Form and Function: A Case Study Using Pedernales Points From The Gault Site (41BL323) In Central Texas

Submitted by

Kristine Fischer

To the University of Exeter as a thesis for the degree of

MS by Research in Archeology

In January 2015

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other university.

Signature: ………………………………….

Table of contents

Acknowledgements

I would like to thank my advisors: Dr. Hurcombe for her advice and encouragement. I appreciate the time taken to provide use-wear related guidance when all I could do was send a grainy photo or provide a vague description. Dr. Bradley, for the support, and taking the time to make experimental replicas for my study.

I am very appreciative of the Gault School of Archeological Research at Texas State University for allowing me access to their Pedernales collection and use of the laboratory. The whole Gault family for being there for me whenever I needed help. Especially Nancy Littlefield who offered huge amounts of encouragement every step of the way. Dr. Micheal Collins and Dr. D. Clark Wernecke, who were very supportive and took the time to answer all my questions. I would also like to thank Jennifer Anderson, for taking the time out of her own studies, to not only teach me how to use the microscope, but provide enthusiastic support and encouragement throughout my research. Also, to Dr. Robert Lassen and Dr. Andy Speer for making additional experimental points for this study.

I would like to thank Dr. Britt Bousman at Texas State University for allowing access to the microscope and Marilyn Shoberg, Researcher at University of Texas for taking the time to respond to all of my emails whenever I needed random use-wear advice.

Finally, I would like to thank my friends, coworkers, and family for putting up with me during this process. Thank you for all the kind words of encouragement and support. I am especially grateful to my husband for believing in me more than I believed in myself at times.

List of Figures

Figures

List of Tables

Tables

Abstract

The relationship between form and function is a complicated issue that needs to be demonstrated rather than assumed. This research investigates the function of artifacts known as “Pedernales points” in order to evaluate their assumed use as projectile points. This research is based on a sample of 34 Pedernales points of the Late Archaic, from area 15, of the Gault Site in Central Texas to determine if they were used solely as projectile points, knives or both. A series of experiments were carried out utilizing use-wear analysis to create a reference database of known use-wear traces to recognize distinct traces of wear, focusing on polish and striations, using high power microscopy. The results of these experiments were then compared to 34 prehistoric specimens to identify patterns of wear, therefore determining if these highly morphologically variable points were used solely as projectiles or served multiple functions. Although post depositional surface modification (PDSM) was a large factor affecting this sample, it became clear that these tools were multifunctional implements used in a variety of tasks on different of materials.

Chapter One: Introduction

1.0 *Research Objectives*

Pedernales points are one of the most common projectile points in the Central Texas Region, yet not much is known about their use-life. They date to the Late Archaic spanning from approximately 3,200 to 2,500 B.P. (Collins 1995:113, Collins 2011:19). Although they are most common in Central Texas, they can also be found as far as South Texas and the Lower Pecos (Turner *et al.* 2011:148). Noticeable variations in body style and size have some scholars suggesting possible regional or temporal differences within the type. This could lead to the question of a functional variation within types. This thesis focuses on a collection of Pedernales projectile points from Area 15 of the Gault site (41BL323), in Central Texas. The objective is to determine through macroscopic and microscopic analysis if these points were used solely as projectile points or recycled and utilized for other purposes such as knives.

Stone artifacts are very often the most common finds on prehistoric sites, therefore, providing a major source of information about past human lifeways. Given their form, certain functional types have been confidently identified (Cahen *et al.* 1979:661). Projectile points are bifacially made tools, probably attached to the end of a spear, used to hunt; choppers are large and heavy with blunt edges, and scrapers have a curved edge outline and a relatively high edge angle. When these tools are found it is argued that they represent the activities that have taken place at a particular site. Although these generalized categories may reflect true functions, these assumptions bear testing and further discussion.

A key question asked by lithic specialists in determining the function of prehistoric stone tools is the correlation between form and function. There is much written about the concept of “type”. One thought emphasizes that certain “types” of things were intended to be made as such and were just exposed by archeologist (Spaulding 1953:305). Another is that types are categories, more or less invented by archeologists for their own analytical purposes (Ford *et al.* 1954:43). The discussion surrounding types and functions have also been the subject of higher level discussions of behavior and typological variation has been used to infer functional differences and thus different explanations for behaviors emerge (Binford & Binford 1966:245). After much discussion it is becoming increasingly clear that function cannot be assumed.

The debate as to whether prehistoric projectile points were also used as knives has been a long one, not so much what the actual function was, but what the assumed function implies about past human behavior because the narrative changes depending on use. For example, as projectile points, they represent hunting equipment, and are assumed to be associated with adult males, and this argument suggests they define seasonal hunting camps and can be used to outline the extent of prehistoric territories. In contrast, as knife blades, they become general purpose tools used by both sexes and not necessarily diagnostic of any one kind of prehistoric occupation (Neumann 1988:367). Identification of the functions of stone tool types has always been problematic. The lack of understanding between form and function is a point that needs attention before too many more archeologists blindly interpret their morphological types in a functional manner, leading to archeological misinterpretations.

Several experimental studies have shown that North American projectile points have, indeed, been used for multiple functions. Stanley Ahler (1971:81-87) conducted a series of experiments focused on cutting and projectile point usage. He tested use as a cutting implement on a variety of materials including wood, deer hide, flesh, and animal bone. Also, five projectiles were used as tips for throwing spears to test for damage characterizing this usage. After comparative analysis of this experimental data Ahler was able to show that less than 25 percent of 114 projectile points from Rogers Shelter, Missouri showed evidence of use as projectile points. Many showed use-action oriented longitudinally to the cutting edge including cutting, slicing, and sawing but also represented was whittling, scraping, graving, and piercing (Ahler 1971:81-87, Odell 1981:324).

Another relevant study is Sally Thompson Grieser's analysis of wear and breakage patterns on a sample of Plano projectile points from the Jurgens site in Colorado. Greiser (1977:113) looked at edge rounding, edge faceting, edge crushing, step flaking, impact fractures, edge serration, and utilization retouch to determine that 96% of the blades of sufficient size for analysis displayed evidence of use as knives. She goes on to suggest that after being utilized as projectile points, half of these tools were then intentionally serrated and used as butchering tools. She proposes that these tools were "manufactured as multi-functional implements" (Grieser 1977:114). This analysis also suggests a sequential set of accompanying modifications.

More recently, in another experimental study, Lafeyette and Smith (2012) used eighteen replicated Great Basin Stemmed projectile points as projectiles or cutting implements. Use wear patterns were then compared to 59 prehistoric specimens to try and determine their morphological variability. Use-wear attributes analyzed included surface and edge dulling, flake termination patterns on the tips, striations, breakage patterns, and crushing. It was determined that the Parmen and Haskett points were primarily used as knives, the Cougar mountain points were used primarily as projectiles then re-utilized as knives, and the Windhurst points were used equally as knives and projectiles (Lafayette & Smith 2012:151-155).

Ahler's study showed very little evidence of use as projectile points, Grieser (1977) concluded that the Plano projectile points were mostly multi-functional and Lafayette and Smith (2012) determined that the function of the Great Basin stemmed projectile points varied depending upon type. Pedernales points are one such type that fit the form of projectile points but it has been argued that they may have been used for multiple purposes as is further discussed in the next chapter.

Prehistoric stone tools often provide abundant evidence of their usage through damage accrued during their use-life, often in the form of a complex sequence of damage traces (Odell 1981:197). Macroscopic analysis are combined with high-power microscopy therefore providing more detail on both function and sequence of the use-life of stone tools. This can be done by analyzing damage patterns macroscopically as well as microscopically examining the working edges of the tool for both flake scars, striations, and polishes, then comparing results to replicas that have been experimentally used (Tringham 1974:196, Keeley 1980:176). The studies above were mostly focused on macroscopic wear traces but still demonstrated firstly, that "projectile points" were not necessarily used as such and for some at least the sequence of wear traces suggested the sequences of function. The methodology uses experimental tools to provide a reference for interpreting archeological tools' macroscopic and microscopic wear traces (Ahler 1971:81-87, Odell 1981:324, Lafeyette & Smith 2012:151-155).

The above discussion indicates a better understanding of the function of Pedernales points would be achieved by a study of use-wear traces. In order to address the question regarding the use-life of Pedernales points an experimental study was conducted utilizing use-wear analysis to create a reference database of known use-wear traces to help recognize distinct types of wear patterns. Then, a selected sample of Pedernales points from Area 15 of the Gault site in Central Texas was collected for study. Although the Gault Site is primarily known for its Clovis occupation during the Paleo-Indian Period, it is an important multicomponent site that has been occupied throughout the entire prehistory. A functional analysis beginning with a macroscopic study of this sample was then conducted by examining the morphological attributes and breakage patterns, followed by a microscopic analysis. The results of the experimental specimens were then compared to the prehistoric specimens.

Chapter Two: Archeological Context

2.0 *Introduction*

The focus of this chapter is to give an introduction of the Gault site and a background into the previous research of Pedernales points. This chapter starts with an explanation of the chronology of Central Texas prehistory from the Paleo-Indian through the Late Prehistoric. A more detailed explanation of the Late Archaic follows. Then, a brief description of the Gault Site, including the history and natural setting both on a large and small scale. Finally, a description of the background and previous research of Pedernales points is presented.

2.1 *Chronology of Central Texas Prehistory*

Although Pedernales points are extremely common in other areas of Texas (Turner & Hester, 1999:171), this study focuses only on Pedernales points from the Gault site in Central Texas. This chapter presents a general description of the archeological region as well as the cultural chronology. Pedernales points are characteristic of the Late Archaic, a more detailed description of the Late Archaic will be presented later in this chapter.

Throughout the years, the boundaries of the Central Texas archeological region (Prewitt, 1981:72 and Collins, 2004:102) and the associated chronology (Johnson & Goode 1994:5, Prewitt 1981:2 Weir, 1976:2, and Collins 2004:113) have been defined by various archeologists. This study has used both the boundaries and associated chronology outlined by Collins (2004:102, 113), as this more recent set of definitions has been widely accepted by researchers in this field. The Central Texas archeological area covers roughly 12 percent of the state with common sites being open campsites, rockshelters, and lithic quarry and workshops (Collins, 2004:103). Three main periods; Paleo-Indian, Archaic, and Late Prehistoric are used by Collins (2004:115) to define Central Texas prehistory and are inferred to be separated by significant shifts in adaption.

The Paleo-Indian period spans from 11500 to 8800 years B.P. and is proposed to be divided into Early and Late subperiods. During the early part of the Paleo-Indian period, fluted, lancelote projectile points, defined as Clovis and Folsom, were used to hunt big game such as mammoth, bison and horse but smaller prey such as water turtle, land tortoise, alligator, mice and badger were also being consumed (Collins 1995:381). Some archeologists see the Later Paleo-Indian period as a transitional period into the Archaic (Collins 1995:382) as corner notched dart points associated with burials, artifacts, and faunal remains became more Archaic-like in appearance.

The Archaic period spans 8800 to 1200 B.P. and is divided into Early, Middle, and Late Archaic. The material culture became increasingly diverse during this time and the hunting and gathering of local flora and faunal resources was intensified compared to that of Paleo-Indian times (Collins 1995:383). The use of heated rocks as cooking elements, ground stone technology, and changes in projectile point styles defined the transformations throughout the long archaic period.

The Early Archaic period lasted from 8800 to 6000 B.P. Specialized tools used for woodworking were noted in the Early Archaic as well as grinding and hammering stones, and a variety of unifacial and bifacial chipped stone tools. Dart points common during the Early Archaic were Angostura, Gower, Uvalde, and Martindale

(Collins, 1995:383). As the mega fauna of the Paleo-Indian period became extinct smaller game such as deer, turtles, and fish were being exploited as well as the cooking of bulbs in large earth ovens. The climate during this time turned from mesic to more xeric conditions (Collins 2004:120) and bison became increasingly uncommon.

The Middle Archaic spans from 6000 to 4000 B.P. An increase in site size and number represents an increase in population during this time (Weir 1976:124). As the conditions in Central Texas became significantly drier, use of earth ovens increased, taking advantage of the xerophytes such as sotol that were thriving. (Johnson & Goode 1994:26). In the earlier part of the Middle Archaic, during a short period of cooler and wetter conditions, thin, deeply notched projectile points known as Bell-Andice-Calf Creek were used as specialized weapons to hunt bison that had, for a short time, returned. As the climate returned to xeric conditions, bison began to again disappear from the record and projectile point technology shifted to more thick, narrow, broad bladed projectile points (Johnson & Goode, 1994:27, & Collins, 1995:384).

The Late Archaic, spanning from approximately 4000 to 1200 B.P. was also a time of increased populations (Johnson & Goode, 1994:36), and increasing interaction among groups, sometimes leading to conflict (Collins 2004:122; Johnson & Goode 1994:36). The use of burned rock middens were at their height in the beginning of the Late Archaic but slowed as climatic conditions became more mesic (Collins, 1995:384). Based on a dataset from Hall's Cave and Bering Sinkhole, there seems to have been a period of cooler temperatures close to 2500 B.P. that lasted 1500 years (Toomey 1993:299). Among distinctive traits of the Late Archaic in Central

Texas are the diverse dart point styles, corner tanged knives, and cylindrical stone pipes. Marine shell ornaments occur, along with caches of large bifaces. Dart points common during the Late archaic include Bulverde, Castroville, Ensor, Fairland, Frio, Marshall, Marcos, and Pedernales (Collins, 1995:384).

The Late Prehistoric spans from 1200 to 300 B.P. and is divided at 800 B.P. into the Austin and Toyah intervals. The Austin interval (1200 to 800 B.P.) is characterized by the change from atlatl and dart to bow and arrow (Collins, 1995:385), and the use of small bifacial knives and small corner notched or expanding stem arrow points (Johnson, 2000:104). Scallorn arrow points found in association with bodies in a number of burials suggests the occurrence of warfare and raiding (Johnson, 2000:104). The Toyah interval (800 to 300 B.P.) is mostly characterized by the Perdiz arrow point, large thin bifaces, end scrapers, and prismatic blades.

2.2 *Late Archaic in Central Texas*

The Late Archaic in Central Texas dates from approximately 4000 through 1200 B.P. (Collins 1995:384). It falls between the Middle Archaic and the Late Prehistoric Periods of the generally accepted regional chronology. The Late Archaic has been divided into temporal categories such as phases, subperiods, and intervals depending on researcher, but all are generally based on changes in projectile point style and adaptive shifts in subsistence strategies. Weir (1976:120) divides the Late Archaic into phases starting with Round Rock, San Marcos, and extending into the Twin Sisters Phase. Prewitt (1981:74) also divides the time periods into phases, from earliest to latest being Uvalde, Twin Sisters and

Driftwood Phases. Johnson and Goode (1994:29) divide the Late Archaic at 2300 B.P. into subperiods I and II and Collins (1995:384) divides the Late Archaic into six intervals based on changes in projectile point style.

Site size and distribution during the Late Archaic indicate an expanding Central Texas population (Weir 1967:124, Prewitt 1981:73, Collins 1995:385). Common site types in the Central Texas region at this time consisted of rockshelters along plateau escarpments and at the base of mesa bluffs in western central Texas and more frequently in the limestone bluffs along stream valleys and canyons to the east. Open campsites occurred frequently along major streams and tributaries and quarry sites could most often be found along extensive limestone outcrops (Weir 1976:128, Prewitt 1981:81).

The use of heated rocks in the form of burned rock middens, a continuation from the Middle Archaic, reached its peak during the Late Archaic (Collins 1995:384). Carbohydrate rich plants such as yucca, sotol and other geophytes were being cooked in the winter and spring, and prickly pear in the summer (Black et al.. 1997:305). Acorns were being utilized in the early part of the Late Archaic as populations increased (Black *et al.* 1997:305, Weir 1976:125). Climatic conditions gradually turned from dry and hot during the early part of the Late Archaic to more mesic, and xerophytic vegetation began to disappear from the eastern parts of the Edwards Plateau (Collins 2004:121, Johnson and Goode 1994:29). The use of burned rock middens was in turn declining (Black *et al.* 1997:304).

Bison made an appearance on the Edwards Plateau during this brief period of mesic conditions somewhere between 2800 and 2500 (Weir 1976:133) then reappeared again at the end of the Late Archaic as the wetter and cooler climate encouraged the growth of broad grasslands (Collins 2004:121, Collins 1995:384). When bison where not present, deer, turkey, antelope, and rabbit were likely the main sources of protein (Black *et al.* 1997:303).

Perhaps due to the population increase during the Late Archaic, interaction between groups increases possibly leading to conflict (Collins 2004:122, Johnson & Goode 1994:36). Evidence of trade is seen in the occurrence of marine shell artifacts and other artifacts fashioned from exotic materials (Prewitt 1981:81). Diverse dart point styles, corner tanged knives, and marine shell ornaments are distinctive material traits of the Late Archaic (Collins 2004:122, Prewitt, 1981:81, Weir 1976:136)

2.3 *History of the Gault Site*

First recognized in 1929, the Gault site (Fig. 1) has been well known by looters, collectors, and archeologist for about 80 years (Wernecke 2012:1). The Gault site has a long history of archeological investigations as well as uncontrolled artifact digging. Dr. James E Pearce of the University of Texas was the first to excavate at the site in 1929, when the property was still owned by Henry Gault. His excavations focused mostly on the Archaic and Late Prehistoric occupations but earlier Paleo-Indian artifacts were also discovered. Uncontrolled digging, including a pay to dig operation, continued for the next sixty years, focusing mostly on the rich cultural deposits of the upper levels and leaving the deeper Clovis age material intact.

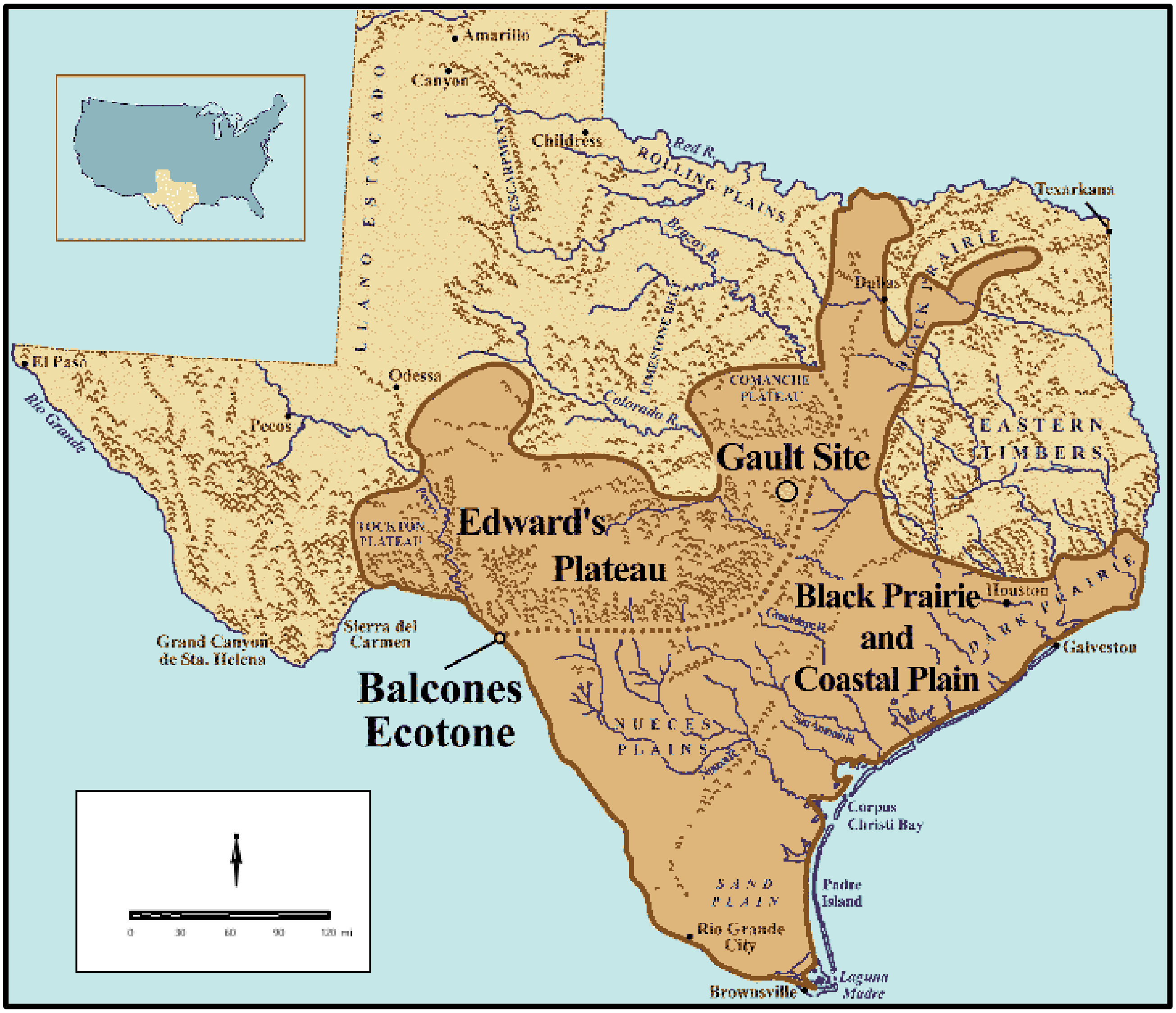


Figure 1. Location of the Gault Site in Central Texas. (Collins 2002)

These excavations revealed an area at least 700 meters long by 200 meters wide, by three meters deep of dense archeological material (Wernecke 2012:1). Dr. Michael Collins and Dr. Tom Hester revisited the site in 1991, when they directed excavations to assess the Clovis-age occupation at Gault. From 1998 through 2002 staff and students from the Texas Archeological Research Laboratory (TARL), as well as a number of other prominent researchers and groups from all over the world, conducted numerous excavations at Gault. They revealed a mammoth mandible as well as bison and horse bones. In 2007, the site was acquired by the Gault School of Archaeological Research (GSAR) and donated to the Archaeological Conservancy in order to ensure its protection. New excavations soon began focusing on the earliest occupations at Gault (Wernecke 2012:1). The results of these excavations reveal that people have been taking advantage of the abundant natural resources at Gault spanning the entire local prehistory

2.4 *Large Scale Ecotone*

On a large scale setting, the Gault site sits on the boundary of two distinct ecotones with the Edwards Plateau to the west and the Blackland Prairie to the east (Texas Parks and Wildlife Department, 2011). The Balcones Escarpment separates these two distinct ecoregions (Fig. 2) and can be easily differentiated by the distinct change in flora, fauna, soils, geology, and hydrology. These modern boundaries are likely to be relevant as past ecotones, even if the environment was different.

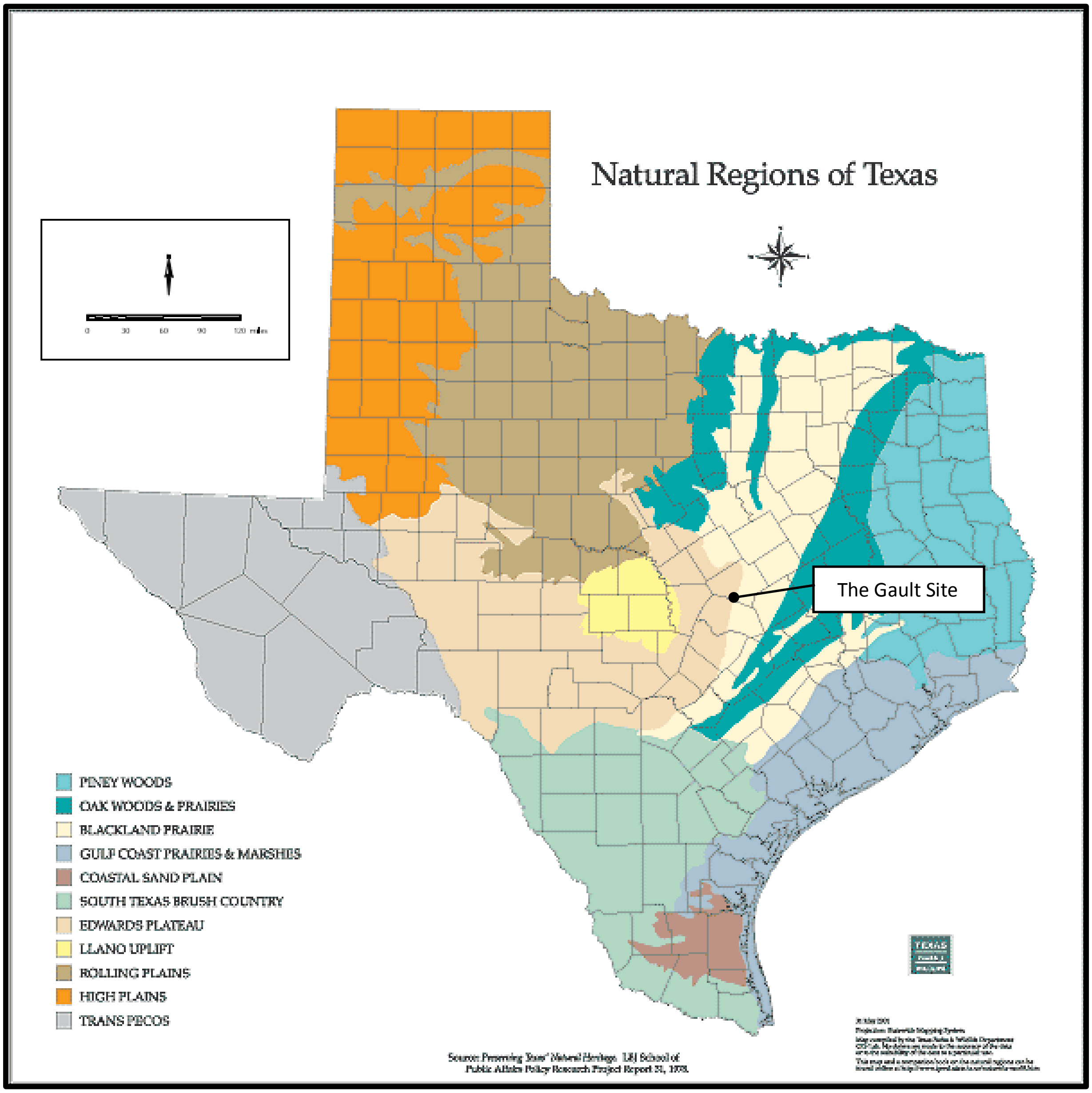


Figure 2. The natural regions of Texas. (LBJ School of Public Affairs 1978)

The Edwards Plateau is known for its shallow soils, stony hills, and steep canyons. Several rivers dissect the landscape and the eastern edge is the outlet for a significant water source in the form of a series of underground lakes called the Edwards Aquifer (Texas Parks and wildlife Department 2013). Live Oak-Mesquite-Ashe Juniper Parks mixed with the Oak-Mesquite-Juniper Parks/Woods characterize the vegetation of the Edwards Plateau. With less than ten percent wooded canopy, the Blackland Prairie is known for its deep, fertile black soils that supported a tall grass prairie full of Little Bluestem, Indiangrass, and Switchgrass for much of the last 15,000 years (McMahan *et al.* 1984:3-7, Black 2002:3). Today much of the original prairie has been put under the plow, utilized for cattle ranching or developed into urban areas (Texas Parks and Wildlife Department 2013:3).

