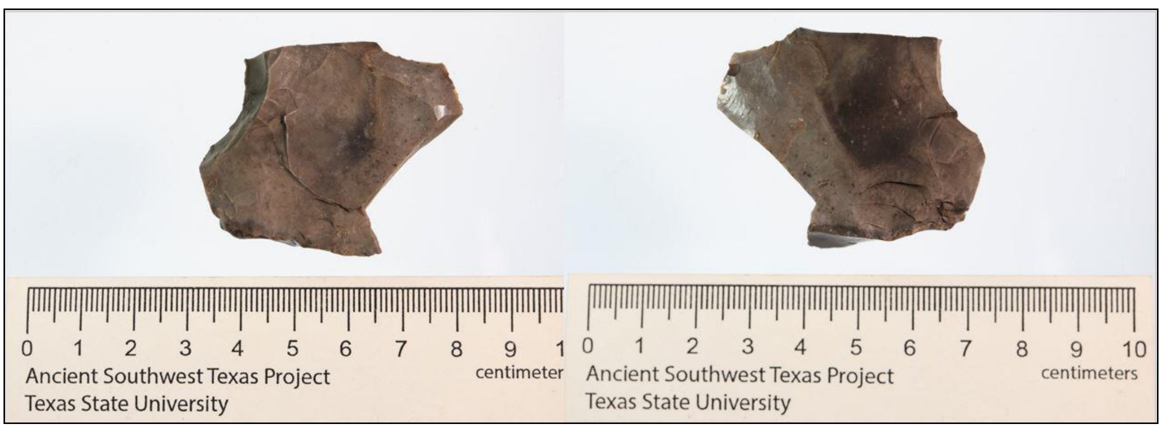

Figure 7.2 Plant-processing toolkit: Eagle Cave Specimen 34173.2 modified flake tool.

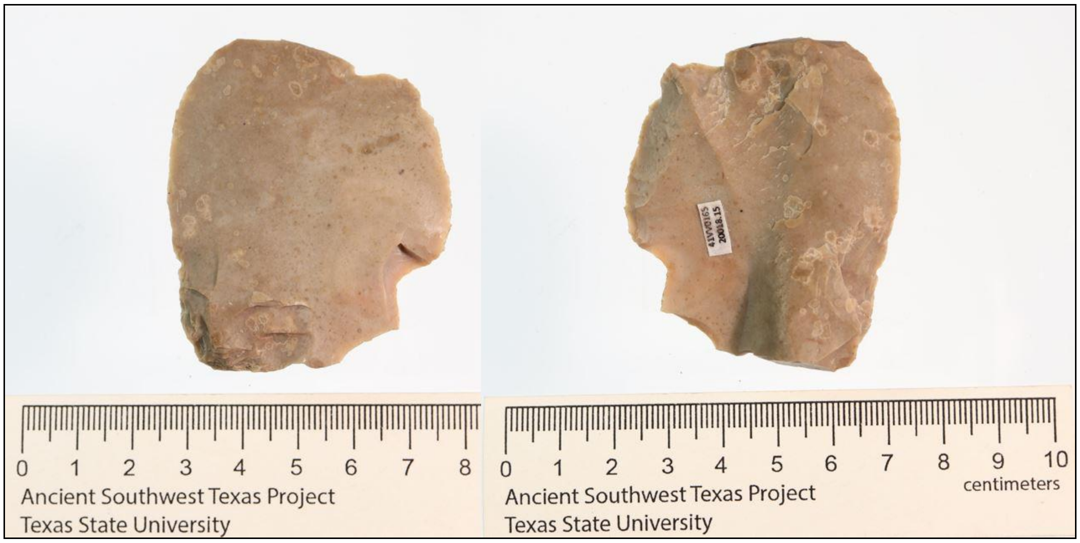

Figure 7.3 Plant-processing toolkit: Skiles Shelter Specimen 20018.15 uniface.