2.5 *Small Scale Ecotone*

Locally, the Gault site is set in a small wooded valley near the head of Buttermilk Creek, a spring fed stream that has not been known to have gone dry in historic times (Black 2002:4). The top of the valley is set with rocky limestone hills, thin soils, and low bluffs. Prickly pear, juniper, live oak, and mesquite dominate the landscape. A 45 foot descent into the valley reveals a distinct vegetation change as the soils become deeper, and wetter, supporting hardwoods such as walnuts, pecans, ash, and elm. Occurring along the valley slopes, in the uplands, and as stream rolled cobbles, massive amounts of extremely high quality chert litter the area of the site (Black 2002:4, Wernecke 2012:1). A reliable water source, an inexhaustible amount of high quality chert and the diverse resources located in the area have made the Gault site a prime location throughout much of prehistory (Wernecke 2012:1).

2.6 *Lithic Issues at Gault*

The major archeological components of the Gault site consist of the Late Prehistoric Period, the Archaic Period, and the Paleo-Indian Period. Also present are petroglyphs found on the valley walls that may document a time that was shared by Europeans and Native Americans (Fig. 3). Every major time period has yielded diagnostic artifacts (Figures 4-10). The Late Prehistoric Period is represented by a variety of arrow points indicating habitation by various groups. Also present was a few pottery sherds.

Because collectors have looted much of the Gault Site for a large portion of the last 80 years, most of the Archaic levels were assumed to be disturbed. A large portion of these deposits were removed prior to excavation, yet despite this it was discovered that some had remained intact. What intact deposits that were left revealed that at one time the Archaic levels were at least 12 or 15 hectares and from 0.1 to 2.5 meters in thickness. Diagnostic artifacts from these levels indicate use of the site throughout the entire 8,000 years of the Archaic. Tools indicative of hunting, woodworking, plant-food processing, and production/maintenance of various kinds were found. Despite the fact that looters destroyed much of the Archaic deposits, an intact midden dating to the Early Archaic was discovered in Area 15.

A thin layer of very Early Archaic artifacts show that the underlying Paleo-Indian layers were still intact. Two style intervals for this period include Folsom and the earlier, Clovis. The Folsom component is sparse at Gault containing debris from the manufacture of stone tools and exhausted or broken tools that are no longer useful (Collins 2002:1-4).

Figure 3. A petroglyph carved into a limestone bluff at the Gault Site. (Lassen & Collins 2014)

Figure 4. Late Prehistoric artifacts from the Gault Site: Scallorn points (A, B), Ceramics (C), Perdiz point (D), Prismatic blade (E). (Lassen & Collins 2014)

Figure 5. Late Archaic points from the Gault Site: Darl (a), Ensor (b), Castroville (c), Montell (d), and Pedernales (e). (Lassen & Collins 2014)

Figure 6. Middle Archaic points from the Gault Site: Andice (a), Bell (b), Taylor (c), and Nolan (d). (Lassen & Collins)

Figure 7. Early Archaic points and tools from the Gault Site: Angostura (a), Hoxie (b), Gower (c), Clear Fork adze (d), and Uvalde point (e). (Lassen & Collins 2014)

Folsom tool kits consist of butchering/meat processing tools and scrapers for working hide that represent a specialized, nomadic lifeway of bison hunting (Collins 2002:1-4). The Clovis component is abundantly represented at Gault, consisting of several hundred thousand pieces of lithic debris from tool manufacture, and a diverse array of tools including choppers, adzes, bifacial knives, scrapers, gravers on blades, and serrated blades. Clovis points are also abundant in various forms including points that were never finished, used and broken, and resharpened (Collins 1996:4). A seemingly never ending supply of high quality chert, dependable springs, and diverse flora and faunal resources has led to continual occupation at Gault, throughout prehistory.

Figure 8. Late Paleoindian points from the Gault Site: St. Mary’s Hall (a), Dalton point (b), Dalton drill (c), Wilson (d), and Scottsbluff (e). (Lassen & Collins 2014)

Figure 9. Folsom Period artifacts from the Gault Site: (a), Midland point (b), Ultrathin biface (c), Folsom preform (d), end scraper (e), and graver (f). (Lassen & Collins 2014)

Figure 10. Clovis points from the Gault Site. (Lassen & Collins 2014)

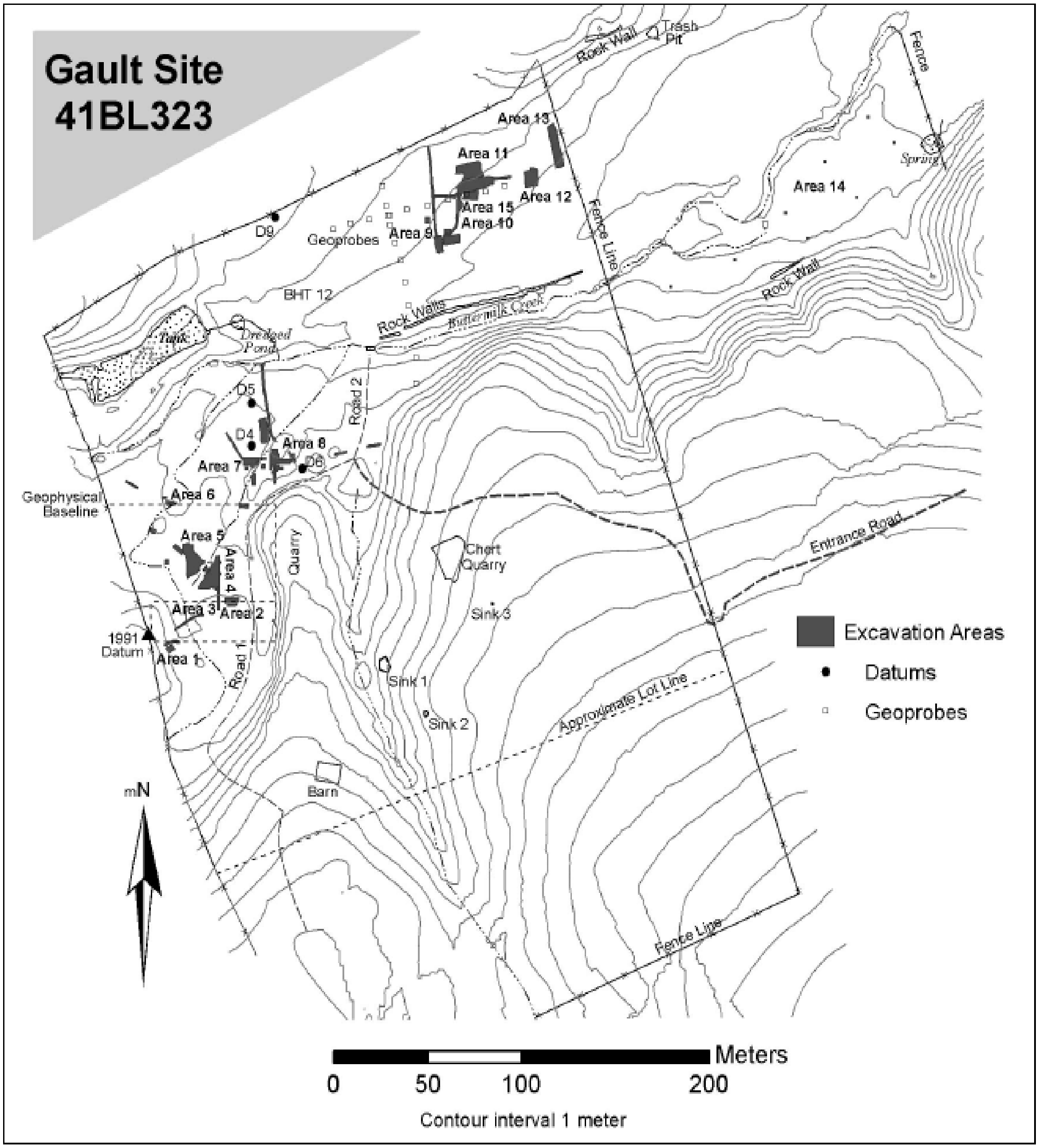


Figure 11. Map of Area 15 Excavation. Area 15 is located in the NW section of the site. (Gault School of Archeological Research)

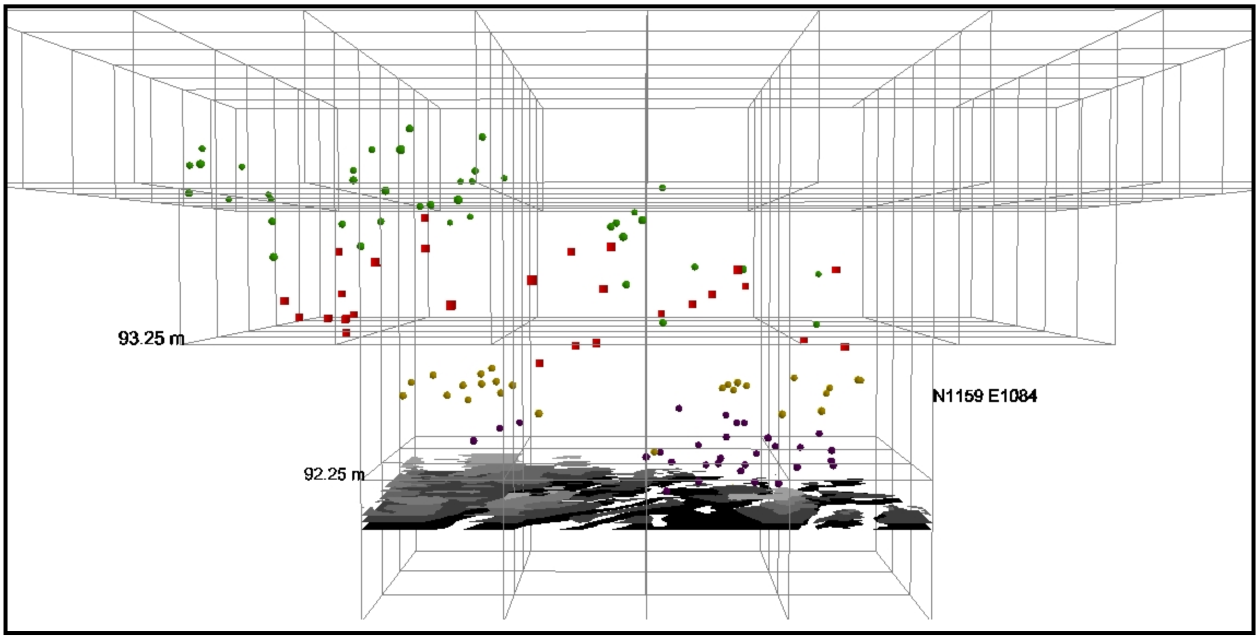


Figure 12. Location of the where the Archaic assemblage lies within Area 15 of the Gault Site. Green = Archaic, Red = Late Paleo, Yellow = Clovis, Purple = Older Than Clovis. (Nash 2014).

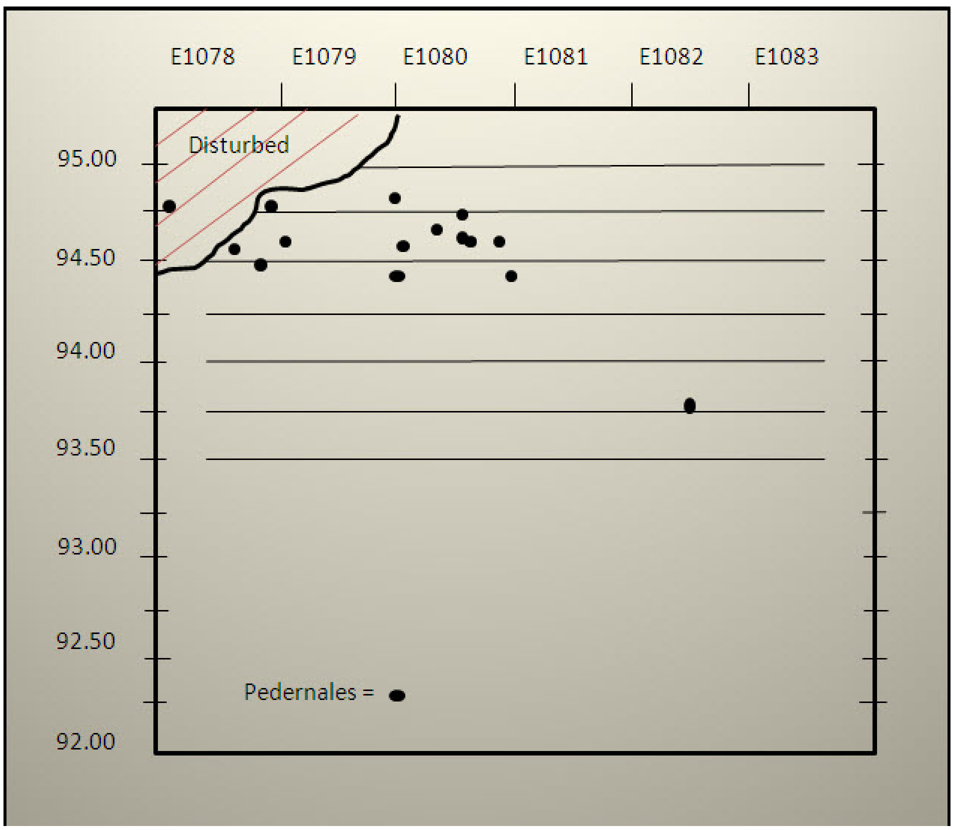


Figure 13. Approximate Location of Pedernales points excavated from area 15 of the Gault Site. (Fischer 2014)

2.7 Pedernales Points: Background and Previous Research

Pedernales points are one of the most common projectile points found in the Central Texas region. Although the size and shape of these points vary considerably, the most identifiable traits include a thick rectangular stem, deeply indented or bifurcated base, and characteristic flute like flake on one or both sides of the stem (Black *et al.* 1998:163, Turner *et al.* 2011:148). Because of the significant variation in Pedernales points some scholars have tried to define regional or temporal differences within the types. Some variations in style within point types may suggest the possibility of a functional variation within the typological variation.

In excavations of a burned rock midden at the John Ischy Site in Williamson County, Texas, Sorrow (1969:17) described five morphological categories of Pedernales points based on the possibility of distributional differences. Johnson (1994:190) described the Pedernales points from the eastern half of the Edwards Plateau as long, narrow and fairly thick; whereas the Pedernales points typical of the southwestern section of the Edwards Plateau and the Gulf Coastal Plain were described as resembling Marshall and Montell points (i.e. flat, thin, and wide), likely occurring later than the points of the eastern half of the plateau. Johnson notes that many of the Pedernales points from the Jonas Terrace site were made from large, reasonably thin flakes. He also identified evidence of edge wear and damage, indicating, at least four of these points had been used as knives (Johnson 1995:200-201).

A study of the manufacture and use-life history from the Bull Pen site in Bastrop County was carried out in an attempt to recognize regional technological traditions and to evaluate variations in artifact form. Six stages of Pedernales point manufacture were identified (Ensor *et al.* 1988:169-171). This six-step reduction model was carried out on local Colorado River gravels as it was assumed that these natural river cobbles would have been preferred over the use of large flakes. The characteristic Pedernales stem was formed in the fourth stage by removing long thinning flakes, and shaping the stem edges and neck before the final blade thinning. The process of finishing the stem early in production of Pedernales points has been noted by many researchers. Thinning the blade was more time and energy intensive, so thinning the stem first prevents wasted effort in the case of stem thinning failure (Ensor *et al.* 1988:169-170, Johnson 1994: 201). The final step identifies the resharpening that often occurs on Pedernales points that results in straightened or sometimes incurvate or thick alternately beveled blade edges, although there is no reported evidence of the recycling of Pedernales points at the Bull Pen site.

During these manufacturing processes, modifications to the chert's surface can be mistaken for those caused by use-related wear. These traces can be caused during platform preparation or as a result of a hammerstone knocking off a flake (Keeley 1980:4). Additional forms of manufacturing wear are the result of contact with antler or bone billets during edge preparation or the rubbing of a protective garment on the tool, such as a leather sheath worn by the knapper for protection. Some of these types of traces can be harder to separate from utilization traces than natural traces as they tend to be non-randomly distributed (Keeley 1980:4). However, it is important that these be clearly separated from those caused by use.

A 2003 investigation of a Late Archaic site in Milam County produced eighteen Pedernales points, none of which were varieties found at other sites, raising the possibility of a regional variant. In response, a study was undertaken comparing Pedernales assemblages from ten sites to gauge variation in stem form and blade form (Figures 14 & 15) to quantify Pedernales varieties by site and region (Tomka et al. 2003:134). Six stem forms were defined using stem edge morphology, basal corner morphology, and relative degree of basal concavity. Special attention was paid to the presence of fluting. Stem form one is defined as having a straight stem, indented base, and sharp stem corners. Stem form two has a barrel shaped stem, convex stem edges, rounded stem corners, and an indented base. Stem form three has a slightly expanding stem, straight stem edges, sharp stem corners, and a weakly indented base. Stem form four has straight stem edges, rounded stem corners, and a moderate to deeply indented base. Stem form five has a contracting stem with straight stem edges, sharp or rounded stem corners, and a weakly to moderately indented base. Finally, stem form six has a contracting stem with convex stem edges and a moderately indented base (Tomka *et al.* 2003:134).

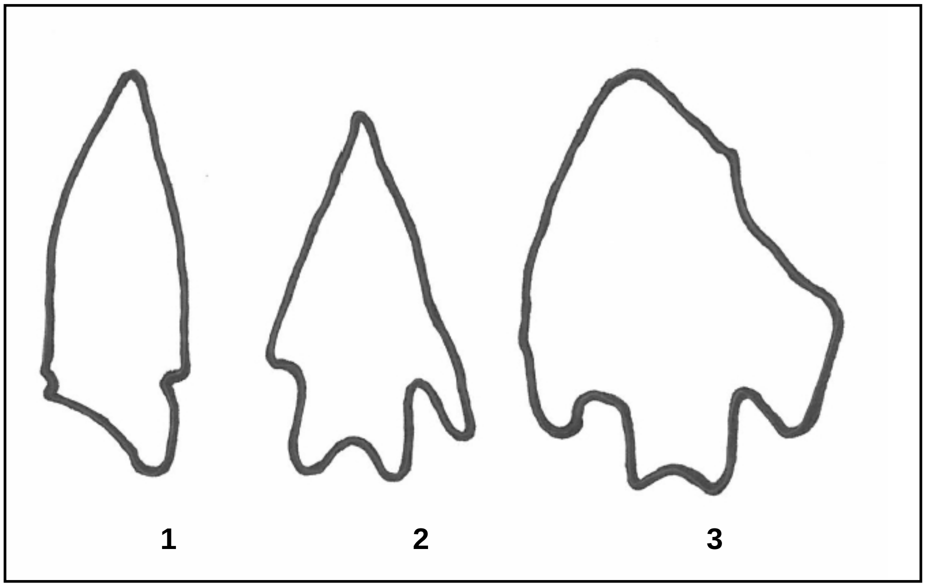


Figure 14. Pedernales Blade Forms. (Redrawn from Tomka *et al.* 2003).

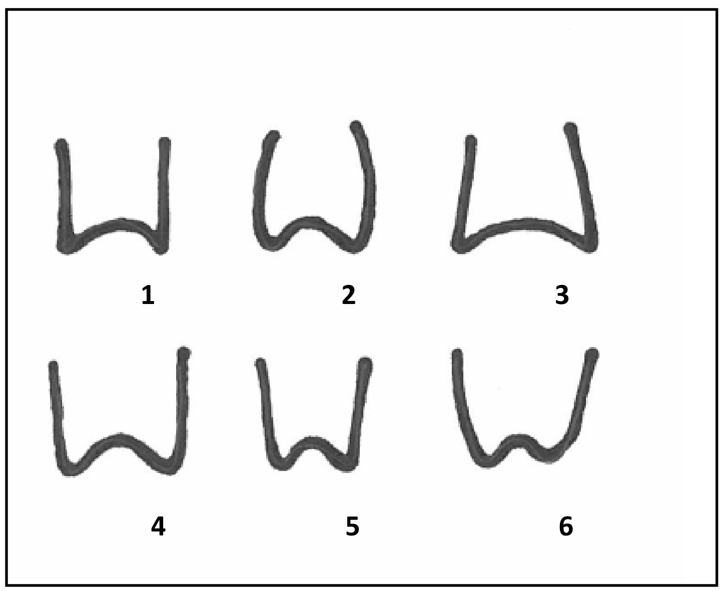


Figure 15. Pedernales Stem Forms. (Redrawn from Tomka *et al.* 2003)

Three blade forms were also defined in this study (Tomka *et al.* 2003:136). Blade form one featured narrow, but relatively thick blades and subtle weak shoulders. Blade form two featured very broad blades with downward pointing barbs and well thinned bodies. These were likely made on broad secondary or tertiary flakes. Blade form three is characterized by well-thinned body cross-sections, and moderate to strong shoulders that may possess short downward pointing barbs or may be shouldered (Tomka *et al.* 2003:136).

These results indicated significant differences in stem forms at the regional level. Stem forms one and five were most common in Central and East Central Texas, and stem forms two, three, and four were more common in the Southern Edwards Plateau. No significant differences were noted in blade form in the regional comparisons (Tomka *et al.* 2003:142).

A study performed on projectile points from the Anthon Site in the South Texas Plains revealed that although Kinney points seemed mostly to have been used as knives, the Pedernales points were primarily used as projectile points (Goode 2002:235). Pedernales points from the Anthon site were subdivided into five varieties because of "techo-morphological" variations that exist between sites, locales, or within a given assemblage (Goode 2002:51). These varieties were differentiated based on variances in blade, shoulder, and stem morphology. Again, special attention was paid to the presence or absence of a large thinning flake at the base, a common characteristic of Pedernales points (Goode 2002:51). Based on blade morphology and microscopy up to 75X Goode (2003:226) concluded that most of the Pedernales specimens were used as dart points, but others had multi-functional purposes, such as knives or perforators, and very few were used only as knives. Goode's (2002:226) microscopic analysis revealed very little polish and no striations, so he relied on the tools' morphologies to dictate their sole use as knives. One specimen he examined exhibited extremely thin edges and a rounded distal section, which Goode described as an "efficient skinning tool." Goode (2003:226) also described a tool's prominent alternate bevel and a needle like tip as hallmark characteristics for indicating usage as a knife. The Kinney biface mostly exhibited evidence that they were likely used as knives such as asymmetrical blades, recurved tips, and prominent bevels that he concludes are also diagnostic of cutting tools. However, a collection of six Pedernales points found in Kincaid Rockshelter in Uvalde County, Texas tells a different story. Changes in the shape of these points as the lateral edges were continually sharpened and resharpened led some archeologists to believe that these points were recycled for use as knives when they were no longer useful as projectile points (Texas Beyond History 2004).

Collins (1994:90) suggests that Pedernales points have two functions that can be differentiated, that of a projectile point and of a knife. When used as a projectile point, the blade becomes increasingly shorter until very little is left atop the barbs and often retains evidence of impact fracture scars. When being used as a knife the blade becomes narrower with use but shortens very little. Fracture patterns are lacking.

2.8 *Conclusion*

Sitting on two distinct ecotones, the inhabitants of the Gault site were able exploit two diverse landscapes that supplied differing types of flora and fauna throughout the entire North American prehistory. This site has provided a wealth of information about its past inhabitants from the Clovis to Late Prehistoric occupation. Although the site has seen many years of destruction, focusing mostly on the archaic deposits, some are still intact and have produced a small sample of *in situ* Pedernales dart points. Previous research into Pedernales points has indicated a varied use-life, and morphological changes based on temporal and distributional differences. Functional variation within a site such as the Gault site, that straddles two such distinct ecotones, could provide opportunity for multiple uses of a single tool. After such sequential uses, resharpening or morphological adjustments are likely to occur. A use-wear study of the Pedernales points from the Gault Site can help shed light on the complex use-history of the Pedernales points and likely add to the existing knowledge.

Chapter Three: The methodologies of functional analysis

3.0 *Introduction*

This chapter presents a brief history of the development of use-wear analysis as well as an explanation of the two most adopted approaches; low-power and high-power magnification. Since the focus of this thesis is to determine if Pedernales points were primarily used as knives or projectile points, a detailed description of patterns of impact damage as well as wear related to use as a knife is also presented.

3.1 *History of use-wear analysis*

In a matter of decades the manner of identifying stone tool usage has evolved from a purely speculative functional approach of stone tool classification to the study of direct evidence involving experimental programs and high/low power microscopy. Although people have been interested in the function of stone tools since they were recognized as such, and much work has been done in this regard, this section provides only a brief overview of the history of microscopic use-wear analysis.

In the 1930's the first microscopic research on stone implements was started using a maximum magnification of 45X (Semenov 1964:3). Curwen's 1920's work on the formation of polish was a significant breakthrough using low power microscopy to examine the edges of tested tools (Tringham *et al.* 1974:175). But it was not until 1964, when Sergei Semenov's *Prehistoric Technology* was published in English, that the type of use-wear study we see today became common. Semenov's study introduced systematic experimentation on stone tool use, using a binocular microscope with magnifications up to 180X as his primary tool to discern wear traces on stone tools, although when necessary he utilized a monocular microscope with capabilities up to and exceeding 500X. Semenov focused on the location of polish, but more significantly the formation of striations to understand the "kinematics", Semenov's term for the dynamic of the action with which the tool was used. He noted that striations were the most important factor in determining the unknown functions of ancient stone tools (Semenov 1964:14, Tringham *et al.* 1974:175).

Following Semenov's work came an important paper by Ruth Tringham with the help of some of her students. Only instead of focusing on polish and striations as Semenov did, her experiments focused on testing the formation of edge damage by looking at microflaking to identify exact function. Using low power microscopy, she systematically tested variables including action, worked material, angle of the edge, and grip. Results indicated that the motion in which the tool was used and the hardness of the material did cause certain patterns of microflaking (Tringham *et al.* 1974:171-196).

Although Semenov's and Tringham's works proved to be major breakthroughs for use-wear analysis, they were not without their problems. Scholars realized that Semenov's technique involved deficiencies in technique and lacked methodological strategy. Tringham's work was criticized for being too mechanical and not replicating true human activity (Keeley 1980:1-7). In response to the need for more communication between researchers and in order to establish a more standardized theoretical framework, the first Conference on Lithic Use-Wear was held. Hayden's (1979) *Lithic Use-Wear Analysis* presents a collection of papers that were published from this conference. These papers included chapters on fracture mechanics, striation, and polish formation (Hayden and Kamminga 1979:6-8). By the mid-1970's two distinct approaches to use-wear analysis occurred. Both based on differing microscopic resolutions, they were called the "low-power" and "high-power" methods.

3.2 *High Power Method*

Keeley's (1980) publication of *Experimental Determination of Stone Tool Uses* was a continuation of Semenov's approach of systematic methods and experimental program. Keeley's work between 1972 and 1977 focused on assessing the functionality of a collection of British Lower Paleolithic implements. He used a binocular incident-light microscope to capture micro photos at up to 400X. Stressing the importance of controlled experimental study, Keeley used English chalk flint to work a variety of materials including wood, bone, meat and hide. According to Keeley (1980:176), his most important discovery was "that the micro polishes formed by various worked materials have distinctive appearances, and, are indeed, distinguishable from one another." Keeley claimed that these polishes allowed him to interpret exactly which materials were being worked, giving him a better understanding about ancient economics. During these "blind tests" Keeley was assisted by Mark Newcomer of the University of London (Keeley & Newcomer 1977:29-62, Keeley 1980:ix). Sixteen artifacts were manufactured and used by Newcomer. Without knowledge of how they were used, Keeley was able to correctly identified 14 (88%) regarding used area, 12 (75%) regarding activity or use-motion, and 10 (65%) regarding contact material (Keeley 1980:174). Later studies supported these results indicating that one can differentiate the appearance of polishes resulting from specific contact material (Hurcombe 1992:60, Anderson 1980:190).

Despite Keeley's and others' success, there have been questions as to whether the appearance of polish can be linked to a specific contact material and how polish forms. Irene Levi-Sala conducted extensive research investigating the formation of microscopic polishes on flint tools after they had been used on various materials. This research also included the effects of natural polish on polish produced by use and the processes involved in polish formation. According to Levi Sala (1996:3) four key theories have evolved about the formation of polish. These four key theories are expressed below, in Levi-Sala's words, then followed by a more detailed discussion.

1) Use-wear polish as an additive, deposited by plant silica on the flint surface (Witthoft 1967).
2) Polish is subtractive, a result of high attrition removing a microscopic part of the flint surface (Diamond 1979, Masson 1981)
3) Polish is a layer built up due to increased temperature, caused by friction, resulting in the formation of amorphous silica trapping plant phytoliths and cells (Anderson-Gerfaud 1981). But see below for a better expression of these ideas.
4) Polish is a result of the combination of the above processes (Del Bene 1979, Kamminga 1979, Meeks *et al.* 1982, Unger Hamilton 1984).

Witthoft (1967:384) argues that polish forms as intense friction generates heat which melts the surface of the tool and molecules from the polishing agent bond into the molten surface of the silica blade building up a thick layer of used silica. In an experimental study to differentiate the causes and properties of different microwear polishes, Anderson (1980:181-190) also agreed that polish is an additive process and the polish on experimental sickles appears "built up" on the surface of the artifacts. She states that the flint surface changes to an amorphous gel layer imprisoning plant residues during the working of plant materials. Variables such as grain structure, duration of tool use, use material, and hardness and regularity of structure are contributing factors to the heat and friction being produced thus contributing to the amount of dissolution of the tool edge during use. Water content also plays a role, contributing to the stronger appearance of polish if material worked is in a fresh or wet state. Anderson (1980:184) suggests that under the right conditions of pH and temperature, combined with the concentration of 115 parts per million of silica to water, silica will form an amorphous gel. This gel traps phytoliths and other elements of the plants cells, contributing to the surface build-up of non-organic materials, causing displacement of the silica gel across the working surface of the tool.

Diamond (1979:165) disagrees that it is an additive process, arguing that the flakes seem to wear down instead of building up. He states that polish formation results from a loss of material from the surface in the form of very fine abrasive scratches, as he calls them "surface fatigue pit," resulting from a combination of mild abrasive wear, fatigue breakage wear, and surface fatigue wear processes. Fatigue breakage results as repeated contact of the edge of a tool with a solid material (Diamond 1979:165).

Another argument for the subtractive process comes from Levi-Sala (1996:3-4). She argued that there is no evidence for the high temperatures necessary for the creation of a silica gel layer, and that such a layer would be too thin to trap organic particles such as phytoliths. She further argued that materials with high water content do not create a silica gel layer but only enhances the surface of the flint. She instead suggests that polish is caused by the removal of “superficial asperities” being dragged across the flint’s surface flattening it. As the surface becomes increasingly flatter and smoother, it reflects light more uniformly, appearing as polish under the microscope.

Some researchers believe in a combination of these processes (Del Bene 1979 170-177, Kamminga 1979: 144-154). One theory is that there are two types of polish, a depositional process produced by a foreign material either temporarily or permanently adhering to the tool surface or that a mechanical polish is formed by the wearing down of the tool surface as it rubs against another material (Del Bene 1979:171). Kamminga (1979:154) argues for a combination of polish formed by a chemical interaction between opal contained in plants, water, the contact surface of the tool and abrasive smoothing caused by foreign substances such as sand or dust adhering to the worked material or part of the tool itself.

Keeley strongly touts the high power approach but admits it should complement rather than replace the low power method. Among the disadvantages of the high-power approach is the expense of equipment and lack of usefulness for large samples due to the large quantities of time analysis takes (Odell *et al.* 1980:88). The high power approach is not always appropriate. For large samples and a short time for analysis, the low-power approach is more useful.

3.3 The Low-Power Method

The low-power approach is generally based on magnifications up to 100X and tool function is determined primarily from the analysis of edge damage in the form of microflake scar characteristics with only slight emphasis on edge rounding and polish (Levi-Sala 1996:2, Odell and Odell-Vereecken 1980:90, Keeley 1980:2, Tringham *et al.* 1974:185) whereas the high-power approach utilizes polish and striations as the most diagnostic elements of wear (Keeley 1980:2, Odell *et al.* 1980:88).

First defined during the first Conference on Lithic Use-Wear, scar characteristics include size, outline, distribution and location. They also consist of two initiation types and four termination types (Fig. 16). The cone or point initiation, which has a concave profile in the area of initiation, and can end in a feather, step, or hinge termination. The bending initiation has a straight or convex profile in the area of initiation and can end in a feather, step, hinge or snap termination (Hayden 1979:133-135).

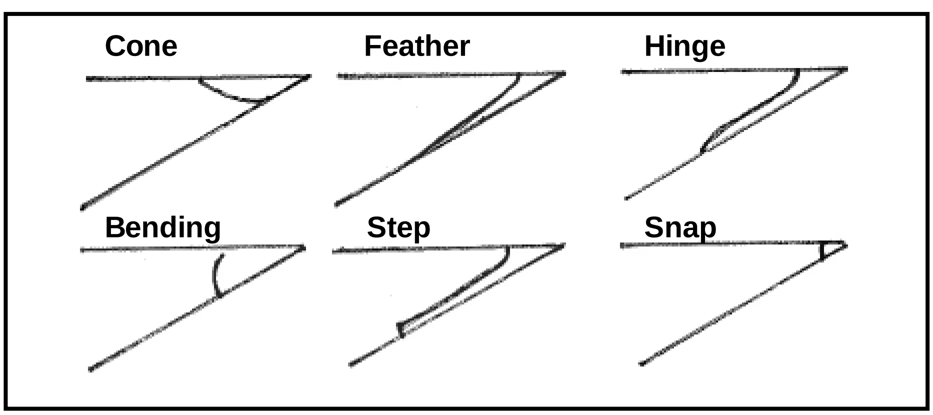


Figure 16. Scar characteristics (Adapted from Hayden 1979)

Keeley classifies scars differently (Fig. 17). He classifies them according to appearance, depth, and size, defining them as large, small, and microscopic deep scalar; large and small shallow scalar; large, small, and microscopic stepped, and half-moon breakages (Keeley 1980:24).

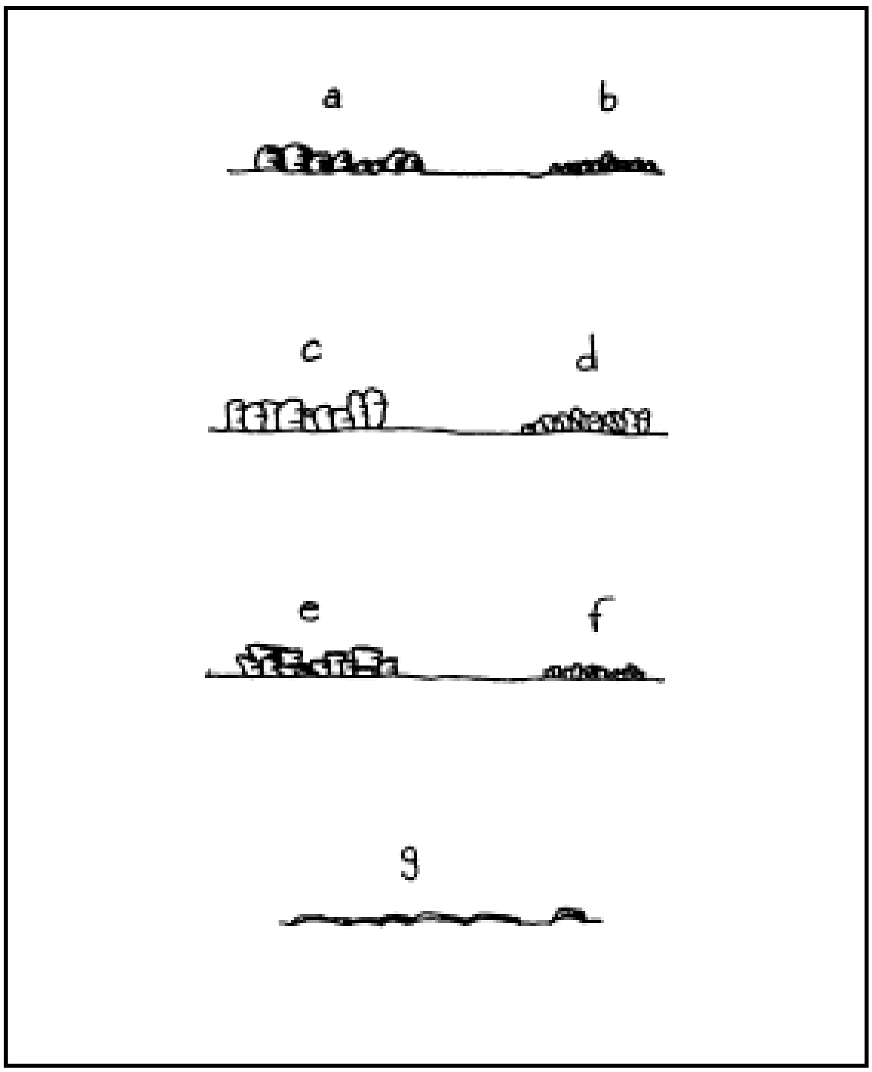


Figure 17. (a) large deep scaler (b) small deep scaler (c) large shallow scaler (d) small shallow scaler (e) large stepped (f) small stepped (g) half moon breakages (Keeley 1980)

Experiments by Charles Keller in the 1960's were concerned with the working edge of artifacts, and factors that influenced the patterns of edge damage (Keller 1966: 501-511, Odell and Vereecken 1980:89). These were followed by a series of experiments led by Ruth Tringham of Harvard University designed to test the formation of edge damage on stone tools manufactured in European chalk flint (Tringham *et al.* 1974:171, Odell and Vereeken 1980:89, Keeley 1980:4). One of Tringham's students, George Odell, later worked continuing her approach.

In response to Keeley's experiments using high-power microscopy, Odell conducted his own "blind Test" utilizing the low-power approach and adhering much to the methods outlined by Keeley (Odell and Odell-Vereecken 1980:90). Forty tools were knapped, by Odell, using fine grained basalt. Some were touched up using a hammerstone and/or antler tine of a deer. They were then given to Odell-Vereecken in a closed box, with no communication involved. Thirty-two tools were selected for analysis. All tools were hand held, as with Newcomer's experiments, although the use of gloves or a leather sheath was allowed. Boards or another type of backing could be used if necessary. Only a select few of the tools were used for multiple purposes and all tasks were to be non-agricultural. All variety of experiments were performed on a variety of materials, all in a reasonable amount of time to complete a task. After utilization each tool was cleaned in soap and water to remove any adhering residues, placed in a plastic bag, and returned to the box in which they came. After being given back to be analyzed they received an additional cleaning in diluted HC1, NH4OH, and water.

Upon completion of analysis, Odell scored a 79% in identifying used area, 69.4% in activity or use-motion, and 38.7% in contact material. Odell reports the difficulty in identifying exact worked material employing the low-power method as do others (Keeley 1980:9, Levi-Sala 1996:2, Odell and Odell-Vereecken 1980:116). However, Odell finds it sufficient to separate worked material into categories based on their hardness, doing this his score in identifying contact material jumped from 38.7% to 61.3%. Odell (1980:116) defines these categories as "soft", "soft medium", "hard medium", and "hard". Soft materials included animal products and soft vegetal substances. They frequently result in the production of polish, and scarring is generally observable in the form of feather terminations and striations, which are often very faint. Soft medium materials include soft woods which generally produced poorly defined, large feather-terminating scars. Hard medium materials were associated with hard woods, soaked antler, and fresh bone. These materials generally produced both striations and polish; and scarring from these materials was generally medium to large in size and typically hinged. Hard materials included bone, antler, and dry hard wood. Scarring was typical from hard materials usually ending in step terminations and was medium to large in size. Polish and striations were usually present, but due to heavy scarring were typically removed, concurrently with use. Edge rounding typically occurred if the artifact was used for moderately long periods of time (Odell and Odell Vereecken 1980:101).

Odell (1980:116) stated that the low-power method worked well for identifying the used portion of an artifact, as well as its use-motion. He categorized use-motion as motions longitudinal to the working edge and transverse to the working edge. Longitudinal motions included cutting, sawing, slicing and carving. Cutting and sawing generally produce scarring on both surfaces of the tool, alternating from side to side. If striations are present, they occur near and parallel to the edge. Slicing and carving usually produce greater scarring on one surface, and striations, if visible are generally unifacial and slanting diagonally to the edge. Transverse motions include scraping, planing, and whittling. With these motions, the scarring is almost always unifacial and if striations occur, they occur perpendicular to the edge, on the surface opposite the scarring.

The low-power approach has many advantages including availability of equipment, the low cost, and ease and speed of analysis (Odell and Vereecken 1980:89). Keeley (1980:25-26) suggests disadvantages of the low-power approach include the impossibility to distinguish between damage caused by intentional retouch, manufacture damage to edges produced during original removal of the piece, and natural movement of soil sediment and use-wear.

3.4 *Recent Trends in Micro-wear Studies*

Microscopic analysis has led to a better understanding of prehistoric tool use and can provide better insight into the daily activities at a given site. Methods used will differ depending on a variety of factors. Different types of flint, in different parts of the world, can produce different breakage and wear patterns. The high-power method, which focuses on polish distribution and striations, is commonly used in areas such as the United Kingdom where finer grain flint and obsidian are more abundant. Studies on courser grained materials such as quartzite require the low-power method as the analyst may be limited to studying edge-wear and rounding. This has been the case in the United States where both fine and coarse grained materials are common. In arid Australia use-wear residue studies has become increasingly common in discussions of artifact and site use. A study of residues and use-wear on 49 ground implements was undertaken starting at 50 X to 100 X to identify areas of abrasion then surfaces were examined at 800 X for residues. Residues recorded include hair, blood, plant fiber, starch, and ochre (Hiscock et al. 2000:101). Depending on the research situation, raw tool material, and research goals, different levels of analysis may be required.

3.5 *Patterns of Impact damage from Projectile Point Usage*

Through experimentation and archeological evidence, there have been a variety of fracture and breakage patterns associated with tools used as a projectile point. However, there seems to be a lack of standardization regarding terminology and recognition of these fracture types (Dockall 1997:321).

Dockall (1997:322) defines two types of wear associated with projectile point damage: abrasive wear and fatigue wear. Abrasive wear types include linear polishes, striations, surface or edge rounding, and dulling. Fatigue wear types include longitudinal macrofracture, lateral macrofracture, crushing or multiple step fractures, and spin-off fractures (Fig. 18).

Linear polishes resulting from abrasive wear are usually parallel to the long axis of the point and can begin on the edge or occur on the surface. They are formed when small flakes detach from the distal end of the point and abrade the surface leaving a linear polished formation (Dockall 1997:322). Striations associated with impact damage likely occur as a result of the dislocation of tool fragments after microfracturing or crushing. These striations most often occur parallel to the long axis of the point. Striations can most likely be viewed as two parts, the head, viewed as an initial deep depression formed during initial contact of the resistant material and the tail, formed as the velocity of the resistant material increases or decreases. Striations can most likely occur on the surface beneath the termination of larger transverse macrofractures. Surface/edge rounding and dulling, mostly on high ridges, and often with associated polish, is not a common form in identifying impact damage and should not be used in isolation to identify use as a projectile point but has been identified experimentally to be associated with projectile contact with animal bone, soil, and stones (Dockall 1997:322-324). For example, Ahler's (1971:85) experimental study of projectile point damage produced light edge rounding and smoothing with some polish, mostly at the distal end after being thrown numerous times into silty and fine grained top-soil. Rounding and dulling of the surface or edge of a tool often appear as microscopic smoothing of flake scar ridges and other areas of high microtopography.

Fatigue wear results as a force of impact and is more commonly associated with the damage of projectile points. Longitudinal macrofracture occurs when there is a failure of the distal end of the point through either cone or bending-initiation along one surface. These fractures have been described as longitudinally directed flakes (Ahler 1971:86), impact channels or impact flutes. Further, their terminations have been described as feather, hinge, or step. Lateral macrofracture occurs with the removal of a macroscopic flake scar along one of the lateral edges of the point.

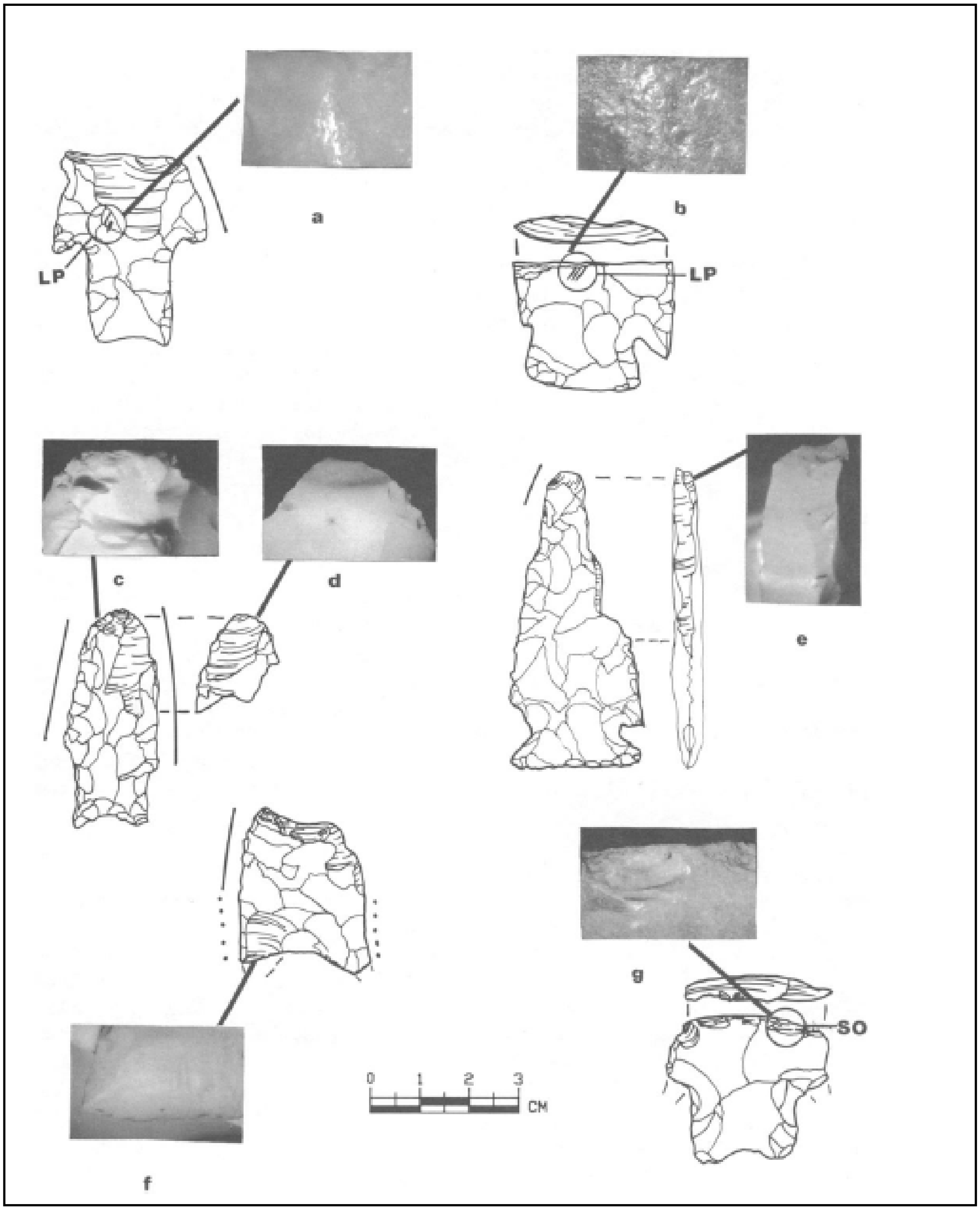


Figure 18. Illustrations and microwear photographs of impact damage and linear polishes discussed in text. (a) linear polishes (LP) adjacent to distal termination of a longitudinal macrofracture. (b) diffuse linear polishes (LP) below a transverse macrofracture (c) distal crushing adjacent to longitudinal macrofracture (d) longitudinal macrofracture (e) lateral macrofracture with a bending initiation (f) basal lateral or longitudinal macrofracture (g) spin-off fractures The outline drawings of a,b, and g exhibit distal transverse snap fractures in addition to other mentioned types of impact damage. (Dockall 1997)

This mostly propagates at the distal edge but can initiate at the base and travel a short distance up the lateral edge. Dockall (1997:326) proposes the term “lateral macrofracture” to distinguish this type of impact damage from a deliberate burin blow. Other terms such as “burin-like fracture”, “burination”, “impact burin” and “burin break” have also been used (Ahler 1979:85, Odell and Cowen:1986:204, Bradley and Frison 1987:216). Distal or transverse fracturing is characterized by a complete removal of the distal end of the point by bending forces acting against the blade in opposite directions (Dockall 1997:326). This can be caused not only during projectile impact but also during manufacture, use, and trampling. Crushing or multiple step-fractures are characterized by a series of step-terminated fractures clustered at the distal end of the point. Often on one surface they can also cascade down both surfaces and are often isolated at the tip due to forces to the distal area of the tool. This damage could also be the result of such tasks as cutting, scraping, drilling, awling, or boring (Dockall 1997:327). Spin-off fractures are identified by a cone initiation from a bending fracture surface that removes flakes from one or both sides of the surface and are associated with transverse and longitudinal impact fractures (Dockall 1997:327).

Dockall (1997:327) describes longitudinal macrofracture, lateral macrofracture, distal crushing, and spin-off fractures as important lines of evidence of projectile impact. He indicates distal or transverse breakage could be used only along with other lines of evidence to prove use as a projectile point. Also, the presence of edge rounding along with other abrasive wear types associated with impact damage does not indicate secondary usage as a cutting implement but rather the accrual of edge damage over an extended period of projectile point use until failure on impact.

Collins (1994:90) suggests that when used as projectiles, Pedernales point blades become systematically shorter due to continual re-sharpening until not much is left forward of the barbs. These points also, often retain impact fractures.

3.6 *Patterns of Wear Related to Use as a Knife*

Motions indicative of an implement use as a knife are cutting (unidirectional) and sawing (bidirectional). Sawing motions are done with the working edge held parallel to the direction of use. Whittling is defined as shaving off material with the working edge of an implement in a unidirectional manner (Keeley 1980:17-18).

Frequency of polish and striations on a cutting or whittling edge can vary depending upon the material being worked but the wear will most likely accumulate close to the working edge of the artifact. Cutting and sawing, both longitudinal motions to the working edge generally produce scarring on both surfaces of the tool, alternating from side to side. If striations are present they occur near and parallel to the edge. Whittling is a transverse motion with the scarring almost always unifacial and if striations occur, they are perpendicular to the edge, on the surface opposite the scarring (Keeley 1980:36).

After an experimental study using replica Great Basin Stemmed points as projectiles and butchering tools, Lafayette and Smith added feather flake terminations on the distal ends of points as a diagnostic trait of tools used as knives (Lafayette 2012:143).

Collins (1994:90) suggests that when used as cutting implements, Pedernales blades become narrower with very little length lost, and no evidence of impact fractures.

3.7 *Conclusion*

Both the “high-power” method and the “low-power” method have advantages and disadvantages. Disagreement exists between certain scholars as to which method is more accurate and produces more reliable results. Blind tests performed using both methods have produced similar results indicating that these methods should not be viewed as conflicting, but as complementary approaches.

The identification of use-wear on stone tools relies on three basic signatures: edge scarring and rounding, striations, and micropolish. Edge scarring and rounding is the primary focus of the low-power approach and is helpful in determining use and hardness of material being worked, but has been shown to be difficult in identifying traces from intentional use and damage from retouch, re-sharpening and post-depositional processes (PDSM). Also, not all types of wear produce edge scarring (Jenson 1988:54). The high-power approach relies on identifying polish and striations. Striations are important in identifying use-motion but should be used in conjunction with other wear-traces such as polish. Micropolish creates a change in the stones’ surface topography and reflectivity depending on the material being worked and the use-time. This can be a reliable way to distinguish worked material, but polish must develop to a certain stage before it starts to exhibit features related to specific materials or use-actions.

Through macroscopic and microscopic study, specific patterns of wear can be used to identify use-related activities. Longitudinal and lateral macrofractures, distal crushing, spin off fractures, and less commonly striations and linear polishes parallel to the long axis of the point are characteristic of projectile point usage. Short, heavily reworked blades with impact damage are another sign of use as a projectile. Depending upon use motion and use-material, striations and polish are common, either parallel, oblique or perpendicular to the working blade edge in tools used for cutting. Pedernales points exhibiting long, narrow blades that lack impact scars are another characteristic of use as a knife.