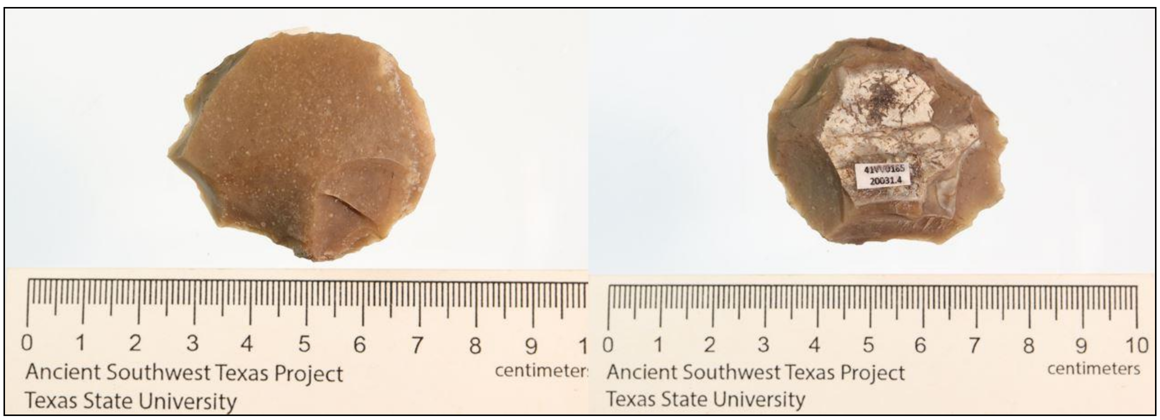

Figure 7.4 Plant-processing toolkit: Skiles Shelter Specimen 20031.4 unifacial scraper.

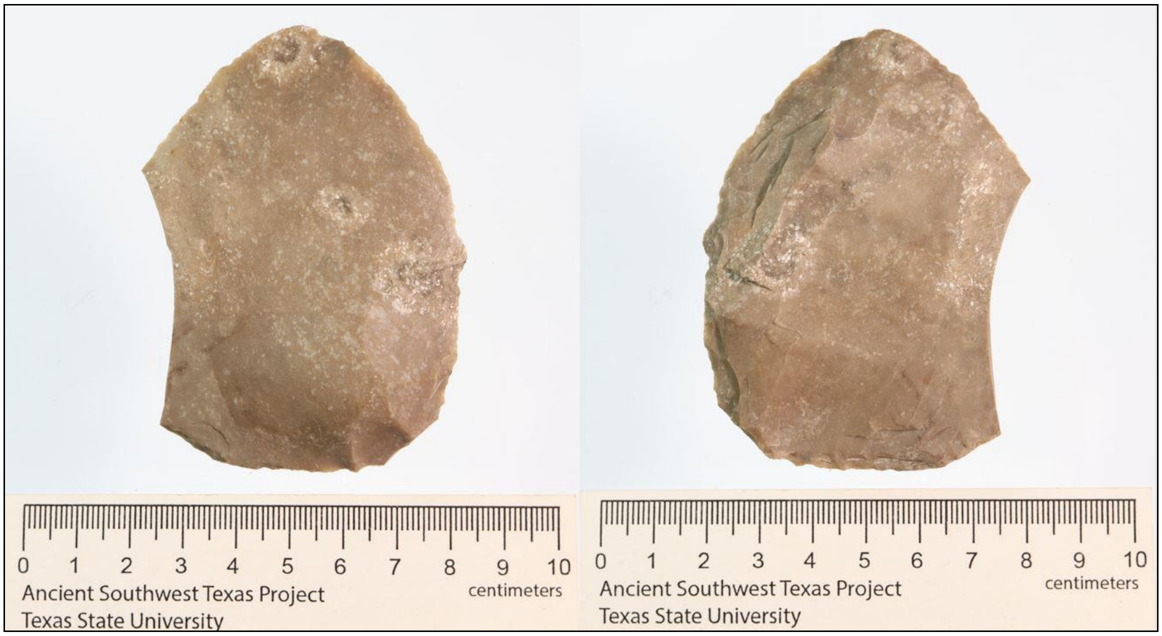

Figure 7.5 Plant-processing toolkit: Skiles Shelter Specimen 20073.1 uniface.

Figure 7.6 Plant-processing toolkit: Little Sotol Specimen 2.5 modified tertiary flake tool.