The scope of this study is to determine if Pedernales points were used as knives or projectile points or both. In order to understand if these points were used for multiple purposes, I will be performing a macroscopic analysis to determine breakage patterns then perform high-power microscopy, identifying patterns in striations and polish formation. Since polish formation and identification of striations are the focus of the microscopic analysis, I chose to use the high-power approach.

Chapter Four: Experimental Program

4.0 *Introduction*

Experimental programs are important for reconstructing past human behaviors. This experimental program was created to develop known use-wear patterns on replicate Pedernales points, and then compare these to a sample of prehistoric Pedernales points, thus determining the tools' function. This chapter focuses on this experimental program's methodologies. An overall description of the program is presented first, followed by more detailed descriptions of the methodology. Finally, the results of the macroscopic and microscopic analysis are presented, followed by the conclusion of results.

The purpose of this experimental program is to gain a better understanding of the use-life history of Pedernales points. The experimental reference set consists of 14 Pedernales points for which different materials were tested. Based on previous experience using Edwards chert as experimental specimens, by use-wear analyst Marilyn Shoberg, the duration of use for each experimental tool ranged from 30 to 90 minutes. Since wear traces take time to form, and to provide ample time to accrue wear, use-duration for each experiment exceeded advised times. Tools worked on like materials were used at a consistent rate of time in either a cutting, scraping, or whittling motion in order to make comparisons between use-actions. In an attempt to replicate prehistoric conditions, all experiments were performed outdoors with no effort to keep the work area clean of debris. First, a macroscopic analysis was performed documenting use-material, prehension of the tool, use-duration, and use-activity. Next, a visual inspection of the tool was performed noting any debris left on the tool, signs of damage, and/or presence of edge rounding or dulling. Finally, the tools were cleaned and a microscopic analysis was conducted utilizing a Leica DM LA optical microscope equipped with adjustable field and aperture diaphragms, and a polarizing filter and analyzer. This equipment is ideal for high magnification analysis. Each experimental tool was analyzed at magnifications up to 500X focusing on areas with polish and striations. The dorsal side of the tool was arbitrarily chosen and labeled with the specimen identification number. The analysis started on the left dorsal blade, scanning in transects from the bottom of the base to the tip and back. Each specimen was initially scanned at 200X, if wear was located then an additional scan at 500X was conducted and micro-photos were taken and wear documented. All micro-photos were done at 500 X. At times, due to the size of the experimental specimen and the short working distance of the 200 X lens, initial scans had to be performed at 500 X. Once the experimental set was established for reference it was compared to the selected archeological sample for analysis and interpretation.

4.1 *Cleaning procedures*

The process involved in cleaning stone tools prior to microscopic examination has been the subject of much debate. Keeley (1980:10-11) suggested cleaning each artifact with a white or methylated spirit to remove finger grease and then wash in hot water and ammonia based detergent. This can be accompanied by gentle finger rubbing if the implement is free of soil deposits. This is followed by immersion in a HCl and NaOH solution for 20 to 30 minutes to remove any lime and mineral deposits and soil residues, then immersion in an ultrasonic bath with a detergent solution followed by clear water. Keeley (1980:11) also recommends prolonged immersion in a solution of hot HCI be used to remove stubborn shallow mineral deposits should the previous cleaning methods be ineffective. While some researchers still use Keeley's method others have criticized his use of such strong chemicals (Hayden 1979:191). During her experiments on microwear polish Anderson (1980:182) noted that cleaning experimental tool's used to work bone and antler with HCI changed the brightness of the polish and changed the tool's surface. Levi-Sala (1996:18) conducted several experiments documenting artifacts before and after the use of NaOH and feels there is nothing to be gained by its use and that organic deposits can be removed from experimental implements with a gentle washing in a biological ammonia-free detergent and warm water followed by immersion in an ultrasonic bath in a plastic container filled with distilled water. In analysis of Clovis tools from the Gault site in Central Texas, Shoberg (2010:139) states that no acid or alkaline cleaners were used in cleaning, instead, an ultrasonic bath was filled with warm water, then she put each artifact in a plastic bag with a few drops of ammonia, they were agitated for 10 minutes then rinsed with distilled water. This is sufficient for removing soils and sediments usually adhering to the artifacts, even after screening and lab processing (M Shoberg 2013, pers. Comm., 20 Sept.). I followed Shoberg's method, occasionally wiping the artifacts with a cotton ball dipped in alcohol to remove any finger grease.

One of the goals of the cleaning process has been to remove organic residues from a tools surface prior to analysis, but much has been learned about the information that can be gathered from the examination of stone tools, including DNA, microbotanical, and residue analysis. In some cases actual plant and animal residues such as pollen grains, plant fibers, blood, hair, and feathers can survive, providing clues as to use-material. Most researchers do not use the harsh methods once utilized by Keeley. Cleaning procedures should be determined on a case by case basis.

4.2 *Raw-material used for experimental tools*

The tools used in this experimental study were all made with Edwards variety chert, a high quality material found in abundance in Central Texas. This material was chosen in order to have a comparable series of experimental tools. A total of 14 experimental specimens were used in this study. They were knapped by skilled knappers familiar with archeological Pedernales Points; Dr. Bruce Bradley, Professor of Experimental Archeology at Exeter University; Dr. Robert Lassen; Post-Doctoral Research Associate at the Gault School of Archaeological Research, and Dr. Andy Speer; also Post-Doctoral Research Associate at the Gault School of Archaeological Research. All specimens fell within the acceptable size range for Pedernales points (Collins, pers. Comm. 2011).

4.3 *Use-material*

The material tested by these experiments were all within the range of materials which could have been exploited by prehistoric people living in the Central Texas region in the Late archaic. I chose to do a grass cutting experiment using Little Bluestem (*Schizachyrium scoparium*), a native prairie grass of Texas found on the Blackland Prairie and Edwards Plateau. I did eight woodworking experiments, four specimens using Live Oak (*Quercus fusiformis*), an indigenous hardwood of Texas and four specimens using Willow (*Salix nigra*), an indigenous soft wood of Texas. I also conducted experiments on fresh white tail deer (*Odocoileus virginianus*) antler and bone. Finally a meat cutting experiment was done using white tail deer meat.

4.4 *Use-action*

In order to have each experiment performed as naturally as possible, the exact direction and application of force was not dictated. Instead, each experiment was performed in a manner that was comfortable for the user. Basic use-actions indicative of knife usage were used including a cutting, sawing, and whittling motion. As Keeley (1980:7) notes, "if one is to break down the more general independent variable such as sawing or scraping into finer and more strictly defined variables, like the length of stroke, the angle of the edge to the worked surface, the angle of the edge to the direction of strokes and so on, then one is driven, by necessity to use the implement in an unnatural and artificial manner"

I chose not to incorporate projectile point experiments into my program due to time constraints and the large amount of existing data-sets that already exist. As discussed in chapter three, other researchers have done extensive experimental studies focusing on fracture and breakage patterns (Dockall 1997:321, Ahler 1971:85, Odell and Cowen 1986:198-212, Lafayette and Smith 2012: 143-157) as well as microscopic analysis (Kay 1996:327).

The grass cutting experiment was performed with both a sawing and cutting motion as the tool was used both bidirectionally (sawing) and unidirectionally (cutting) (Keeley 1980:19). Experiments using both hard wood and soft wood, in both green and dried states, included sawing and whittling motions on a branch of each species, equaling a total of eight experiments were performed. A sawing experiment was also conducted on white tail deer (*Odocoileus virginianus*) antler. The intention was to conduct a whittling experiment on antler as well but due to the extreme ineffectiveness of this motion, this experiment focused on a scraping motion, with the edge held at approximately 90 degree angle to direction of use, being pulled towards the experimenter (Keeley 1980:19). Sawing and whittling experiments were also conducted on a fresh ulna of a white tail deer (*Odocoileus virginianus*).

4.5 *Use-duration*

Different ways of measuring use-duration include counting strokes, accomplishing a task, or measuring in minutes. Counting strokes can become very mechanical and lead to regularization in stroke length, direction, and frequency. In addition, accomplishing individual tasks is ideal if the task lasts long enough to produce wear (Hurcombe 1992:34). I chose to measure duration in minutes, keeping the use time the same for like-materials. This was done so that comparisons could be made between the different use actions on like-materials. Due to her prior experience conducting use-wear experiments with Edwards chert, Marilyn Shoberg (Research Assistant at University of Texas) was consulted regarding use-times that would be likely to produce distinct wear. She has done experimental work using Edwards chert on many genera of both green and dry wood, antler, bone, and grass. Shoberg has documented the formation of polish on scraping green wood in 30-45 minutes, longer on dry wood (M. Shoberg 2013, pers. Comm., 17 Oct.) I chose to do all my woodworking experiments for 60 minutes in order to improve the likeliness of producing sufficient wear-patterns. Marilyn also suggested a time of 15 to 30 minutes for wear to form when working bone and wood.

Table 1. Summary of Experiments

Specimen ID	Raw Material	Use-Material	Use-Action	Use-Duration
BB-03	Edwards Variety Chert	Little Bluestem Grass	Cutting	90 Minutes
AS-09	Edwards Variety Chert	Dry Live Oak	Whittling	60 Minutes
RL-02	Edwards Variety Chert	Dry Live Oak	sawing	60 Minutes
BB-01	Edwards Variety Chert	Green Live Oak	Whittling	60 Minutes
BB-04	Edwards Variety Chert	Green Live Oak	Sawing	60 Minutes
BB-02	Edwards Variety Chert	Dry Black Willow	Whittling	60 Minutes
AS-03	Edwards Variety Chert	Green Black Willow	Sawing	60 Minutes
BB-05	Edwards Variety Chert	Green Black Willow	Whittling	60 Minutes
AS-02	Edwards Variety Chert	Dry Black Willow	Sawing	60 Minutes
AS-04	Edwards Variety Chert	Antler	Sawing	30 Minutes
AS-08	Edwards Variety Chert	Antler	Scraping	30 Minutes
AS-10	Edwards Variety Chert	Bone	Sawing	30 Minutes
AS-01	Edwards Variety Chert	Bone	Whittling	30 Minutes
AS-07	Edwards Variety Chert	Bone/Meat	Cutting	40 Minutes

4.6 *Equipment*

The microscopic use wear analysis conducted for this study utilized a Leica DM LA optical microscope. This microscope is equipped with adjustable field and aperture diaphragms, and a polarizing filter and analyzer. The adjustable field diaphragm narrows the view to a specific area while decreasing the amount of light reaching the specimen to reduce glare without adding contrast. The adjustable aperture diaphragm reduces the amount of light reflecting off the specimen by reducing the amount of light allowed to enter the condenser. The polarizing filter and analyzer further reduces the glare to the reflective surface of the artifact. The microscope is also equipped with a digital camera. Through the use of Image-Pro Plus software, micro-photos were taken of all observed wear.

4.7 *Macroscopic Analysis of Experimental Points*

After each experiment the replica Pedernales points were macroscopically examined for damage and wear including edge rounding or dulling, and any accumulation of debris. Use-duration, use-action, and use-material were also recorded. In the present work it was not possible to design for hafting. Consideration of hafting was carefully thought out. There are many variables to consider during hafting including haft limit, haft material wrapping, haft type, and hafting method. Other authors (Rots *et al.* 2006:936) that have worked on this aspect show it is an extra element that is equivalent to the work of another whole project, as it is impossible to explore all hafting options in the time available. Another disadvantage to hafting during experimental studies experienced by other researchers is that the points continue to fall out of the haft during experimentation

(Lafeyette & Smith 2012:148) or the tools will move around in the haft. I chose to hand hold each tool during experimentation. Holding the tool in the hand ensures better blade control as heavier forces can be applied for longer periods of time without fear of blade fracture (Moore 2005:158). Position of the hand during use is recorded in each experiment.

4.7.1 *Grass*

BB-03. This specimen was used to cut little bluestem, for 90 minutes, mostly in a back and forth sawing motion parallel to the cutting edge of the blade, although at times, one cutting motion was enough to cut through the blades (Fig. 19). The tool was held from the base to the midpoint of the right lateral edge, between the thumb and the forefinger. Following the experiment the tool was inspected for signs of macroscopic damage and wear. The right stem barb was broken during manufacture. After use, there was an accumulation of particles along the whole blade edge to 11.1 mm and 15.2 mm from tip to end of the shoulder. The blade serrations were noticeably duller after one hour of cutting and even more so after the full duration of the experiment but exhibited no edge rounding or dulling. The tip of the tool glanced a rock twice during the experiment but this did not cause any macroscopic damage.

Figure 19. Cutting little bluestem for 90 minutes using experimental specimen BB-03.

4.7.2 *Wood*

AS-09. This specimen was used to whittle the bark off the branch of dry live oak (Fig. 20). The majority of the exercise was conducted with the tool being held at the base between the thumb and the middle finger as the forefinger ran along the right blade edge. At times the tool was held with two hands, one at the tip and the other at the base. The tool was pulled toward the user the entire time. The entire left blade edge was used from tip to shoulder in a unidirectional planing motion perpendicular to the cutting edge of the blade for 60 minutes.

Figure 20. Scraping/whittling the bark off dry live oak for 60 minutes using experimental specimen AS-09.

Following the experiment the tool was examined for macroscopic damage and wear. There was a light particle accumulation along the blade edge. Although the tool was not very effective for this action, the blade edge seemed to remain fairly sharp and there was no edge rounding or dulling.

RL-02. This specimen was used to saw through a branch of dry live oak (Fig. 21). The tool was held at the base between the thumb and the middle finger, with the forefinger pushing on the right dorsal blade edge. A back and forth motion was used parallel to the blade edge from distal tip to shoulder. This activity was performed for 60 minutes. The tool remained effective throughout the experiment. Following the experiment the tool was examined for macroscopic signs of damage and wear. A layer of fine sawdust was visible along the entire working edge. The blade serrations remained sharp with no edge rounding or dulling.

BB-01. This specimen was used to whittle bark off a branch of green live oak. The tool was held with both hands along the right blade, one at the tip and the other at

Figure 21. Sawing through a branch of dry live oak for 60 minutes using experimental specimen RL-02.

the base. The tool was pulled toward the user throughout the entire experiment. The tool was used along the right blade, 3 cm from the distal tip to 2 cm from the tip of the shoulder. The tool became noticeably duller after 40 minutes but still remained effective during the full 60 minutes of use. Following the experiment the tool was examined for macroscopic damage and wear. Only a light particle adhesion was observed on the ventral side along the blade edge but a substantial layer of brown and yellow wet, sticky, sawdust had accumulated along the dorsal side of the blade edge, covering most of the dorsal side from the tip midway down the tool (Fig. 22). The serrated blade edge still remained fairly sharp with light edge rounding.

Figure 22. Brown and yellow sawdust accumulation on dorsal face of experimental specimen BB-01.

BB-04. This specimen was used to saw through a branch of green live oak. The tool was held at the base between the thumb and middle finger with the forefinger pushing down on the blade edge. The tool was used along the entire left blade edge, in a back and forth motion, parallel to the blade edge from the distal tip to the end of the shoulder. This activity was performed for 60 minutes and the blade remained effective throughout the entire experiment. Following the experiment the tool was examined for sign of macroscopic damage and wear. A layer of yellow sawdust accumulated along the entire used blade edge on both sides of the tool (Fig. 23). The use-edge exhibited edge dulling.

Figure 23. Yellow sawdust accumulation on left blade edge of BB-04.

BB-02. This specimen was used to whittle the bark off of a branch of dry black willow. The tool was held at the base between the thumb and the middle finger with the forefinger resting along the right blade edge (Fig. 24). The tool was pulled toward the user throughout the entire experiment. The entire blade edge was used from tip to shoulder, with an emphasis on the distal half, in a unidirectional planning motion, perpendicular to the edge of the blade for 60 minutes. Following the experiment the tool was examined for signs of macroscopic damage and wear. There was a very light accumulation of fine “sawdust” on the use-edge. The tool was not an effective tool for this action but did not exhibit any edge rounding or dulling.

Figure 24. BB-02. Whittling the bark off a branch of dry willow for 60 minutes using experimental specimen BB-02.

AS-03. This specimen was used to saw through a branch of green black willow. The tool was held along the right blade edge between the thumb and middle finger, occasionally exerting pressure along the blade edge with the forefinger. The tool was used along the entire blade edge in a back and forth sawing motion, parallel to the blade edge from the distal tip to the tip of the shoulder. This activity was performed for 60 minutes and the blade remained effective throughout the entire experiment. Following the experiment the tool was examined for macroscopic damage and wear. A layer of yellow, wet sawdust accumulated along the blade edge from approx. 2cm from the tip to 2cm from the shoulder on both sides of the tool (Fig. 25). The blade edges remained effective with no edge rounding or dulling.

Figure 25. Yellow wet sawdust accumulation on experimental specimen AS-03.

BB-05. This specimen was used to whittle bark off the branch of a green black willow. The tool was held along the right blade edge between the thumb and the forefingers, sometimes the forefinger would run parallel to the blade edge pushing down as the tool was pulled towards the user. The entire left blade was used from tip to shoulder, concentrating on the distal two thirds of the point, in a unidirectional planing motion perpendicular to the cutting edge for 60 minutes. The tool remained effective throughout the entire experiment, although wood shavings were consistently being removed from the blade edge. After the experiment the tool was examined for macroscopic signs of damage and wear. An accumulation of sawdust had built up along the distal two-thirds of the use-blade edge. Edge rounding and dulling were noted.

AS-02. This specimen was used to saw through a branch of dry black willow. The width of the tool combined with the width of the branch made sawing straight through very difficult so the branch was cut in a V shaped wedge. The tool was held at the base between the thumb and the middle finger, with the forefinger resting along the right lateral blade edge, sometimes exerting pressure to more efficiently cut through the branch. A back and forth motion was used parallel to the blade edge from the tip to approx. 3cm from the end of the shoulder. This activity was performed for 60 minutes. The tool remained effective throughout the experiment. Approximately half way through the experiment the tip of the tool was used to pry bark from the branch that was not previously manually removed, this caused a transverse macrofracture, ending in a feather termination at the extreme distal end of the tool. A very light film of sawdust accumulated along the blade edge. The serrations remained sharp with no evidence of edge rounding or dulling.

4.7.3 *Antler*

AS-04. This specimen was used to saw grooves in the tine of a white tail deer antler (Fig. 26). The tool was held between the thumb and the middle finger with the forefinger running along the right blade edge. A back and forth motion was used parallel to the blade edge from the distal tip to approximately 2cm from the end of the shoulder. This activity was performed for 30 minutes. The tool was noticeably duller after ten minutes and although it quickly deteriorated, the tool was able to be of some use to the end of the experiment. Following the experiment the tool was inspected for macroscopic signs of damage and wear. A soft layer of sawdust had accumulated along the blade edge and edge rounding was noted.

Figure 26. Grooves sawed into the tine of a white tail deer antler for 30 minutes using experimental specimen AS-04.

AS-08. This experiment chosen for this specimen was to whittle the tine of a white tail deer antler into a sharp tip (Fig. 27) but it quickly became clear that this action was completely ineffective. The tool was much more effective in a scraping (90 degree angle) motion. The tool was held on the right lateral edge, at the base, between the thumb and the middle finger. The forefinger exerted pressure on the blade edge to make the action more efficient. The top third of the distal left blade edge was used during the experiment. This activity was performed for 30 minutes. Sawdust-like antler particles built up on the used portion of the blade and edge rounding was noted.

Figure 27. Antler tine after being scraped with experimental specimen AS-08 for 30 minutes.

4.7.4 *Bone*

AS-10. This specimen was used to saw eight V shaped grooves into a fresh white tail deer fore-limb (Fig. 28). The tool was held on the right lateral edge, at the base, between the thumb and the middle finger with the forefinger resting on the non-working blade edge. A back and forth motion was used parallel to the blade edge from the distal tip to approx. 2 cm from the end of the shoulder. This activity was performed for 30 minutes. Although the tool was effective throughout the experiment, it became noticeably duller approximately five minutes into the experiment, deteriorating from that point. Following the experiment the tool was examined for microscopic damage and wear. A line of fine bone particles similar to sawdust (Fig. 29) ran the entire length of the working blade edge edge dulling was noted.

Figure 28. V-shaped grooves sawed into white tail deer bone for 30 minutes using experimental specimen AS-10.

Figure 29. Particle adhesion from sawing eight V-shaped grooves into deer bone for 30 minutes using experimental specimen AS-10.

AS-01. This specimen was used to whittle the cut end of a fresh white tail deer ulna. In the beginning of the experiment the bone had light remnants of meat and fibrous material that were scraped off to expose the bone. The tool was held on the right dorsal blade edge, at the base, between the thumb and middle finger. The forefinger exhibited pressure along the non-working blade edge. The tool was pulled towards the user along the entire left blade edge for a total of 30 minutes. Bone particles were brushed off the edge of the tool intermittently throughout the experiment. Following the experiment the tool was examined for signs of macroscopic damage and wear. A line of fine bone particles similar to sawdust accumulated along the entire blade edge. The working edge was slightly dulled.

4.7.5 *Meat*

AS-07. This specimen was used to cut the meat off of a white tail deer ulna for approximately 10 minutes. It was then used to cut white tail deer meat into thin strips which took 30 minutes. The tool was held on the right dorsal blade edge, at the base, between the thumb and the middle finger while the forefinger exerted pressure on the proximal third of the right dorsal blade edge. Following the experiment the tool was examined for signs of macroscopic damage and wear. The entire tool was covered in a shiny greasy film with fat buildup (Fig. 30) in flake scars along the midline of the point on both faces. No edge rounding or dulling was noted.

Figure 30. Fat buildup on experimental specimen AS-07 from cutting white tail deer meat.

4.8 *Microscopic Analysis of Experimental Points*

4.8.1 *Methodology*

After each experiments all replica Pedernales point were cleaned using an ultrasonic bath filled with warm water. Each replica point was put in a plastic bag filled with warm water and a few drops of ammonia, then placed in the bath. It was agitated for ten minutes then rinsed with distilled water and allowed to dry.

After cleaning, each replica Pedernales point was microscopically examined focusing on evidence of polish and striations. Systematic transects were started on the dorsal left blade edge which in each experiment was the working blade edge. Transects started at the shoulder and ended at the distal tip, then back until the complete point was examined. Initially the points were examined at a magnification of 200X, when wear was detected an examination at 500X was completed. At times, the close aperture of the 200X lens combined with the shape of the artifact made examination of the tool at 200X very difficult, so an initial magnification of 500X was required. This was very time consuming but was required for thorough examination. Both sides of the tool were examined. Each specimen is presented with an image of the specimen including microscopic observations if applicable. In order to make the best use of space and keep the text together, these images are presented in a block in the plates section at the end of the text and are labeled 4.1 – 4.14. The dorsal face is always on the left and the left dorsal blade edge was the working edge in each experiment. Presented with each image are photomicrographs of wear observed. All photomicrographs are oriented normal to the specimen from which they came and are enlarged. The close distance of the 200X aperture lens to the experimental tool made taking some photos difficult. Also, wear patterns were easier to identify at 500X. For these reasons, and to remain consistent, all photomicrographs presented were taken at 500X.

4.8.2 *Grass*

BB-03. This specimen was used to cut little bluestem for 90 minutes (4.1). This was done mostly in a back and forth sawing motion but occasionally one motion was enough to cut the blades. Transects at the extreme blade edges revealed a band of completely linked polish wrapping the entire edge of the working blade and atop flake scar irrises. The polish quickly dissipated as it spread outward from the blade edge. The polish was similar to the plant polishes described by Keeley (1980:60); very smooth with a highly reflective surface and exhibited a fluid-like appearance with "filled in" striations, although it was apparent that these very fine striations ran in a roughly parallel direction to the working edge of the blade. Also noted was an area of heavy, highly reflective polish on the dorsal surface where the tool was held, near the right shoulder, by the base of the thumb. Wide, deep, crosshatched striations could be easily seen in this polish.

4.8.3 *Wood*

Dry Hard Wood

AS-09. This specimen was used to whittle the bark off a branch of dry live oak for 60 minutes (4.2). The tool was pulled toward the user throughout the entire experiment. The entire left blade edge was used from tip to shoulder in a unidirectional planing motion perpendicular to the cutting edge of the blade. A light polish was visible in patches on both sides of the used blade edge from the tip of the shoulder to the extreme tip of the tool. No striations were visible in this polish. Also visible on a high ridge on the dorsal surface was a patch of heavy, highly reflective polish, at 500X crosshatched striations were visible. This area would have been covered by the thumb during use.

RL-02. This specimen was used to saw through a branch of dry live oak for 60 minutes (4.3). A back and forth motion was used parallel to the blade edge from the distal tip to shoulder. A heavy band of polish could be seen on both blade edges along the high ridges of flake scars with very fine striations running roughly parallel to the blade edges. This band of polish was narrow and limited in distribution. A less developed polish rested in between these high ridges. This wear was consistent with Keely's (1980: 35) description of wood polish; troughs and crests, gently undulating in the direction of use. A well-developed polish had formed on the dorsal surface where the thumb was resting during use and on the ventral surface where the forefinger rested. No striations could be found in this polish.

BB-01. This specimen was used to whittle bark off a branch of green live oak for 60 minutes (4.4). The tool was pulled toward the user throughout the entire experiment. The tool was used along the right blade edge, 3cm from the distal tip to 2cm from the tip of the shoulder. The only use-related polish detected was on the high ridges of the ventral surface and exhibited faint oblique striations. The placement of this polish, closer to the mid-line of the tools face, was probably due to the angle the tool was being held as the ventral face scraped against the wood as it was being pulled toward the user. Patches of heavy polish could be found where the tool was being held.

BB-04. This specimen was used to saw through a branch of green live oak for 60 minutes (4.5). The tool was held at the base between the thumb and the middle finger with the forefinger pushing down on the blade edge. The tool was used along the entire left blade edge, in a back and forth motion, from the distal tip to the end of the shoulder. Small intermittent patches of polish developed on the dorsal cutting edge, and along the entire ventral cutting edge, fine striations in a band of undulating polish oriented parallel to the cutting edge could be seen. This wear was observed slightly inward from the cutting edge of the tool, this is probably due to small flakes that are removed along the immediate edge during use, causing removal of the use-related wear. A heavy polish had formed on both faces where the tool was held during use.