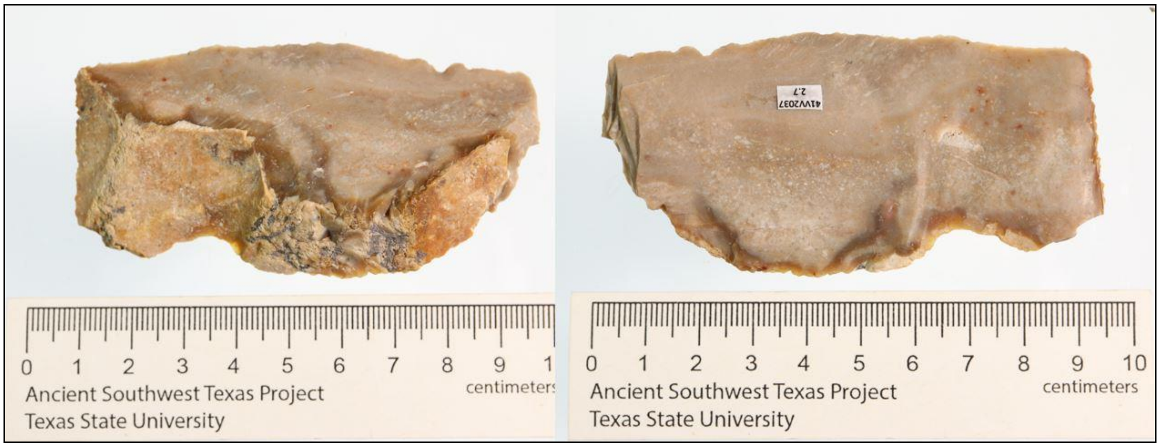

Figure 7.7 Plant-processing toolkit: Little Sotol Specimen 2.7 secondary flake tool.

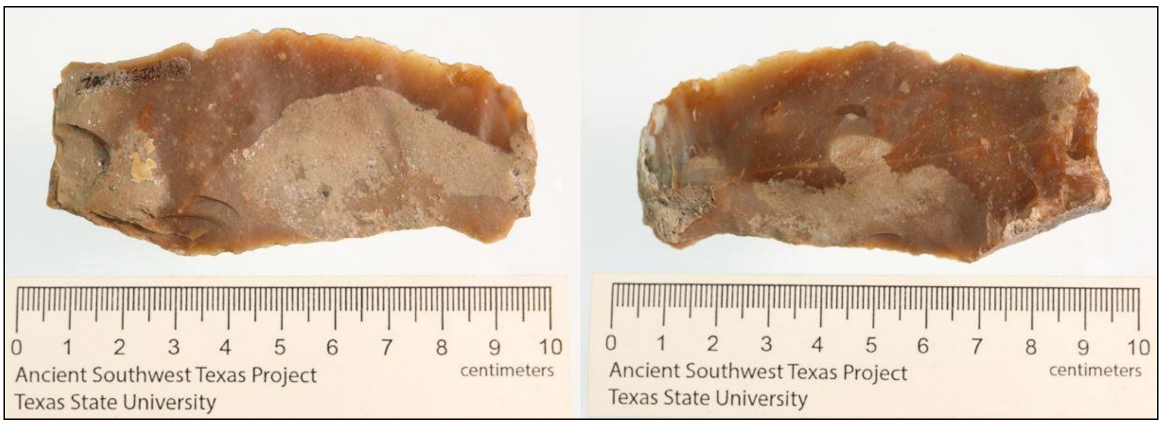

Figure 7.8 Plant-processing toolkit: Little Sotol Specimen 4.2 secondary flake tool.

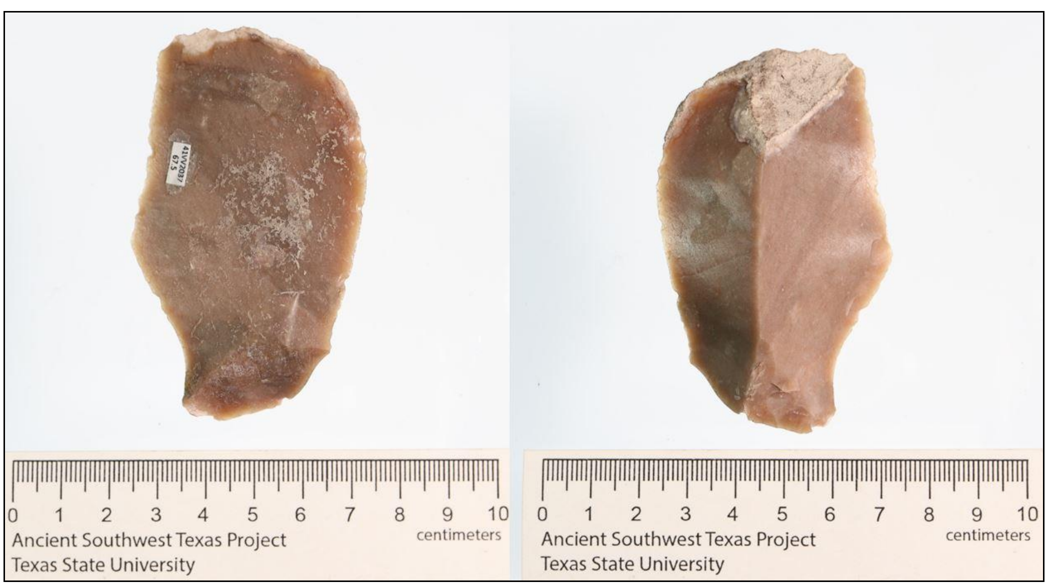

Figure 7.9 Plant-processing toolkit: Little Sotol Specimen 67.5 secondary flake tool.