Dry Soft Wood

BB-02. This specimen was used to whittle the bark off a branch of dry black willow for 60 minutes (4.6). The tool was held at the base between the thumb and the middle finger with the forefinger resting along the right dorsal blade edge. The tool was pulled toward the user throughout the entire experiment. No striations were found on either the dorsal or ventral surface, but patches of a domed polish in various stages of development could be seen along both sides of the blade edge. Keeley (1980:35) describes wood polish as very rarely a flat plane but as commonly gently curved, or domed when on the high points of microtopography. Signs of polish were also detected in the areas where the thumb and forefinger rested during use.

AS-03. This specimen was used to saw through a branch of green black willow for 60 minutes (4.7). The tool was held along the right blade edge between the thumb and the middle finger, with the forefinger resting along the right dorsal blade edge, sometimes exerting pressure to cut more efficiently through the branch. A back and forth motion was used parallel to the blade edge from the tip to the shoulder. The dorsal surface exhibited polish on high ridges of the flake scars and on the right shoulder in an area where the tool was held. Also, a highly reflective polish was noted in patches from along the length of the blade edge. Striations were noted intermittently on the high parts of the flake scar irrises; these were long, thin, and ran parallel to the working edge. Patches of polish could be seen on both faces in the area the tool was held during use.

Green soft wood

BB-05. This specimen was used to whittle bark off the branch of green black willow for 60 minutes (4.8). The tool was held along the right blade edge between the thumb and the forefinger; sometimes the forefinger would run parallel to the blade edge, pushing down as the tool was pulled toward the user. The entire left blade was used from tip to shoulder, concentrating on the distal two thirds of the point, in a unidirectional planing motion perpendicular to the cutting edge. Long thin striations were found along the top third of the ventral right blade edge running perpendicular to the cutting edge of the tool in a gentle undulating polish. These undulations occur after prolonged use in woodworking (Keeley 1980:35). Patches of heavy polish were also found where the thumb and forefinger rested during use.

AS-02. This specimen was used to saw through a branch of dry black willow for 60 minutes (4.9). Although a bright undulating polish was located on both sides of the working edge, only the ventral blade edge seemed to have faint striations that ran roughly parallel to the edge. A strong “greasy looking” polish had begun to develop on both sides of the tool where it was held during use.

4.8.4 *Antler*

AS-04. This specimen was used to saw grooves into the tine of a white tail deer antler for 30 minutes (4.10). The tool was held between the thumb and the middle finger with the forefinger running along the right blade edge. A back and forth motion was used parallel to the blade edge, from the distal tip to approx. 2 cm from the end of the shoulder. The dorsal surface exhibited patchy polish along the high ridges approx. 3cm from the edge of the blade. Both working edges exhibited small patches of polish with striations running parallel to working edge of the tool. One small area on the ventral side revealed a patch of developing polish where the base was held against the meaty part of the palm of the hand during use.

AS-08. This specimen was used in a scraping motion to sharpen the tip of a white tail deer antler for 30 minutes (4.11). The small amounts of polish found after this experiment were grainy in appearance and exhibited deep, wide, parallel striations and were only found on the dorsal surface. The ventral surface had a small line of developing polish where the tool rested in the palm of the hand during use.

4.8.5 *Bone*

AS-01. This specimen was used to whittle a fresh white tailed deer ulna for 30 minutes (4.12). Transects revealed a splotchy bright polish along the midline of the tool and on some high ridges with no striations visible. The tip of the tool, on the dorsal face revealed an undulating polish with long, thin, parallel striations running at an oblique angle to the edge. The ventral right edge, near the tip also revealed polish, though not as well developed with striations running perpendicular to the edge of the tool. Both faces of the tool near the base featured very heavy polish were the tool was resting in the hand during use.

AS-10. This specimen was used to saw eight V shaped grooves into a fresh white tail deer ulna for 30 minutes (4.13). This specimen revealed a heavy amount of crystal inclusions that made finding any kind of use-related wear difficult. However, a patch of coarse textured polish with long straight striations was found on the ventral face near the cutting edge. Patches of polish were also found on the ventral face where the tool was held with the forefinger during use.

4.8.6 *Butchery*

AS-07. This specimen was used to cut the meat off of a white tail deer ulna for approximately 10 minutes (4.14). It was then used to cut white tail deer meat into thin strips which took 30 minutes. Patches of an intermediately developed polish could be found on the left dorsal blade from the midline of the point to the blade edge. This polish was similar to Keely's (1980:53) description of the polish that developed in his meat cutting experiment; relatively dull with a "pronounced greasy luster" resulting from the smoothing of the microtopography. Striations associated with this polish were short, relatively deep, wide, and crosshatched.

4.9 *Conclusion*

Fourteen separate experiments were conducted to produce distinctive patterns of wear on Pedernales replicas. Use-materials included were grass, hard wood both in dry and green states, soft wood both in dry and green states, antler, bone, and meat attached to bone. Angle of contact between tool and wood and length of stroke were not predetermined in order to replicate natural human behavior as much as possible. Prehension was not predetermined, but upon completion of the experiments it was noticed during each experiment the tool was held approximately in the same manner. This would make sense as in order to keep the working edge free, the location of the grip would tend to cluster. Duration of each experiment was kept constant in like experiments in order to compare like results. In comparison to other experimental programs, these duration-times were substantial.

Grass cutting produced the most polish. Completely linked polish could be seen wrapped along the entire working edge. The polish was very bright and smooth with a fluid-like appearance. Striation were faint but could be easily seen running roughly parallel to the cutting edge.

Whittling wood produced the least amount of wear. Whittling on green and dry hard wood produced a heavy polish with very faint striations, but on dry soft wood, a patchy polish was noted on the blade edges with no striations. Green soft wood produces the most amount of wear from whittling with light undulating polish and long thin striations. Striation manufactured from whittling ran perpendicular to the working edge. Sawing all types of wood produced polish and all but one produced striations. Green and dry hard wood produced the most wear, all types produced a moderate to heavy undulating polish. All but sawing green soft wood produced varying degrees of long, thin striations running roughly perpendicular to the cutting edge.

Scraping and sawing antler produced the least amount of wear. Very small patches of polish were somewhat grainy in appearance and when striations were visible, they were deeper and wider than with wood or grass. Sawing produced wear on both sides of the blade edge but the scraping only produced wear on the dorsal blade edge.

Whittling and sawing bone both produced wear. Sawing produced a somewhat matte polish with long thin striations running parallel to the working edge while whittling produced quite a bit more polish. This could have been due to the fact that most of the whittling was concentrated at the tip and not spread out over the whole blade edge as was with the sawing. Polish associated with the whittling was also matte but also exhibited an undulating surface. Most wear was found on the dorsal side of the tool and had striations running perpendicular to the cutting edge. Polish on the ventral side was in small patches and striations ran parallel to the cutting edge.

Butchery produced the most distinctive striations; short, wide, deep, and crosshatched in a relatively dull polish that had started to link together adding a “greasy luster” to the appearance.

As stated earlier, mode of prehension was not dictated during the experiment. However, it became clear that the tools were all held in a similar manner throughout the experiments. In all of the experiments the left dorsal blade edge was the use-edge of the tool. They were all conducted by the same person and were held in the right hand, either between the thumb and the forefinger, or between the thumb and the middle finger with the forefinger running along the right dorsal blade edge for support or added pressure during the exercise. During microscopic examination, ten of the fourteen tools had polish on the dorsal face in the area that the thumb rested during use, eleven of the fourteen had polish on the ventral face where the forefinger would rested during use, and eight had polish on both surfaces. Four of these had wide, deep, crosshatched striations in the polish. (Sala 1996:17). These results had to be re-assessed after further discussion.

4.10 *Issues Affecting Analysis*

After completion of the microscopic analysis it was brought to my attention that the polish I had identified as prehensile wear on certain experimental specimens may have been a result of finger grease. Prehensile wear is not necessarily a direct result of the flesh of the hand but is more likely to occur as a combination of pressure, contact with the hand, particles from the worked material which cover the hand, and any grit or other material in the working environment. These detached, abrasive, particles influence the form of prehension polish. This type of polish is most common on worked materials such as bone and antler that tend to produce more debris, and less developed on woodworking and hide-working tools (Rots 2004:13). As Keeley (1996) points out; prehistoric men, their food and raw material sources, and their immediate environment were all a good deal grittier than present day laboratories. Sala (1996) doubts that even after prolonged periods of use, prehension with the fingers could leave lasting traces on chert artifacts, and washing in a biological detergent would remove these traces.

It was recommended (Hurcombe :Personal Communication) that I rewash a select sample of the experimental pieces that had been recorded as having prehensile wear in a 10% alkaline solution (Hurcombe 1992:49), re-examine them, and compare them to the original results. It is often the case that residues left on a tool cleaned with only acetone would be removed after a chemical cleaning (Hurcombe 1992:37). Experimental specimens RL-02 and AS-04 were soaked in a solution of 10% NaOH for a total of 20 minutes then rinsed with distilled water and re-examined. After re-examination the polish I had identified as prehensile wear was not visible on either specimen. The polish I had identified as use-related wear was still visible. After these results, it is likely that the "polish" wear identified as "prehensile" on the additional 11 specimens was misidentified and these results were due to residues which would not survive on archeological specimens. In a dirtier environmental context the location where the hand made contact with the tool during each experiment is likely a valid location for prehensile wear to form and show more pronounced wear traces. The possibility of prehensile wear is still legitimate, but such traces might be very subtle, even after a tool had prolonged use on a material where particles detached and covered the hands and holding areas. Prehensile wear was only identified on one prehistoric specimen, 5158-11. Due to the misidentification of prehensile wear on the experimental specimens, the identification of prehensile wear on specimen 5158-11 must be treated with caution.

Table 2. Microscopic Use-Wear Characteristics

Specimen ID	Use-Material	Use-Action	Use-Wear Characteristics
BB-03	Little Bluestem Grass	Cutting	**Polish –** Very smooth, highly reflective surface with a fluid like appearance. **Striations** – Very fine striations roughly parallel to the working edge of the blade.
AS-09	Dry Live Oak	Whittling	**Polish** – Patches of light polish along both blade edges. **Striations** – No striations visible.
RL-02	Dry Live Oak	Sawing	**Polish** - Heavy, narrow banded polish on both blade edges and along high ridges of flake scars. Less developed between ridges. **Striations** – Very fine striations running roughly parallel to the blade edges.
BB-01	Green Live Oak	Whittling	**Polish** – Along high ridges of the ventral surface, close to the midline of the tools face. **Striations** – Faint, oblique striations.
BB-04	Green Live Oak	Sawing	**Polish** – Small intermittent patches of undulating polish. **Striations** – Fine striations oriented parallel to the cutting edge.

Table 2. Microscopic Use-Wear Characteristics

BB-02	Dry Black Willow	Whittling	**Polish** – Patchy, domed polish in various stages of development along both sides of the blade edge. **Striations** – No striations visible.
AS-03	Green Black Willow	Sawing	**Polish** – Highly reflective polish in patches along the length of the blade edge. **Striations** – Long, thin striations running parallel to the working edge.
BB-05	Green Black Willow	Whittling	**Polish** – Gently undulating polish. **Striations** – Long, thin striations running perpendicular to the cutting edge of the tool.
AS-02	Dry Black Willow	Sawing	**Polish** – Bright undulating polish on both sides of the working edge. **Striations** – Faint striations running roughly parallel to the ventral blade edge.
AS-04	Antler	Sawing	**Polish** – Patchy polish along high ridges of the dorsal surface and both sides of the working blade edge. **Striations** – Striations running parallel to the working blade edge.
AS-08	Antler	Scraping	**Polish** – Small, grainy patches of polish.

Table 2. Microscopic Use-Wear Characteristics

			Striations – Deep, wide, parallel striations on the dorsal surface.
AS-10	Bone	Sawing	**Polish** - Patches of course, textured polish. **Striations** – Long, straight striations running parallel to the cutting edge.
AS-01	Bone	Whittling	**Polish** – Patches of bright polish along the midline of the tool and on some high ridges. Tip of tool displayed undulating polish. **Striations** – Long, thin, parallel striations running at an oblique angle to the edge at the tip. The right ventral edge revealed striations running perpendicular to the edge of the tool.
AS-07	Bone/Meat	Butchery	**Polish** – Intermittently developed with a dull “pronounced greasy luster” found from the midline of the point to the working blade edge. **Striations** – Short, relatively deep, wide, and crosshatched.

Chapter Five: Macroscopic and Microscopic Analysis of the Prehistoric Pedernales Points

5.0 *Introduction*

The following presents descriptions and observations from the macroscopic and microscopic analyses of the prehistoric Pedernales points. Each macroscopic observation includes a description of the morphological attributes (Fig. 31) and breakage patterns.

Following the macroscopic observations are the microscopic observations. Microscopic observations include descriptions of use-related wear including polish and striations. If polish is present, degree and type are recorded. If striations are present, description and orientation are documented. Post depositional surface modification (PDSM), if present, is also recorded.

Each specimen is documented with an image, at the same scale. If any use-related wear is evident it is documented by a photomicrograph at 500X magnification. Each micro-image is oriented normal to the specimen from which it came. All images accompanied by photomicrographs can be found in a block in the plates section at the end of the text and are labeled 5.1 – 5.35.

The Gault Site has produced hundreds of Pedernales points over the years. To keep this study small enough to perform microscopic analysis in the time available, I chose to limit the sample to one area of the site. Focusing on one area would also keep the sample coherent and manageable. The points selected were excavated from Area 15 since this unit was the most recently excavated. The sample of 21 Pedernales points from the excavation area was a bit smaller than I would have liked, so I chose to include all Pedernales surface finds that were acquired during the time of excavation at area 15. Surface finds included in this study consisted of 3013-1, 4799-73, 5014-2-SF2, 5018-8-SF3, 5158-SF8, 5158-SF9, 5158-SF11, 5158-SF12, 5285-193-SF4, 5285-194-SF5, 5445-SF7, 5445-76-SF6, and 5741-10. This addition of the surface finds brought the total to a manageable 34 points.

5.1 *Macroscopic and microscopic Analysis of Prehistoric Pedernales Points*

F13-09-18

Macroscopic Observations. (5.1) A series of small flake scars along both blade edges, narrow blade, and weak shoulders indicate this specimen is a reworked point. It's made on a light tan to grey chert and has a broken distal tip. The stem edges are straight with rounded ears and a slightly indented base. The blade edges are narrow, relatively thick, and straight with weak shoulders.

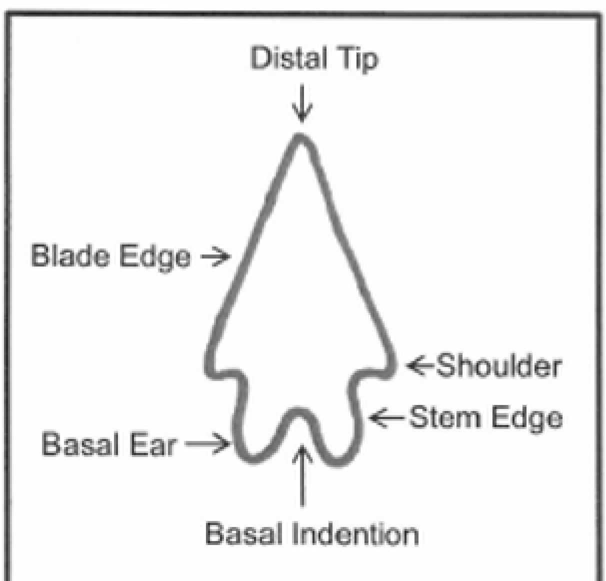


Figure 31. Morphological features of Pedernales points as discussed in macroscopic Analysis.

Microscopic Observations. Light discoloration in the form of orange/brown colored stains resulting from the presence of iron and manganese in the groundwater is visible on both surfaces of this specimen. These stains can occur in clusters or stand-alone (Sala 1986:52, Burroni et al. 2002:1284). These stains coupled with a colored patina made detecting any use-related wear difficult. Colored patinas are usually a result of differing types of minerals present in the groundwater (Sala 1986:52).

Conclusion. The break at the extreme end of the distal tip and the reworked blade edges are not enough evidence to infer how this specimen was used, except to infer that it was curated. Since no microscopic use-related wear was detected, the use-life of this specimen is inconclusive.

F13-09-24

Macroscopic Observations. (5.2) This specimen is a complete point with a sharp needle-like tip. It's made from light to medium grey chert. The flat dorsal surface and moderate curvature on the ventral surface indicate that this tool was made from a flake. This point has a contracting stem with convex stem edges, sharp ears, and a deeply indented base. A thinning flake runs up the ventral surface. The series of small flake scars, small blade, and weak shoulders, indicate this point has been reworked.

Microscopic Observations. This specimen exhibits a uniform polish over both faces. This is likely a result of soil sheen and thus a type of PDSM. This sheen likely destroyed any previous use-related wear, creating a more linked distribution.

This is caused by movement in the soil such as bioturbation, more mild settling of sediment under pressure, or mild chemical alterations accruing in the soil (Sala 1996:70).

Conclusion. The re-worked edges of this specimen suggests it was a curated tool, any additional speculation of the use-life of this specimen is inconclusive.

3013-1

Macroscopic Observations. This is a base fragment that has a transverse hinge termination. It has basal thinning flakes running up both faces, one face also exhibits a series of small hinge terminating flakes made after the initial fluting. What is left of the stem edges are slightly convex and both ears are damaged.

Microscopic Observations. (5.3) Large orange colored stains resulting from the presence of iron and manganese in the groundwater are visible on both surfaces of this basal fragment (Burroni et al. 2002:1284). These stains along with crystalline inclusions made microscopic analysis difficult. With that being said, a line of heavy polish with oblique striations was visible running along the high ridge of the basal thinning flake on the ventral surface. This is indicative of use in a haft. Striations are produced as small flint particles that have detached within the haft, get stuck between the stone and the haft, causing highly localized friction (Rots 2004:12).

Conclusion. Transverse fractures should be used along with other lines of evidence to reach a conclusion about tool use. The use-related wear indicates this tool was used in a haft. The contact material of the working edge of this specimen is inconclusive.

4799-73

Macroscopic Observations. (5.4) This is a very large, light grey, complete point with a broken distal tip. It has a contracting stem with convex stem edges, sharp ears, and a deeply indented base. The blade is very long, straight, and narrow. The shoulders are weak with small barbs. There are no basal flutes but it exhibits crescent shaped thinning flakes.

Microscopic Observations. This specimen is covered with a mottled calcium carbonate and pervasive white patina. White patina is typically a result of two distinct chemical leaching processes in which moisture, solution pH, temperature, duration of exposure, and composition are key variables. A selective dissolution of the most soluble silica in the cherts structure interacts with moisture in the soil and presents itself as a soluble amorphous gel polish, sometimes destroying surficial use-wear (Burroni et al. 2002 1281/1285). White patina can also develop on flint which is exposed to the sun for extended periods of time, especially in hot climates (Sala 1986:52). No use-related wear was detected.

Conclusion. The break at the extreme distal end of this point is not enough macroscopic evidence to state the use-life of this tool. This along with the extreme patination likely destroyed any use-related wear and makes the use-life of this specimen inconclusive.

5001-21

Macroscopic Observations. (5.5) This specimen is a reworked complete point with a sharp needle-like tip. The stem is slightly expanding with straight edges and an indented base. Both sides of the base exhibit thinning flakes. The right stem ear is round and the left is sharp. The body is thin with long narrow straight blades and very weak shoulders. This, along with a series a small flake scars along both blade edges indicate this point has been reworked.

Microscopic Observations. A heavy discoloration in the form of orange/brown stains made detecting any use-related wear impossible. Extended interaction between natural sediments and chert tools can obscure or destroy use-wear (Sala 1986:51-57).

Conclusion. Collins (1994:90) suggests that Pedernales points with long, narrow blades and weak to non-existent shoulders, lacking impact damage, indicate use as a knife. But, without additional microscopic evidence, the use-life of this specimen is inconclusive.

5001-22

Macroscopic Observations. (5.6) This point is made on light tan chert and has a broken distal tip. The stem edges are slightly convex with rounded ears and a deeply indented base with a long thinning flake on one face and a shorter thinning flake on the opposite face. The blade edges are narrow and straight with weak shoulders. A Series of small flake scars, small blade and weak shoulders indicate this specimen has been reworked.

Microscopic Observations. Although a moderate orange/brown staining was visible on both faces of this specimen, isolated patches of bright polish appeared on the high ridges and flake scar irrises. These polishes are likely the result of soil sheen, a form of mechanical PDSM.

Conclusion. A broken distal tip is not enough macroscopic evidence to confirm tool use. This, together with the extreme amount of mineral staining and soil sheen, makes interpreting the use-life of this specimen inconclusive.

5001-77

Macroscopic Observations. This specimen is a proximal fragment made on light tan chert. The distal end has broken off in a diagonal transverse fracture. A small feather terminating flake scar and inclusion in the material at the point of fracture indicate that this point may have been broken during manufacture. The left blade edge is beveled and exhibits serrations. The stem has convex edges and a moderately indented base. The ears are rounded and one is damaged.

Microscopic Observations. (5.7) Along the high ridges and flake scar arrises a grainy polish with a greasy luster appeared with obliquely oriented striations. Oblique striations in relation to an edge can infer use on material that yields (Shea 1992:144) such as meat. Softer material can allow for a motion causing an angled slice through the material. This polish is similar to polish identified by Keeley as meat polish (Keeley 1980:53). A well-developed polish on the haft element suggests this tool was hafted.

Conclusion. A transverse macrofracture can occur during use, this coupled with the meat polish, obliquely oriented striations and a well-developed polish on the haft element indicate this tool was likely hafted and used as a butchering knife.

5014-2-SF2

Macroscopic Observations. (5.8) This specimen has a slightly expanding stem with straight edges, rounded ears, and a moderately indented base with a thinning flake on one side. The blade is relatively thick, narrow, and slightly convex with weak shoulders. It is an almost complete reworked point, the extreme tip has been snapped off. Invasive flaking, along the left blade edges and weak shoulders suggest this specimen has been reworked.

Microscopic Observations. Red/orange staining from iron and manganese together with a pervasive off-white patina obscured any use-related wear that may have been on the surface of this specimen.

Conclusion. The use-life of this specimen is inconclusive.

5049-5

Macroscopic Observations. (5.9) This is a badly burned proximal fragment with a diagonal transverse fracture. The stem is slightly contracting with round ears and a deeply indented base.

Microscopic Observations. Multiple transects revealed that the extreme thermal damage this specimen exhibits, obscured any visible evidence of use-related wear.

Conclusion. The extreme thermal damage of this point makes determining any use-related activity inconclusive.

5018-8-SF3

Macroscopic Observations. This point was made with a light tan chert. The invasive pressure flaking on the dorsal face of this specimen and extremely shortened remaining blade, indicate this point has been heavily resharpened. The distal tip has been broken off in a longitudinal macrofracture. The stem edges are straight with sharp ears and a heavily indented base with long thinning flakes on both faces. The blade edges are relatively straight with weak shoulders.

Microscopic Observations. (5.10) This specimen had a light spattering of orange/brown spots related to the manganese and iron in the surrounding groundwater, more specifically on the ventral face that moderately obscured the view. However, a heavy line of polish was detected along the ridgeline of the basal thinning flake on the ventral side. Smooth, bright, highly reflective polish spots in the hafting area increases as friction increases and more pressure is exerted during use (Rots 2004:12). Also, a well-developed dull polish with a grainy texture and greasy luster could be seen on the dorsal face. This polish contains mostly oblique striations.

Conclusion. Short, heavily resharpened blades retaining impact fractures are indicative of use as a projectile point (Collins 1994:40, Dockall 1997:325). This along with well-developed meat polish and oblique striations suggests this point was a multifunctional implement. Possibly used interchangeably as a butchering tool and projectile point until no longer serviceable. The bright highly reflective polish in the hafting area suggested this tool was hafted, at least one point in its use-life.

5158-SF8

Macroscopic Observations. This specimen is a complete point with the distal tip snapped off. The base is slightly convex with rounded ears and a deeply indented base. The body is well thinned with a straight blade and almost non-existent shoulders. Invasive pressure flaking along both blade edges and almost non-existent shoulders indicate this specimen has been heavily reworked.

Microscopic Observations. (5.11) Use-related wear was found along both blade edges in the form of a bright, smooth, domed, polish from contact with hard plant material like wood. It is similar to the wear found on experimental specimen BB-04 that was used to saw through a branch of green live oak.

Conclusion. Microscopic use-wear indicates that this specimen was likely used to cut through hard plant material.

5158-SF9

Macroscopic Observations. This is a proximal fragment where the distal portion has been snapped off, resulting in a longitudinal macrofracture. The blade edges are long, straight, and narrow with weak shoulders that exhibit weak downward pointing barbs. The stem edges are straight with rounded ears, a deeply indented base, and a crescent shaped thinning flake on one side. The left blade edges on both faces have been resharpened.

Microscopic Observations. (5.12) This specimen showed heavy polish along both blade edges with striations either oblique or transverse to the blade edge. The heaviest accumulation of polish was at the distal terminus wrapping around the fractured end of the tool, indicating it had been heavily used after it was broken. Crosshatched striations could be seen in this polish. This wear is similar to wear found on experimental specimen BB-03 which was used to cut little bluestem.

Conclusion. The impact fracture followed by the microscopic examination indicate this tool was first used as a projectile point then recycled and used as a cutting tool on soft plant material.

5158-SF11

Macroscopic Observations. This is a proximal fragment of medium to light grey chert. It exhibits a slightly diagonal transverse fracture. The stem edges are straight with rounded ears, and a moderately indented base with a long thinning flake on one face. The blade is relatively narrow with one concave edge with a small barb and one straight edge with a moderate shoulder. Both left blade edges exhibit invasive flake scars. This, along with a flaring barb and concave blade edge indicate this specimen has been reworked.

Microscopic Observations. (5.13) Bright, smooth meat polish with obliquely oriented striations were detected along the left dorsal blade edge. This polish was also detected along the midline of the tool on the ventral surface, also, with crosshatched striations. Butchering is generally done with multiple sawing and slicing strokes producing a characteristic pattern of crosshatched striae (Kay1996:327).

Conclusion. This specimen was likely used as a butchering tool and was broken during resharpening.

5158-SF12

Macroscopic Observations. This specimen is a nearly complete point made from a dark grey Edwards chert. The extreme distal end is sharp and exhibits a small longitudinal macrofracture with a hinge termination. The base has a slightly expanding stem, straight edges with round ears and is moderately indented with thinning flakes on both faces. The blade is narrow, relatively thick, with weak shoulders. A recurvate blade edge and areas of invasive pressure flaking along both edges indicate it has been heavily reworked.

Microscopic Observations. (5.14) A bright, smooth polish similar to working hard plant material could be seen on the high ridges and flake scar arrises. These patches of polish exhibited oblique and parallel striations and are similar to experimental specimen BB-05 that was used to whittle green black willow. During resharpening and re-use, use-related wear becomes more heavily concentrated on the high microtopogrphy as flakes are being continuously struck off during retouch. When the tool is used again there is a break in the sequence of wear.