Figure 7.10 Plant-processing toolkit: Sayles Adobe Specimen 50158.1 agave knife.

Summary

This thesis documents the use-wear analysis of chipped stone tools from the LPC: Eagle Cave (41VV167), Skiles Shelter (41VV165), Little Sotol (41VV2037), and Sayles Adobe (41VV2239). In Chapter 1, I introduced the study area, evergreen rosette plants and lithic use-wear research, and described my research objectives and thesis organization. I discussed the natural environment and cultural chronology of the LPC in Chapter 2, in addition to the previous archaeological investigations of the targeted sites.

Chapter 3 presented ethnographic accounts of tools, food, and fiber production associated with evergreen rosette processing and baking from the Southwestern United States and Northern Mexico. This provided context and evidence that evergreen rosettes were an important resource well into historical times. From these accounts, we gain insight into the prehistoric use of these plants and what tool types are comparable from prehistoric to historic times. Chapter 4 served to discuss archaeological evidence of evergreen rosette processing from the four targeted sites and additional sites within the LPC. This provided context for the samples chosen for this study and showed the vast array of organic plant materials present at these sites that people were processing. The methodology for the experimental and use-wear analysis in this study is detailed in Chapter 5, which includes the descriptive statistics of the experimental and archaeological assemblage and the length of time/contact material processed experimentally. Chapter 6 presented the results of the use-wear analysis to support the hypothesis of intensive plant-processing in the LPC.

Challenges of Use-Wear Analysis

Every research design has limitations that create challenges; I have learned a lot over the course of this study. It was a difficult challenge to learn how to use the Leica microscope and get high-quality, well-focused, photomicrographs at the precise angle necessary to observe use-wear evidence. Part of my research design, as described in Chapter 5, was to select a variety of tool types in the archaeological assemblages and create experimental tools that reflected these tool types. Only later did I realize that there was a limited space between the microscope stage and the lenses, which prevented microscopic analysis of certain tools (with a large size or steep edge angle). There were not many tools that this limitation affected (Table 7.1), however I may have refrained from selecting these tools if that was a known factor at the time. My sampling strategy was based mainly on what was included in the specimen inventories of the sites and what previous analysts had stated. When I was looking for certain specimens, I looked at other tools but should have been more thorough. While this sampling strategy was largely useful and effective, I should have also gone through the entirety of the chipped stone tool collections myself to see if there were any potential plant-processing tools that they missed.

Use-wear analysis and interpretations itself has been a big learning curve; identifying and detailing such minute, subtle differences of wear patterns requires a keen eye indeed. In hindsight, I would have selected a smaller sample size or perhaps focused on one site and then done high-power microscopic analysis on a much larger sample of chipped stone artifacts. The higher magnifications showed a much greater level of detail than seen under lower magnifications. I also would have selected more formal tool types to balance the number of flake tools in the archaeological assemblage. During the experimental portion, I would have used a smaller number of tools and used them for longer in order to develop more use-wear evidence.

Conclusion and Future Research

This study shows concrete use-wear evidence of intensive plant processing in the LPC, supporting other lines of evidence in the region such as coprolites, macrobotanical remains, and perishable material culture. The results of this analysis show that many flake tools have extensive polish from being used to process evergreen rosettes for fiber and food. The use-wear evidence from flake tools is comparable to that found on formal, curated tools such as the Sayles Adobe agave knife. This suggests that a wide variety of tool types were used for the processing of these essential plants, and that some tools were used multiple times while others were only used for a short time. The variety of chipped stone tool types and sizes that had evidence of plant use-wear likely reflects the diverse processing methods and uses of evergreen rosettes for food and fiber. Further use-wear analysis research will be required to gain a more complete understanding of how prehistoric people used evergreen rosettes at other sites within the LPC.

This study was designed to investigate a small sample from several sites to draw informed conclusions to then apply to the assemblages as a whole. In order to gain a better understanding of plant-processing activities within the LPC, use-wear analysis research should be done on much larger samples. Organic residue analysis would complement use-wear analysis studies and provide more precise evidence of contact materials. The targeted site assemblages have many unwashed, specimens that would be ideal for this type of research that are curated at the Center for Archaeological Studies at Texas State University.

Intensive experimental work would be essential for future researchers conducting use-wear analysis in the LPC. Working with experimental basket makers/weavers, for example, could provide useful insight into how tools were used to craft evergreen rosette leaves and fibers into containers and other fiber artifacts (e.g., cordage, sandals, mats, drying racks). Such future studies are essential to improve our understanding of how Native peoples transformed these desert plants into sustenance, material cultural, and ritual life.

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