Conclusion. This specimen was likely used to work hard plant material.

5207-52

Macroscopic Observations. This specimen is narrow and thick with invasive flaking suggesting it was reworked to exhaustion but still in possible working condition. This point has crushing at the distal tip and was probably reworked and used as a drill. The blade edges are asymmetrical and slightly recurved with very weak shoulders. The stem has straight edges and rounded ears, one ending in subcortical material. The base is weakly indented and exhibits small crescent shaped thinning flakes.

Microscopic Observations. (5.15) A moderate staining from iron and manganese in the surrounding groundwater coated most of the tool's surface, but transects along the distal portion of the dorsal face revealed long, thin, striations running roughly parallel and oblique to the blade edge.

Conclusion. The striations identified on this specimen are also similar to those found on experimental specimen BB-05. This tool was likely used on hard plant material.

5207-77

Macroscopic Observations. (5.16) This specimen exhibits a lateral macrofracture at the distal end. It has an expanding base with straight stem edges. One ear is broken and the other is rounded. The blade edges are fairly straight with one very weak shoulders. The almost non-existent shoulders and invasive flaking indicate this tool was heavily reworked.

Microscopic Observations. Upon immediate examination of this specimen a red/orange and brown stain came into view (5.17). This is a result of the presence of iron and manganese in the surrounding groundwater or soil and is a type of post-depositional chemical process that affects a tool while buried (Burroni et al. 2002:1284). These microscopically visible stains were coupled with a pervasive cloudy patina. No use-related wear was visible through the patina.

Conclusion. Although no microscopic use-related wear could be seen due to heavy staining and patination, the lateral macrofracture and broken ear likely resulted from impact (Dockall 1977:326). This specimen was likely used as a projectile point.

5211-33

Macroscopic Observations. This specimen has had the extreme distal tip snapped off. The stem edges are straight with rounded ears and a weakly indented base with no basal fluting. The body is well thinned with slightly concave blade edges and moderate shoulders. The left shoulder retains a small amount of cortex. Invasive flaking along both blade edges and concave blade edges suggests this point has been reworked.

Microscopic Observations. (5.18) When viewed microscopically both faces of this specimen exhibited orange/red and brown spots randomly distributed across the surface. These are caused by iron and manganese in the surrounding groundwater

(Sala 1986:70, Burroni et al. 2002:1284). Although these spots combined with a colored patination made identifying use-related wear difficult, a few spots of intermediately developed polish was identified on the high arrises and near both shoulders on the ventral surface. When polish first starts to develop, it is rarely a flat surface. The polish appears gently domed, developing on the high points of the microtopography. As it becomes more developed it creates a linked pattern, eventually covering most of the microtopography (Keeley 1980:35, Sala 1996:13). This bright smooth polish is similar to experimental specimen AS-09 that was used on dry live oak.

Conclusion. This specimen was likely used to work hard plant material.

5222-8

Macroscopic Observations. Invasive flaking and the extremely exhausted blade indicate that this specimen has been reworked to exhaustion. The stem edges are straight with rounded ears, and a deeply indented base. What is left of the blade edges are relatively straight with weak shoulders. A slight build-up of calcium carbonate is present.

Microscopic Observations. (5.19) Wear was prevalent on both faces of this specimen in the form of a meat polish with a grainy appearance and a dull greasy luster (Keeley 1980:53). Oblique striations are visible in most of these patches. These wear patterns form when butchering, as the tool makes contact with meat and bone.

Conclusion. Microscopic evidence suggests this heavily used tool was used to butcher animals.

5233-65

Macroscopic Observations. (5.20) This specimen is a complete point with a needle-like tip. The base has a contracting stem with slightly convex edges, sharp ears and a deeply indented base with thinning flakes on both faces of the stem. The blade is serrated and long, narrow, straight, and relatively thick with moderate shoulders. Invasive flake scars and slight left beveling suggests this point has been reworked. The pink discoloration suggests it was subjected to heat at some point in its use-life (Collins 1974:136).

Microscopic Observations. Both surfaces of this specimen exhibit red/orange staining resulting from minerals in the groundwater. This, in addition to a cloudy patina that covered the surface likely destroyed any surficial use-wear, although isolated patches of bright polish could be found intermittently on both faces. These polishes are likely a result of soil sheen.

Conclusion. Due to the high level of PDSM affecting this specimen, its use-life is inconclusive.

5287-7

Macroscopic Observations. (5.21) This is a thin broad bladed Pedernales point. The distal tip has been removed by a transverse fracture. The blade is asymmetrical with strong shoulders. It has a contracting stem with straight edges and sharp ears, with a moderately indented base.

Microscopic Observations. This specimen exhibits heavy red/orange staining and a moderate cloudy patination. This may have obscured any use-related wear as none was detected.

Conclusion. The use-life of this specimen is inconclusive.

5243

Macroscopic Observations. The far distal end of this point exhibits a longitudinal impact fracture ending in a feather termination. The stem edges are straight with rounded ears and a very weakly indented base. It has relatively thick blades with straight edges. One shoulder is weak and the other is almost non-existent giving this specimen an almost lanceolet appearance. This, along with invasive flaking and slight left beveling indicate heavy reworking.

Microscopic Observations. (5.22) Haft wear in the form of a bright, smooth polish was noted on both sides of the base. This was the only use-related wear detected.

Conclusion. The longitudinal macrofracture is indicative of impact (Dockall 1997:325). This tool was likely used as a hafted projectile point.

5285-193-SF4

Macroscopic Observations. This is a moderately indented Pedernales basal fragment made of light grey chert. One face has a long thinning flake and the other has a crescent shaped thinning flake. The distal end has been removed by a longitudinal macrofracture that extends down what's left of both the dorsal and ventral faces. Some crushing is also visible.

Microscopic Observations. (5.23) Light patches of red/orange staining were visible over both faces of this specimen. Although no use-related wear was detected, a thick layer of soil sheen covered most of this artifact. This can cover the entire artifact or appear in the form of isolated bright spots (Sala 1996:32).

Conclusion. Impact damage in the form of longitudinal macrofractures and end crushing indicate this specimen was used as a projectile point and broke in the haft as a result of impact (Dockall 1997:327).

5285-194-SF5

Macroscopic Observations. This is a heavily damaged proximal fragment. The distal portion has been removed by a transverse fracture with some additional crushing at the point of fracture. Both blade edges have been removed by lateral macrofracture. The lateral macrofracture on the right blade edge extends down to the haft element. The base is relatively long with straight stem edges, rounded ears, and a deeply indented base. A long thinning flake runs up one face and the other exhibits a crescent shaped thinning flake.

Microscopic Observations. (5.24) This specimen has a moderate covering of red/orange staining from iron and manganese in the groundwater. Through the staining long, thin, parallel striations could be seen near the left blade edge. These striations are similar to impact striations identified by Kay (1996:328).

Conclusion. Impact damage in the form of lateral macrofractures and distal crushing along with parallel impact striations suggest this specimen was used as a projectile point (Dockall 1997:326).

5294-2

Macroscopic Observations. This specimen is a tan to light grey complete point that appears to have been made on a flake as one side is free of flake scars and exhibits a bulb of percussion while the other side displays a moderate curvature. The base has straight stem edges, rounded ears with one being damaged, and a slightly indented base. Both sides of the base exhibit long thinning flakes. It has convex blade edges and moderate shoulders.

Microscopic Observations. (5.25) Red/brown spots of iron and manganese and a cloudy patina obscured parts of this tool, but patches of bright smooth micro-wear polishes resulting from working hard plant material like wood were detected. This same polish was found localized, at the top of the haft element with oblique striations. This is the result of the point moving around in the haft during use (Kay 1996:330).

Conclusion. This tool was likely hafted and used on hard plant material.

5294-6

Macroscopic Observations. This is a proximal fragment with a transverse hinge termination. There is additional damage on one face at the point of fracture in the form of multiple hinge flakes. The stem edges are long and straight with rounded ears and a weakly indented base. The blade edges are long, narrow, and straight with weak shoulders. Weak, flared, shoulders and a series of small flake scars indicate this point has been reworked.

Microscopic Observations. (5.26) The red/orange stains and almost complete patination obscured any use-related wear on this specimen. A small area of chert free of patination revealed pervasive soil sheen.

Conclusion. The results were inconclusive.

5332-19

Macroscopic Observations. This specimen is a complete point with a needle-like tip. The stem is slightly expanding with straight edges, round ears, and a deeply indented base. The base has a thinning flake on one side that ends in a step termination and the remains of subcortical material on the end of one ear. This specimen is slightly beveled with one straight blade edge and one which is slightly concave, this, along with weak shoulders and invasive flaking indicating reworking.

Microscopic Observations. (5.27) This specimen exhibited a moderate amount of red/brown staining and cloudy patina. A patchy bright polish was also visible that exhibited faint randomly oriented striations. These wear traces are likely indicative of soil sheen. Soil sheen is sometimes mistaken for use-wear but is produced on the surface after prolonged exposure to movement of the soil (Sala 1996:70). Sheen usually occurs over the entire surface of the artifact but can vary in its degree of intensity from very faint to very glossy (Sala 1996:32).

Conclusion. Long, narrow blades that have little to no shoulders and are free of impact damage are indicative of use as a cutting tool (Collins 1994:40) but without other lines of evidence, the results are inconclusive as to the use-life of this specimen.

5373

Macroscopic Observations. (5.28) This is a badly burned point that has contracting stem edges, sharp ears and a weakly indented base. What's left of the blade edges exhibit a series of small flake scars indicating this tool has been reworked into a drill. One shoulder is missing and the tip has been broken in a longitudinal macrofracture. This could have occurred during use as a drill or could have been used to pry something loose.

Microscopic Observations. The extensive thermal damage to this specimen made detecting any use-related wear difficult, none was detected.

Conclusion. Due to the extreme heat damage microscopic use-related wear could not be detected. The macroscopic evidence suggests that this point was resharpened and its last use was as a drill.

5533-2

Macroscopic Observations. (5.29) This is a heavily patinated, nearly complete point with the extreme distal tip snapped off. The base has straight stem edges and a weakly indented base. Both ears have been damaged, and one side of the base is completely subcortical material up to the bottom of the shoulders. The body is well thinned with slightly concave blade edges and relatively long sharp barbs. Invasive flaking along both blade edges and a slightly concave right blade edge indicate this specimen has been reworked.

Microscopic Observations. Due to the glare caused by the pervasive white patina no use-related wear could be detected.

Conclusion. The results were inconclusive.

5445-SF7

Macroscopic Observations. This point is made with a light grey Edwards Chert and is broken at the extreme distal tip. The stem edges are straight with rounded ears and a moderately indented base. The blade edges are straight with weak shoulders. The ventral face of the base exhibits a thinning flake, and the dorsal face is almost completely covered in cortex. A series of small flake scars along both blade edges, and shortened blade indicate this specimen has been heavily reworked.

Microscopic Observations. (5.30) The dorsal surface is almost completely covered in cortex and exhibits no use-related wear. One patch of moderately developed meat polish was detected on the left ventral blade edge. Oblique striations were found in this polish.

Conclusion. This specimen was likely used as a butchering tool.

5445-76-SF6

Macroscopic Observations. This specimen has a longitudinal macrofracture that likely resulted during impact at the distal end (Odell et al. 1986:204, Dockall 1997:325). It has an expanding stem with one large rounded ear; the other ear has been snapped off which could have been a result of impact while in the haft. Both shoulders are weak, one appears to have been resharpened and the other is missing. A pink hue which indicates previous exposure to heat was noted. This specimen is beveled and the rounded nature of the tip suggests an attempt at resharpening after impact.

Microscopic Observations. (5.31) The dorsal face of this specimen exhibits a heavy polish along most high ridges and flake scar arrises. This polish was well developed with a grainy texture similar to experimental specimen AS-08 used to scrape white tail deer antler. Although experimental specimen AS-08 exhibits clear striations, Keeley (1980:56) states that striations in antler polish is not common. Haft polish could be seen on the high ridges on the haft element on the dorsal side. Heavy patination was visible on the ventral face.

Conclusion. Based on evidence of impact damage in the form of a longitudinal macrofracture, this specimen was likely first used as a hafted projectile. Microwear analysis suggests further use on a hard material such as antler.

5533-1

Macroscopic Observations. This specimen is a complete point made on dark grey Edwards chert. The stem has a contracting base with straight edges and is slightly indented with a thinning flake on one side. The blade edges are relatively straight with moderate shoulders. Both shoulders are damaged.

Microscopic Observations. (5.32) Grainy, pitted polish similar to experimental points AS-10 and AS-08, both used to work antler, appeared on both sides of the right blade edge. This description is similar to Keeley's (1980:56) description of sawing antler. Striations were present, running parallel to slightly oblique. Haft-wear with crosshatched striations were noted, indicating that this tool moved around in the haft during use.

Conclusion. This tool was likely hafted and used on antler.

5567-10

Macroscopic Observations. This specimen is a complete point made on light grey Edwards chert with a sharp needle-like tip. It has a slightly expanding stem with straight stem edges, rounded ears, and a deeply indented base with a basal thinning flake on the dorsal surface. The blades are narrow, and relatively thick with weak shoulders. One barb and one ear on the same side have been damaged. One concave blade edge suggests resharpening.

Microscopic Observations. (5.33) Microscopic examination revealed this tool was heavily used. Use-polish on the distal end of the dorsal face and along the right ventral blade edge revealed use similar to that on experimental point AS-01 that was used to whittle bone. Bone polish exhibits a slightly grainy texture and although it is brighter than the surface of the tool, it does not exhibit the brightness of wood or some antler polishes (Keeley 1980:43). This bone polish has long oblique striations. A bright, smooth meat polish with crosshatched striations was noted on the distal end of the ventral face. Haft wear with oblique striations was noted on the dorsal face. Abrasive microparticles were visible in this polish.

Conclusion. This specimen was used as a hafted butchering tool.

5741-10

Macroscopic Observations. This specimen is a proximal fragment with a transverse fracture. It has relatively straight stem edges, a deeply indented base and a long thinning flake on one face. One ear is sharp and the other has been broken off. What's left of the blade is very thin, fairly straight with moderate shoulders. One barb has been damaged and has a hinge terminating flake scar ending at the haft element, indicating impact damage.

Microscopic Observations. (5.34) No use-related wear was visible on the ventral side of this specimen, however transects on the dorsal blade edge revealed patches of hard plant polish similar to more than one experimental specimen. When the broken edge was examined splotches of a bright polish with randomly oriented striations appeared on the high promontories. This was likely a result of PDSM.

Conclusion. This tool was used on hard plant material.

6202-2

Macroscopic Observations. This specimen is a proximal fragment with a transverse fracture. It has straight stem edges, rounded ears, and a deeply indented base with no basal fluting. The remaining blade exhibits a series of small flake scars indicating it has been reworked. The blade is narrow and relatively thick with weak shoulders.

Microscopic Observations. (5.35) The ridge along the distal break exhibits a bright spotty polish, likely soil sheen. A well-developed bone polish wraps over the distal break and runs along the right dorsal blade edge.

Conclusion. This specimen was likely a butchering tool.

5.2 *Conclusion*

The macroscopic and microscopic observations presented in this chapter present an overview of the use-life of Pedernales points at the Gault site. A summary of all use-related wear and indications of PDSM is presented in Table 2. Further results are discussed in chapter six.

Table 3. Summary of macroscopic and microscopic observations.

Specimen ID	Form	Breakage Pattern	Use-Wear	PDSM
F13-09-18	Complete Point (missing distal tip)		None Detected	Iron and manganese staining; Colored patina
F13-09-24	Complete Point		None Detected	Soil sheen
3013-1	Basal Fragment	Transverse hinge termination	Haft Wear	Iron and manganese staining; Colored patina
4799-73	Complete Point (missing distal tip)		None Detected	White patina; Mottled calcium carbonate
5001-21	Complete Point		None Detected	Iron and manganese staining
5001-22	Complete Point (missing distal tip)		None Detected	Iron and manganese staining; Soil sheen
5001-77	Proximal Fragment	Diagonal transverse fracture	Butchering meat; Haft Wear	
5014-2-SF2	Complete Point (missing distal tip)		None Detected	Iron and manganese staining; Off-white patina

Table 3. Continued.

Specimen ID	Form	Breakage Pattern	Use-Wear	PDSM
5018-8-SF3	Complete Point (missing distal tip)	Longitudinal macrofracture	Projectile point; butchering tool; Haft Wear	Iron and manganese staining
5049-5	Proximal Fragment (badly burned)	Diagonal transverse fracture	None Detected	
5158-SF8	Complete Point (missing distal tip)		Hard plant material	
5158-SF9	Proximal Fragment	Longitudinal macrofracture	Soft plant material such as grass	
5158-SF11	Proximal Fragment	Diagonal transverse fracture	Butchering meat	
5158-SF12	Complete Point (missing distal tip)		Hard plant material	
5207-52	Complete Point (missing distal tip)	Distal crushing	Drill used on hard plant material	Iron and manganese staining
5207-77	Complete Point (burinated)	Lateral Macrofracture; Broken Ear	Projectile point	Iron and manganese staining; Colored patina

Table 3. Continued.

Specimen ID	Form	Breakage Pattern	Use-Wear	PDSM
5211-33	Complete Point (missing distal tip)		Hard plant material	Iron and manganese staining; Colored patina
5222-8	Complete Point (reworked to exhaustion)		Butchering meat	Mottled calcium carbonate
5233-65	Complete Point (thermal exposure)		None Detected	Iron and manganese staining; Colored patina, Soil sheen
5243	Complete Point (missing distal tip)	Longitudinal macrofracture	Haft wear; projectile point	
5285-193-SF4	Basal Fragment	Lateral/Longitudinal macrofracture	Projectile point	Iron and manganese staining, Soil sheen
5285-194-SF5	Proximal Fragment	Lateral/Transverse macrofracture	Projectile Point	Iron and manganese staining
5287-7	Proximal Fragment	Transverse fracture		Iron and manganese staining; Colored patina
5294-2	Complete Point		Hard plant material; Haft Wear	Iron and manganese staining

Table 3. Continued.

Specimen ID	Form	Breakage Pattern	Use-Wear	PDSM
5294-6	Proximal Fragment	Transverse hinge termination	None Detected	Soil Sheen; Iron and manganese staining
5332-19	Complete Point		None Detected	Iron and manganese staining; soil sheen
5373	Partial Point (badly burned)	Longitudinal macrofracture	Drill	
5445-SF7	Complete Point (missing distal tip)		Butchering tool	
5445-76-SF6	Complete Point (missing distal tip)	Longitudinal macrofracture	Working antler; Haft wear	
5533-1	Complete Point		Working antler; Haft wear	
5533-2	Complete Point (missing distal tip)		None Detected	White patina
5567-10	Complete Point		Butchering tool; Haft wear	
5741-SF10	Proximal Fragment	Transverse fracture	Hard plant polish	Soil sheen
6202-2	Proximal Fragment	Transverse fracture	Butchering tool	Soil sheen

Chapter Six: Conclusion of Function of the Pedernales points from the Gault Site

6.0 *Introduction*

The preceding chapter discussed the macroscopic and microscopic examination of the prehistoric Pedernales points from Area 15 of the Gault site to determine patterns of use-related wear. A discussion was given for each specimen including macroscopic and microscopic observations followed by a brief conclusion. This chapter will discuss these results in further detail. Also discussed will be issues that affected this analysis such as the high rate of PDSM and cleaning methods. The uncontrolled variables in this experimental study will be reviewed as will the context of the Pedernales points and ecological setting of the Gault Site.

6.1 *Regional Patterning and Ecological Setting of Pedernales Points*

Pedernales point points are extremely common in central Texas, the northern parts of south Texas and the coastal plain, and into the lower pecos (Turner & Hester 2011:148). This area covers six different natural regions of Texas including the Edwards Plateau, Blackland Prairie, Llano Uplift, Rolling Plains, Oak Woods and Prairies, and the South Texas Brush Country. The Gault site straddles two distinct ecoregions, the Blackland Prairie to the east and the Edwards plateau to the west (Texas Parks and Wildlife Department, 2011).

The Blackland Prairie is known for its fertile dark clay soils on gently rolling hills to level land, and were historically, dominated by little bluestem, big bluestem, Indiangrass, switchgrass, and side oats grama (McMahan *et al.* 1984:3-7, Black

2002:3). Some of these tall-grass prairies still exist but most have been used for cropland, cattle ranching, and urban development (Texas Parks and Wildlife Department 2013:3). Some woody species in the area include mesquite, hackberry, elm, osage orange, and live oak. Some native wildlife species include small game animals, waterfowl, songbirds, reptiles and white-tailed deer but animals that require large expanses of habitat such as bison, bears and pronghorn once roamed the prairies.

The Edwards Plateau is known for its clay to clay loam shallow soils, stony hills, and steep canyons. Several rivers dissect the landscape as well as thousands of caves. The eastern edge is the outlet for a significant water source in the form of a series of underground lakes called the Edwards Aquifer (Texas Parks and wildlife Department 2013). Vegetation consists of some tall medium and short grasses intermixed with live oak, Texas oak, honey mesquite, and Texas plum. Near springs and creeks, bald cypress and Sycamore can be found. Wildlife that can be found in the area include bobcats, rabbits, turtles, and white tail deer.

These two ecoregions support distinct changes in flora, fauna, soils, and geology, and as stated in chapter two these modern distinct boundaries were likely to be relevant as past ecotones, even if the environment was different, supporting a wider variety of resources for use by the prehistoric inhabitants.

6.2 *Uncontrolled Variables*

There have been two different approaches within experimental archeology as to how to construct an experiment; laboratory experimentation and actualistic experimentation (Outram 2008:2). During laboratory experimentation researchers attempt to enforce strict limits on every possible variable. This often leads to so much emphases being put on the scientific method that the actual archeology gets lost. Trying to control every variable can lead to standardized results. This method is useful but should be employed in such a way that limits its drawbacks and preserves the benefits. Actualistic experimentation emphasizes an experimental design that most accurately reflects characteristics that would be recovered in the archeological record rather than the laboratory by allowing for a greater chance of human error. These types of experiments reflect more “real life” scenarios. Both of these approaches have their benefits and should be used to complement each other. Laboratory experiments enhance the scientific principles while actualistic experiments keep the human variable intact (Outram 2008:2).

When designing my experiments I opted for a combination of both the laboratory and actualistic design. I kept the use-duration constant as to keep control over the wear acquired on each tool, but as stated in chapter four, the finer variables such as length of stroke, the angle of the edge to the direction of stroke, and the angle of edge to the worked surface was not recorded to keep each experiment as natural as possible. If all of these limits were to be enforced than one would be forced to use the tool at one angle throughout the entire task. This can produce results which are unlikely to be compared to the wear traces found on archeological specimens.

Another variable that was not controlled for was the hafting arrangement. I chose to hand hold my tools as I felt I had better control over the tool. Holding the tool in the hand ensures better blade control as heavier forces can be applied for longer periods of time without fear of blade fracture (Moore 2005:158). Also, the practicality of picking up and hand holding the tool outweighed the complications and disadvantages of hafting. A simple form of haft could have been employed but the possibility of the tool becoming loose in the haft would present too many problems. Also, some of the Gault specimens had been reworked and in some cases would have been out of the haft or even one that was originally hafted one way could have been utilized in another form of haft making things more complicated.

Hafting a tool has advantages and disadvantages. Advantages include the increased force that may be exerted during work enhancing the efficiency and precision of work such as using a drill (Keeley 1982:799, Rots *et al.* 2001:129). Some tools such as projectile points require hafting. Hafting allows for the formation of cutting edges of size or shapes unobtainable with unhafted tools, and as a strategy for conserving lithic raw material by constricting the use of stone only to the working edges, or by increasing the size of the complete tool, decreasing the likelihood of loss (Keeley 1982:799).

Disadvantages of hafting tools include the investment in the procurement of raw material and the manufacture of the haft. When using a jam haft, proximal portions of a broken tool can be difficult to extract, and they characteristically move around in the haft, which increases breakage and lowers the obtainable precision of work. Wrapped hafts are slightly more time consuming than jam hafts, and because cordage stretches with tension, they expand or contract with differences in humidity, causing the tool to consistently become loose in the haft. Mastic hafts do not allow much movement but initial hafting and subsequent retooling require fire, making these haft arrangements more complicated and time consuming. This hafting arrangement often takes longer than the time it takes to manufacture the tool (Keeley 1982:800).

6.3 *Context of Pedernales Points From the Gault Site*

A total of 34 Pedernales points were used in this study. Twenty one of these were excavated *in situ* from Area 15 of the Gault Site. The remaining thirteen were surface finds acquired during excavation of Area 15.

Twenty of the *in situ* sample were excavated from an undisturbed context between the depths of 94.30 to 94.80 with one outlier, 5222-8 excavated at a depth of 93.80. One specimen was excavated from previously disturbed context at a depth of 94.80.

The surface finds were found in various locations. Four were recovered from the excavation pit during wall cleanup and midden removal. One was found near the dredge pond/screening area. The remaining eight were found lying in various areas around the excavation site, including in the road, under the excavation table and in a gravel bar.

6.4 *Post Depositional Surface Modification (PDSM)*

Early in the microscopic analysis it became clear that PDSM was a large factor affecting this sample as out of a total of 34 prehistoric specimens that were examined, 21 exhibited varying types of PDSM. Six displayed only orange/red/brown staining, three were affected by only soil sheen, one by only patina, one by mottled calcium carbonate, and 12 displayed a combination of two or more of these conditions. Use-related wear was found on only eight of the 21 specimens exhibiting PDSM. PDSM alters the chert's surface as a result of taphonomic process that can occur either chemically or mechanically (Burroni et al. 2002:1286).

Chemical processes include patination or leaching from fluctuations in the soil's moisture content. The most prevalent form of PDSM altering this sample were the red/orange/brown stains affecting 16 of the Pedernales specimens. This is believed to result from hydroxides of iron and manganese in the surrounding ground water. These stains can occur in clusters or appear alone (Burroni et al. 2002:1284). Some of these stains were visible macroscopically but most were only detected when viewed under the microscope. Patination, both white and colored, was also an issue affecting eight of the sample. White patina can occur for a number of reasons including long durations of sun exposure, especially in hot climates. Drying out, exposure to sun and moisture, and differences in temperature all play a role. Colored patinas result as deposits of mineral in the ground water (Sala 1986:52). The presence of these chemical processes creates a glare, making use-ware analysis ineffective. Of the specimens affected by staining and colored patina, 13 were excavated and only four were surface finds, which makes sense as the *in situ* artifacts would more than likely have been exposed to groundwater for a longer period of time. Fluctuating water levels at the Gault Site likely contributed to the large amount of patina and staining on this prehistoric sample.

Mechanical processes include abrasion as a result of churning of artifacts within sediment, trampling, or post excavation damage (Sala 1986:54). Soil sheen was the biggest mechanical factor concerning this sample, affecting seven specimens. Soil sheen is in fact polish that is caused by taphonomic processes, degrading use-related polish making it impossible to distinguish it from actual use-related wear (Sala 1996:17). The surfaces of artifacts affected by these processes are unreliable for microwear analysis (Sala 1996:17).

6.5 *Methodology*

After further examination of the experimental points it became clear that the cleaning methods employed were not substantial enough to remove finger grease so soon after use. However the use-related wear on the working edges were not affected nor was the analysis of the Prehistoric specimens.

After cleaning, each Prehistoric Pedernales point was macroscopically examined focusing on morphological attributes and breakage patterns. Then, each point was microscopically examined, utilizing high-power microscopy, focusing on polish and striations. Systematic transects started at the left shoulder and ended at the distal tip of each artifact until both sides of the entire tool were covered. These transects started at 200X and when wear was detected were re-evaluated at 500X. If use-related wear was present, microphotographs were taken at 500X. Also, a sample of PDSM was also recorded with microphotographs at 500X.

6.6 *Discussion of the Function of Pedernales Points From the Gault Site*

This sample included all Pedernales points from Area 15. All but one of these specimens displayed evidence of resharpening and one had been reworked to exhaustion. The most numerous specimens in this sample comprised complete points that lacked only the distal tip (n=13). The next most numerous specimens were proximal fragments (n=9). Complete points followed (n=8), then basal fragments (n=2) a badly burned drill (n=1) and a partially complete point that had been burinated (n=1)

The most common breakage pattern associated with this sample was impact related (n=9). Five longitudinal macrofractures, two lateral macrofractures, one specimen exhibited distal crushing and one specimen exhibited both lateral and longitudinal macrofractures. These types of fractures result as a force of impact and are associated with use as a projectile point (Dockall 1997:322-324). Of the ten specimens exhibiting impact fractures, two had been reworked into drills. One was badly burned with no use-related wear detectable. Four of the nine specimens with impact damage were positive for use-related wear. One specimen reworked into a drill was used on hard plant material. Five were used as projectile points with one being recycled and used as a butchering tool. One was used to work soft plant material and the other had evidence of use on antler.

Transverse macrofractures were associated with nine specimens. Transverse breaks are characterized as a complete removal of the distal end and could be the result of manufacture, use, or trampling (Dockall 1997:326). In order to determine if a specimen with a transverse break was used as a projectile point, other lines of evidence need to be present. Six of these nine specimens exhibited microscopic use related wear. One was used to work hard plant material and three served as butchering tools. One exhibited only haft wear. Another also displayed a lateral macrofracture and is hypothesized to have been used as a projectile point.

Seventeen points were either complete or the extreme distal tip had been snapped off exhibiting no impact related breaks. Nine of these specimens displayed signs of PDSM and no use-related wear could be detected. Four were used on hard plant material, three were used as butchering tools, and one was used on antler.

6.7 *Experimental Tools*

The basis of the functional analysis of the Pedernales points from the Gault Site was constructed around the belief that microscopic analysis provides recognizable patterns of use-wear that could be matched with the experimentally made patterns to determine a tools function. The experimental program served as a useful reference collection as effective comparisons were able to be made. Use-related wear from working hard plant material, soft plant material, antler, and butchering was detected by comparing the use-related wear from the experimental tools to the Prehistoric specimens.

6.8 *Conclusion*

In conclusion, it is important to acknowledge that use-wear analysis is not an exact science and it may be virtually impossible to determine with great certainty if a tool was used for different overlapping purposes. As a tool is used, portions of the edge may have been subsequently removed by the most recent use. This can result in the mixing of wear traces or the total obliteration of previous use-related wear

(Tringham 1974:193). The mixing of wear traces can be very difficult to identify. In these cases results of the analysis are not definitive but are “most likely” scenarios.

Because the practice of use-wear analysis is an interpretive technique, the use-wear traces must be documented as carefully as possible and the interpretations offered be justified, otherwise the conclusions may be questioned. The methods employed in this study relied on evidence from multiple variables as well as careful comparisons to the experimental tool set. The functional determination of each tool was made based on the supporting evidence.

Macroscopic and microscopic analysis on the Pedernales points from Area 15 of the Gault site seem to support the hypothesis that these tools were used, sometimes interchangeably, as projectile points and as other tools such as knives and drills. Analysis shows they were used on a variety of materials, mostly, and almost equally as butchering tools or used to work hard plant material. Evidence also exists that soft plant material and antler were being worked. This study reveals that form does not necessarily determine a single function. Furthermore, these “types” of tools have complex life histories where breakage during one kind of use, or retouch can allow the tool to have a complex record of use. The wear analysis results demonstrate a new way of understanding one class of object, Pedernales points, and the role they played in an important North American site.

Chapter Seven: Conclusions

7.0 *Suggestions for future research*

This study, focusing on Pedernales points from the Gault site, offered a glimpse into the use-life of the most common projectile point form in Central Texas. Due to time constraints only a small portion of the Pedernales form from this site were examined. A study incorporating the additional 300 plus specimens excavated and collected would shed further light on the economic activities taking place at the Gault Site.

The Gault site has produced over 300 Pedernales specimens. Because of the substantial variation found in Pedernales points and the large volume excavated from the Gault site, further research, similar to past studies by Sorrow (1969), Johnson (1994), and Tomka (2003), trying to define regional or temporal differences would be useful.

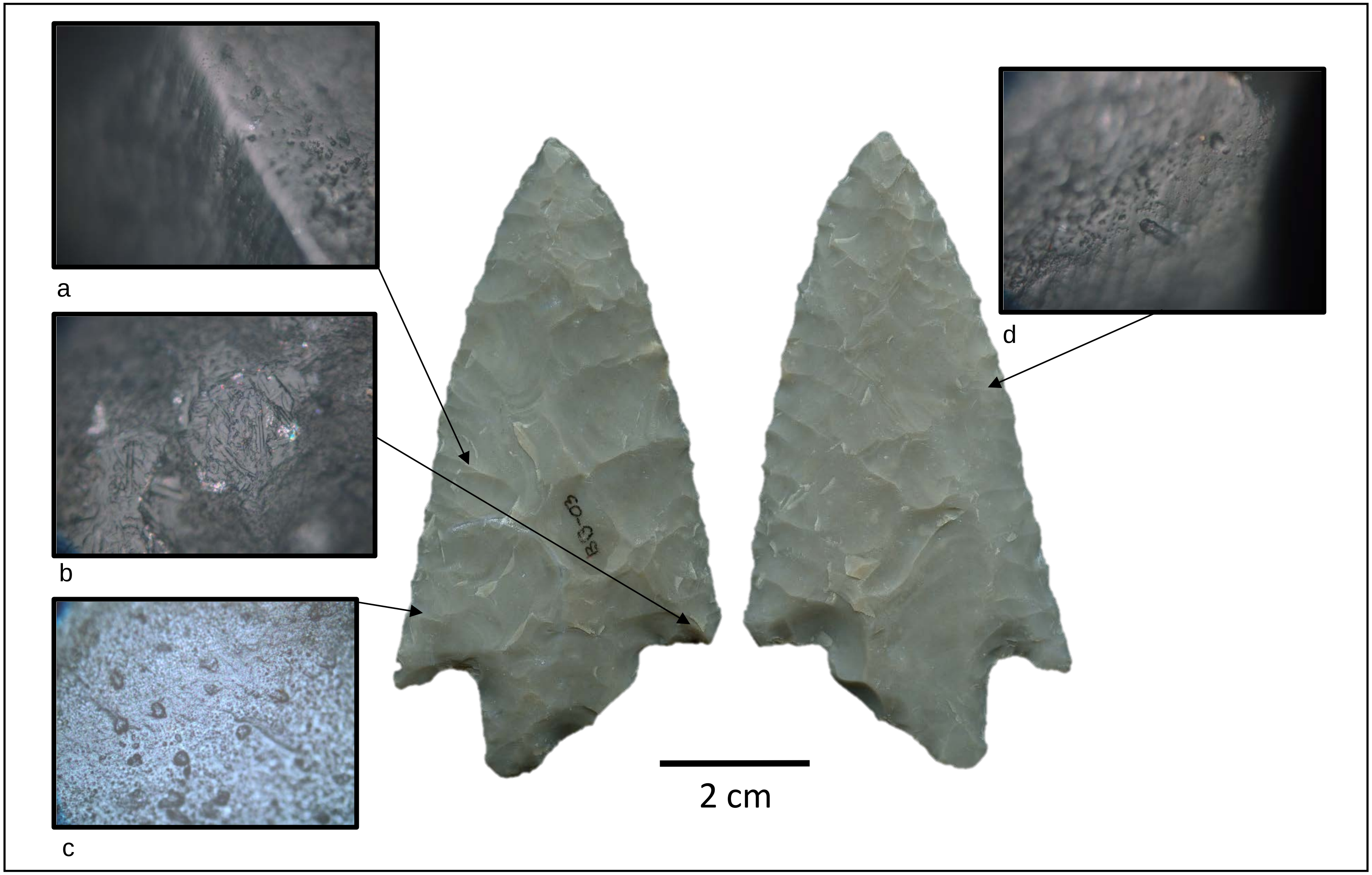
Finally, due to the large portion of this sample that was affected by PDSM, a study regarding the relationship of Georgetown flint to the mechanical and chemical processes affecting surface alteration is desirable. Extensive studies have been undertaken regarding the effects of PDSM on flint artifacts (Sala 1996, Burroni 2003), but these were not focused on Georgetown flint which is found in extremely large quantities at the Gault Site.

The present study has shown the value of wear analysis as a method for advancing our knowledge of the activities at the Gault Site and offered a first step towards further investigations. It has also added to the literature showing the need for caution in the association between form and sole function.

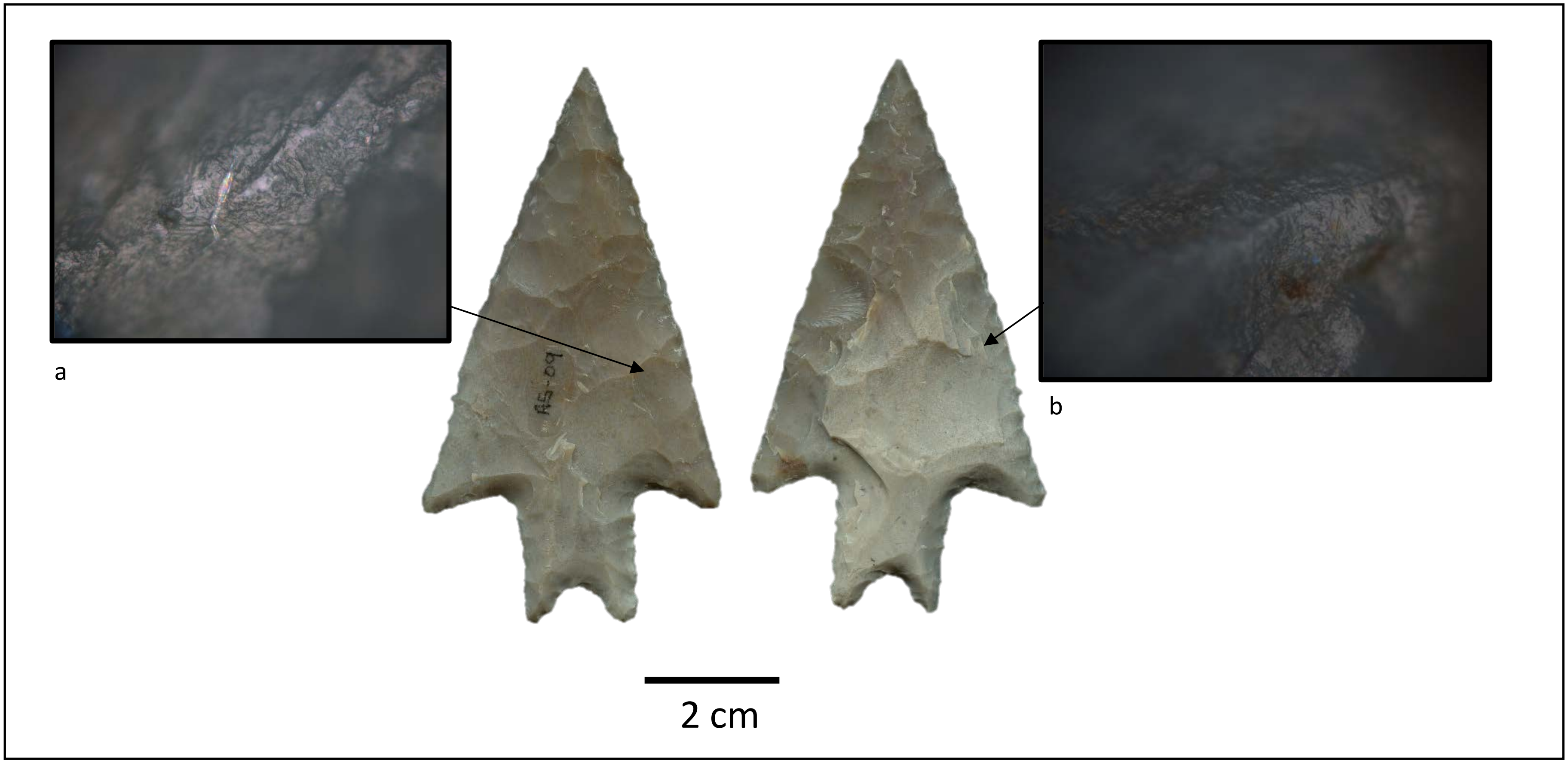
Plates for Chapter Four

Photomicrographic Images of Experimental Specimens

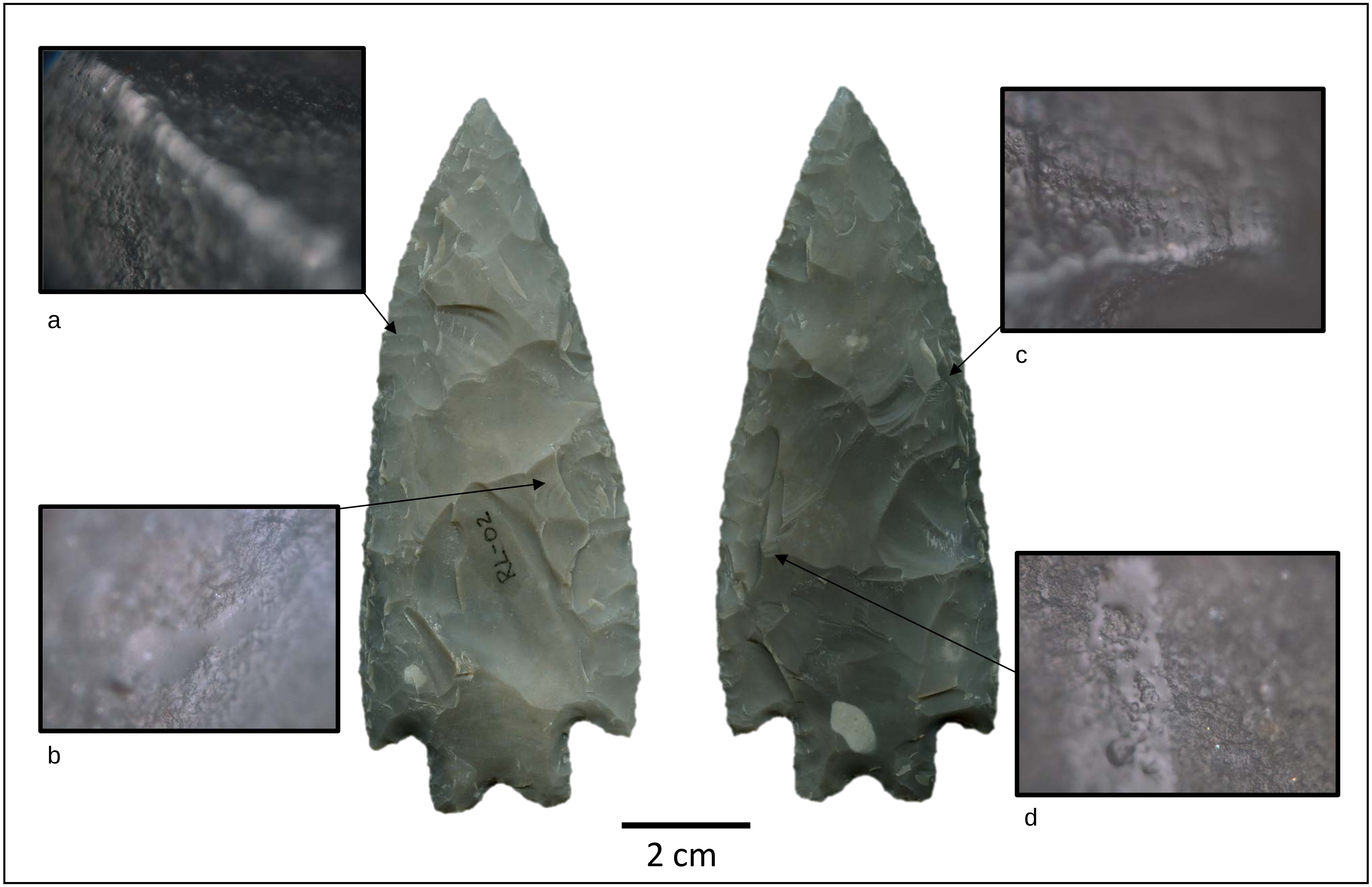
4.1 Photomicrographs of experimental specimen BB-03. Wear that results from cutting little bluestem for 90 minutes. All photomicrographs at 500X original magnification. (a,d) Siliceous plant traces in the form of completely linked polish exhibiting very fine parallel striations. (b) Prehensile wear in the form of wide, deep crosshatched striations in highly reflective polish. (c) Finger grease prior to cleaning.



4.2 Photomicrographs of experimental specimen AS-09. Wear resulting from whittling the bark off a branch of dry live oak for 60 minutes. All photomicrographs at 500X original magnification. (a) Finger grease prior to cleaning. (b) Light patchy wood polish.

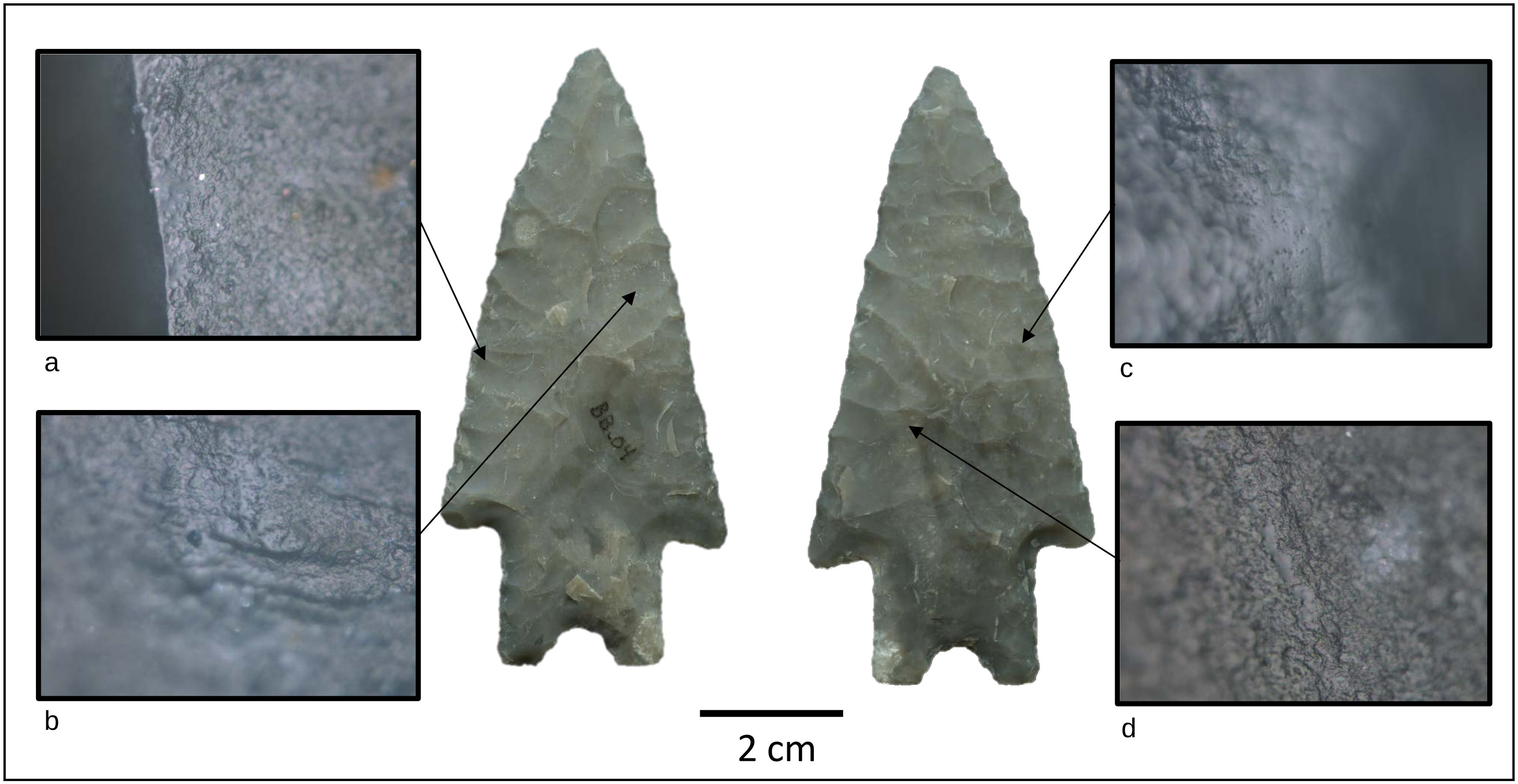


4.3 **Photomicrographs of experimental specimen RL-02. Wear resulting from sawing through the branch of dry live oak for 60 minutes. All photomicrographs at 500X original magnification. (a,c) Narrow bands of heavy wood polish with faint striations running roughly parallel to the blade edges. (b,d) Finger grease prior to cleaning.**

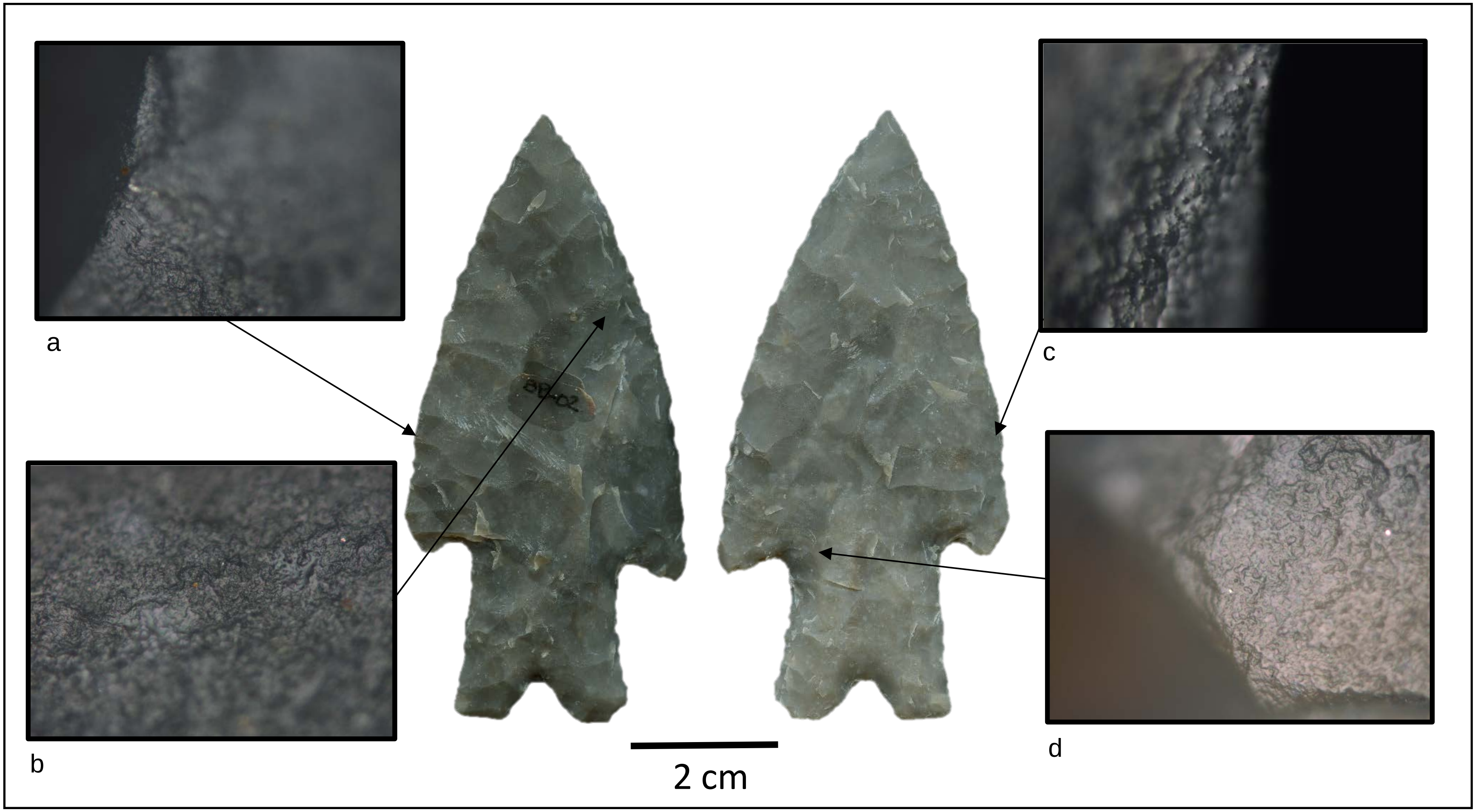


4.4 Photomicrographs of experimental specimen BB-01. Wear resulting from whittling the bark off a branch of green live oak for 60 minutes. All photomicrographs at 500X original magnification. (b) Heavy wood polish with faint oblique striations. (a,c) Finger grease prior to cleaning.

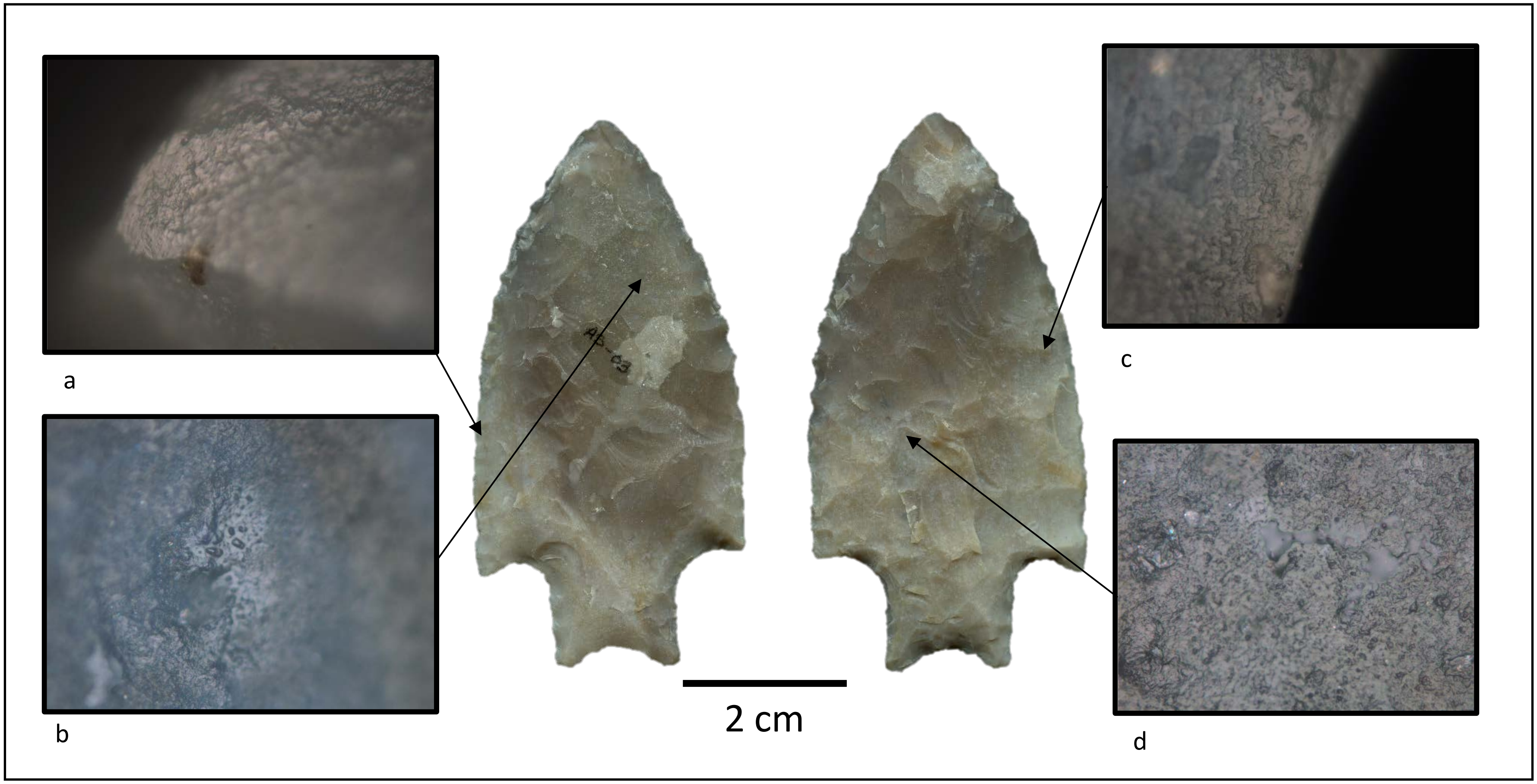
4.5 Photomicrographs of experimental specimen BB-04. Wear that results from sawing through a branch of green live oak for 60 minutes. All photomicrographs at 500X original magnification. (a) Small intermittent band of wood polish on a high ridge. (c) Faint striations in a band of undulating polish. (b,d) Finger grease prior to cleaning.



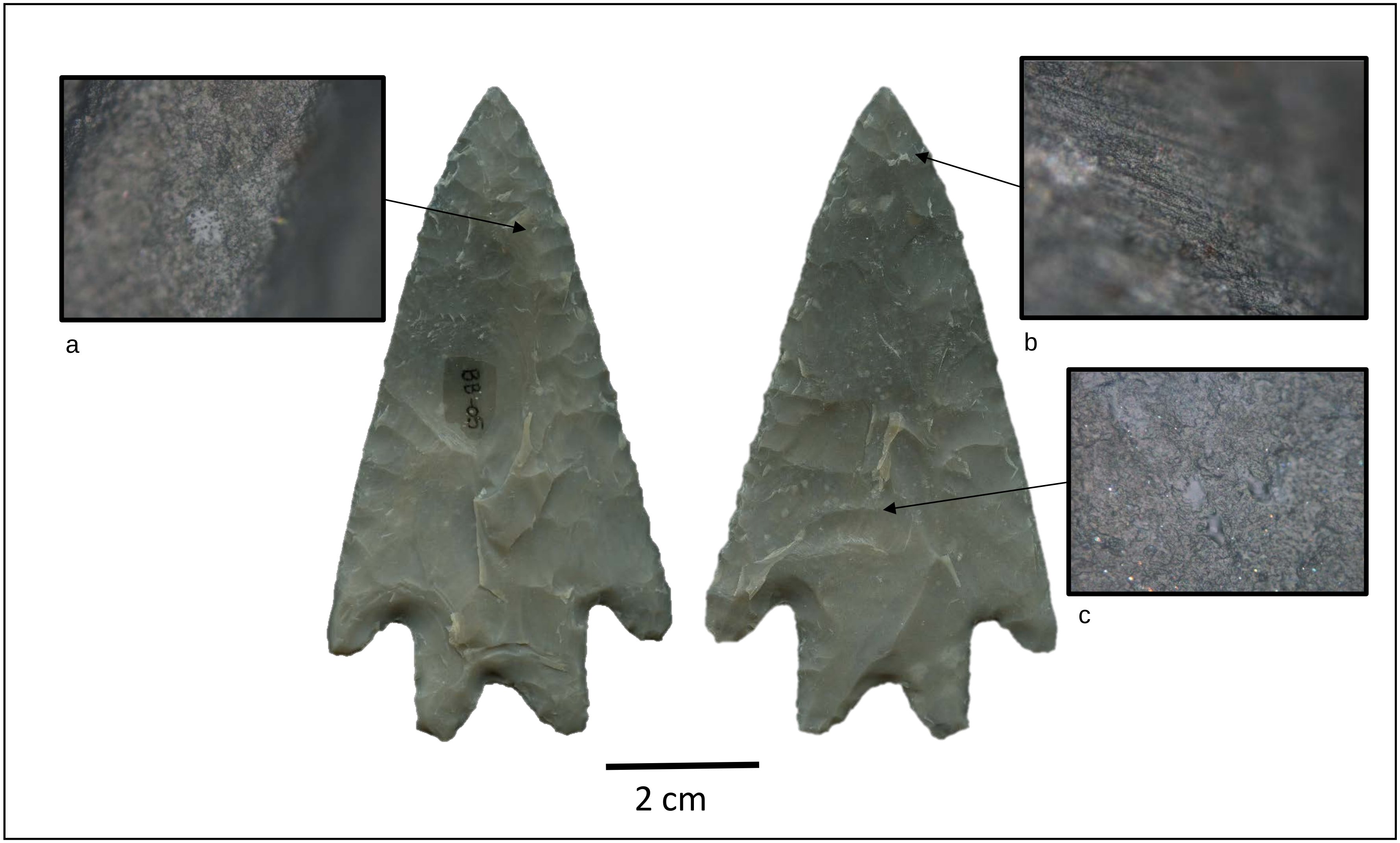
4.6 **Photomicrographs of experimental specimen BB-02. Wear resulting from whittling the bark off a branch of dry black willow for 60 minutes. All photomicrographs at 500X original magnification. (a,c) Patches domed polish in various stages of development along both blade edges. (b,d) Finger grease prior to cleaning.**



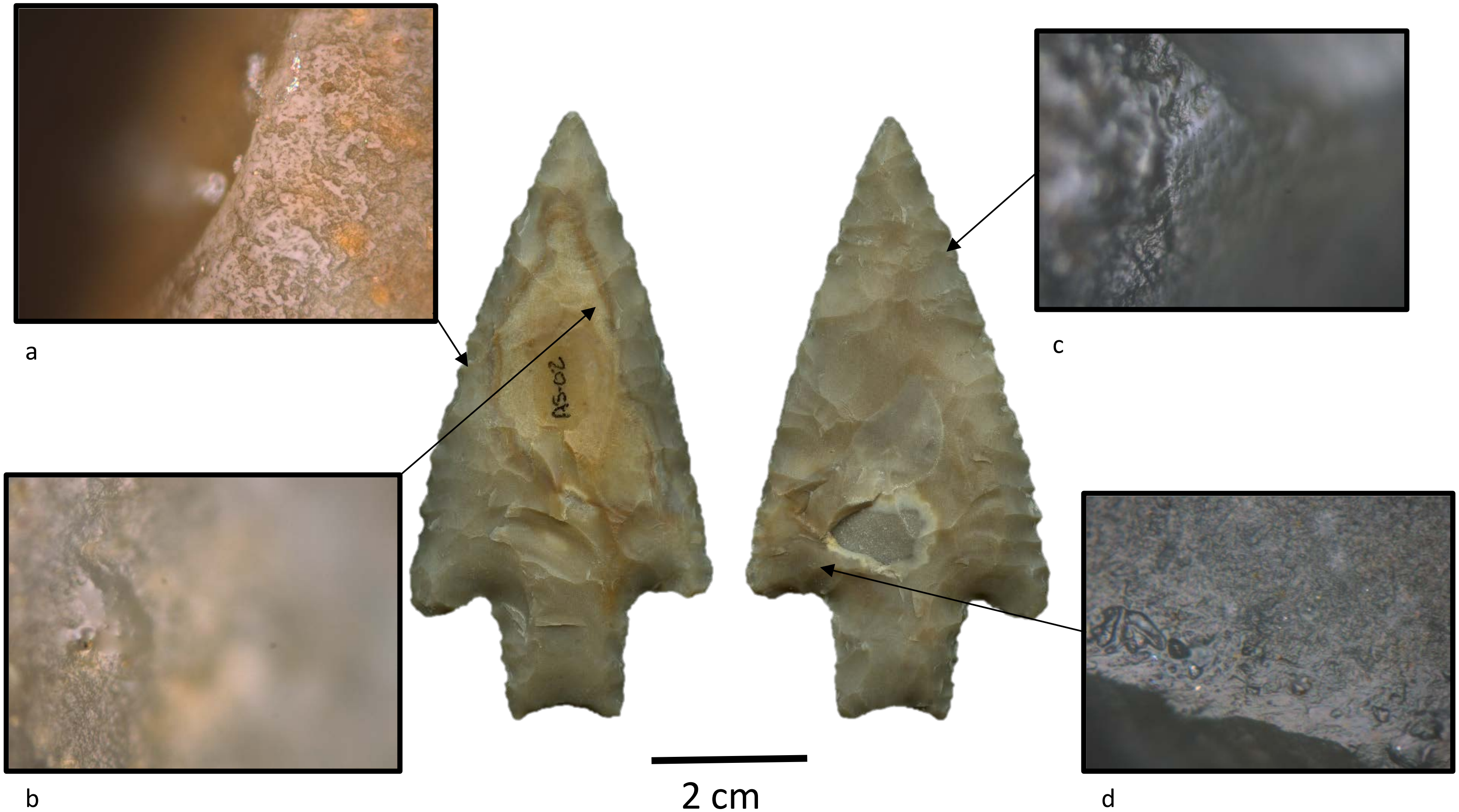
4.7 Photomicrographs of experimental specimen AS-03. Wear resulting from sawing through a branch of green black willow for 60 minutes. All photomicrographs at 500X original magnification. (a) Highly reflective polish along blade edge. (b) Polish on high ridges of a flake scars. (b,d) Finger grease prior to cleaning.



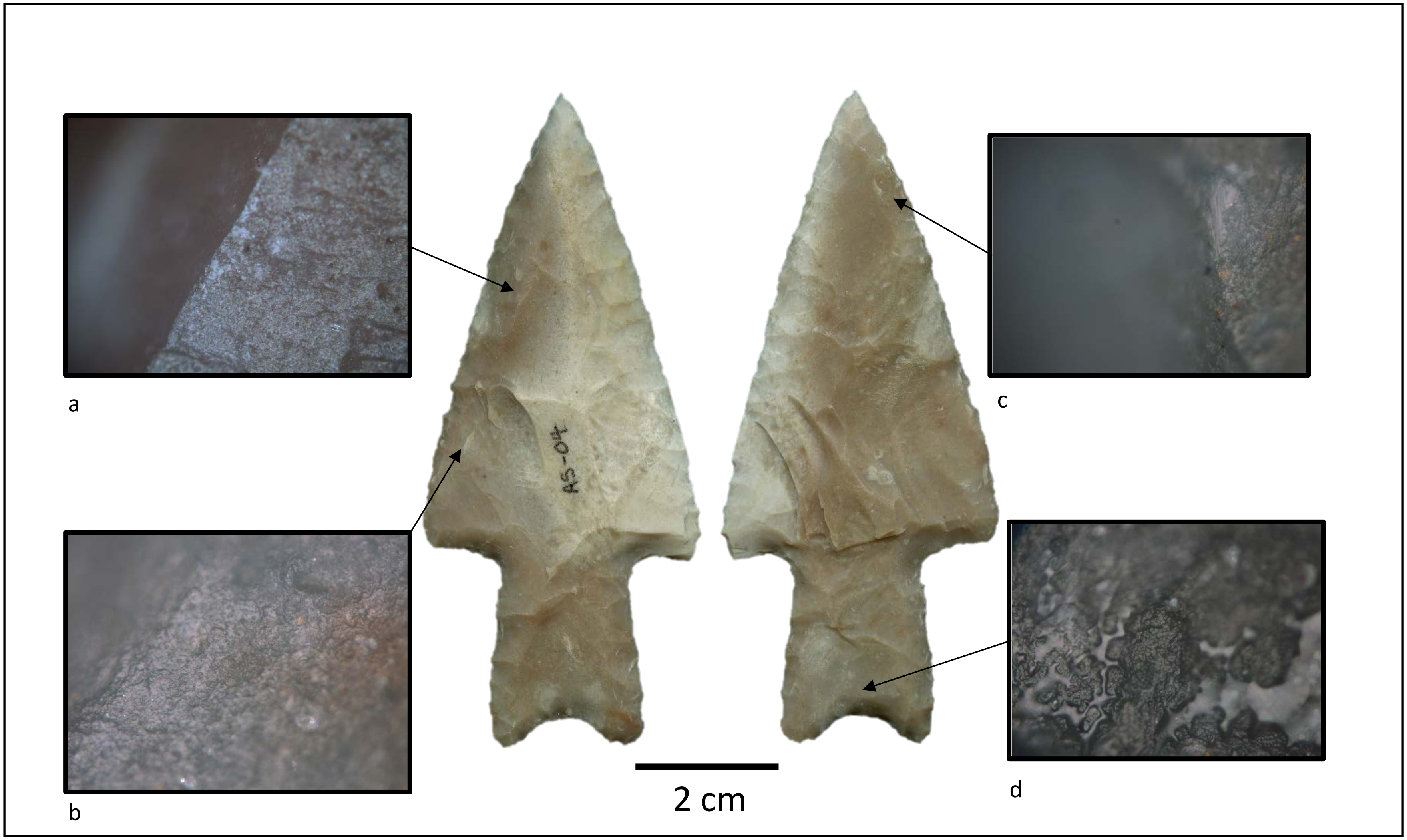
4.8 Photomicrographs of experimental specimen BB-05. Wear resulting from whittling the branch of green black willow for 60 minutes. All photomicrographs at 500X original magnification. (b) Long thin striations perpendicular to the cutting edge in a gently undulating polish. (a,c) Finger grease prior to cleaning.



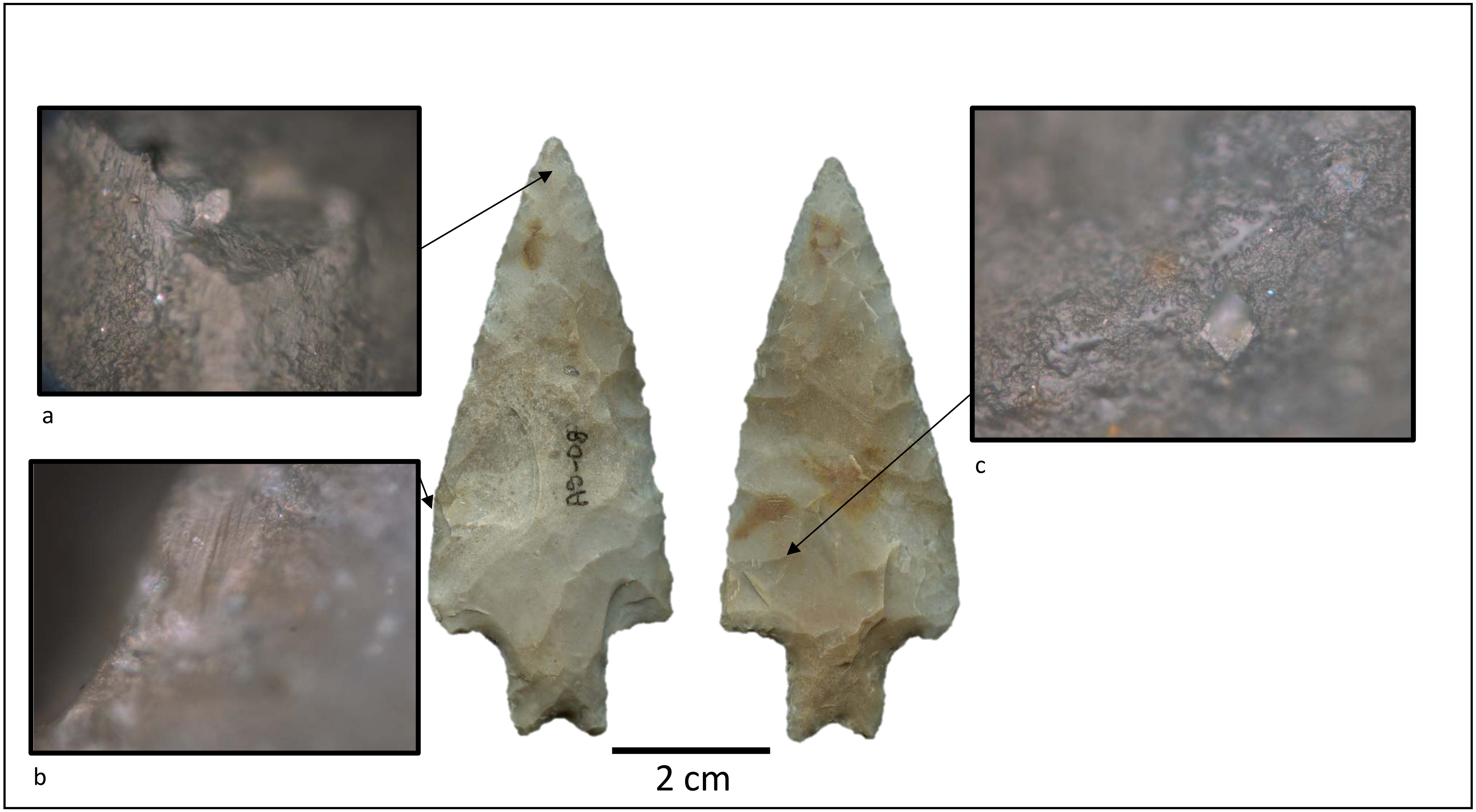
4.9 Photomicrographs of experimental specimen AS-02. Wear resulting from sawing through a branch of dry black willow for 60 minutes. All photomicrographs at 500X original magnification. (a) Bright undulating polish. (c) Bright undulating polish exhibiting faint striations. (b,d) Finger grease prior to cleaning.



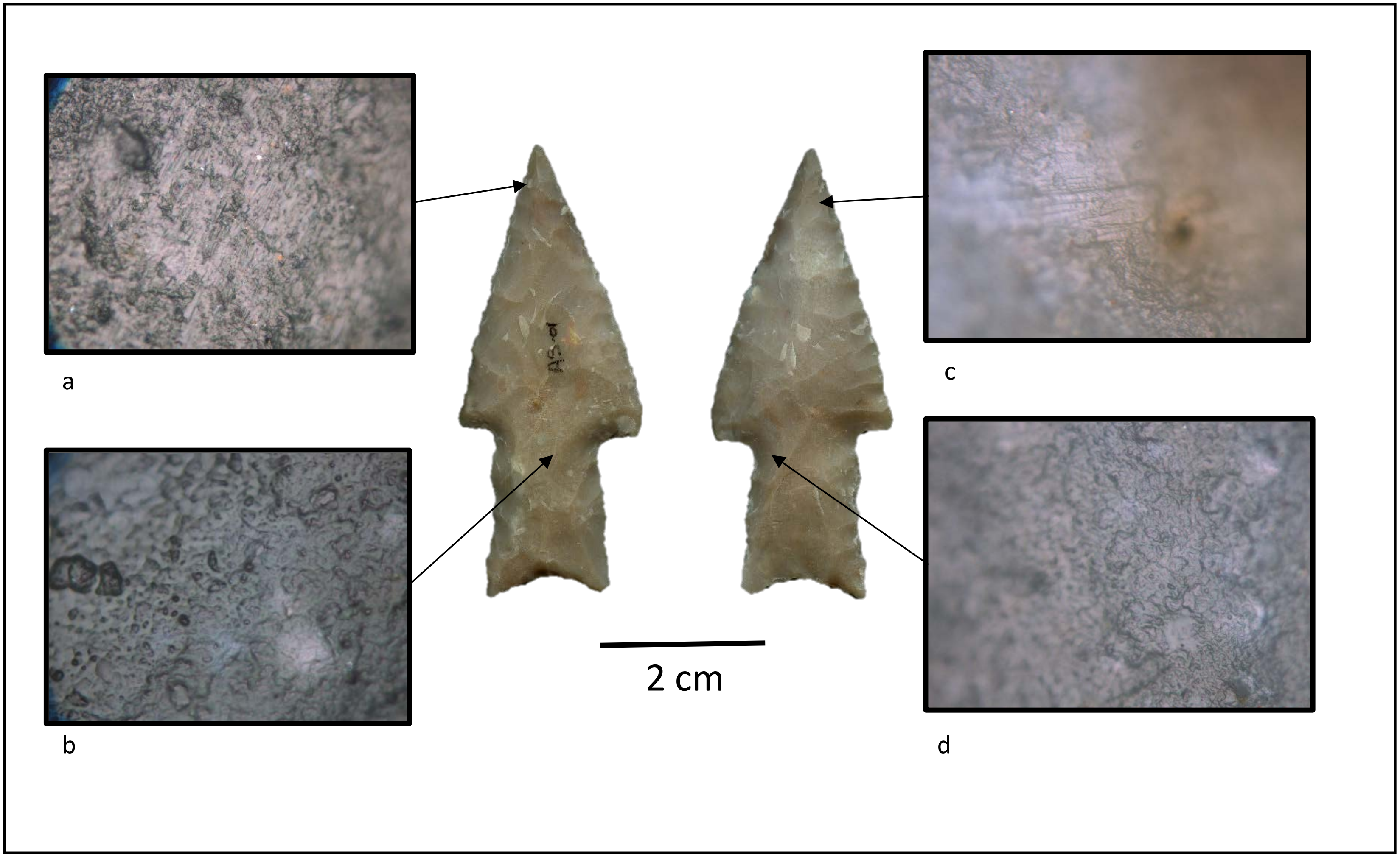
4.10 Photomicrographs of experimental specimen AS-04. Wear resulting from sawing grooves into the tine of a white tail deer antler for 30 minutes. All photomicrographs at 500X original magnification. (a,b,c) Light patchy polish. (d) Finger grease prior to cleaning.



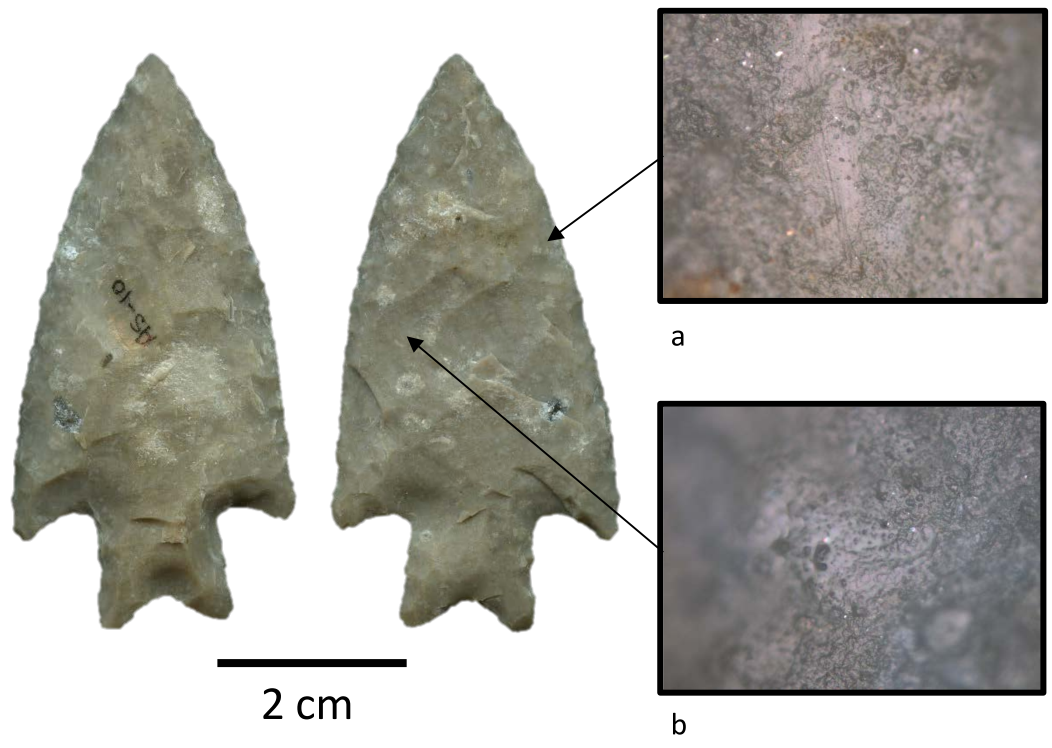
4.11 Photomicrographs of experimental specimen AS-08. Wear resulting from scraping a white tail deer antler for 30 minutes. All photomicrographs at 500X original magnification. (a,b) Grainy polish exhibiting deep, wide, striations running parallel to the cutting edge of the tool. (c) Finger grease prior to cleaning.



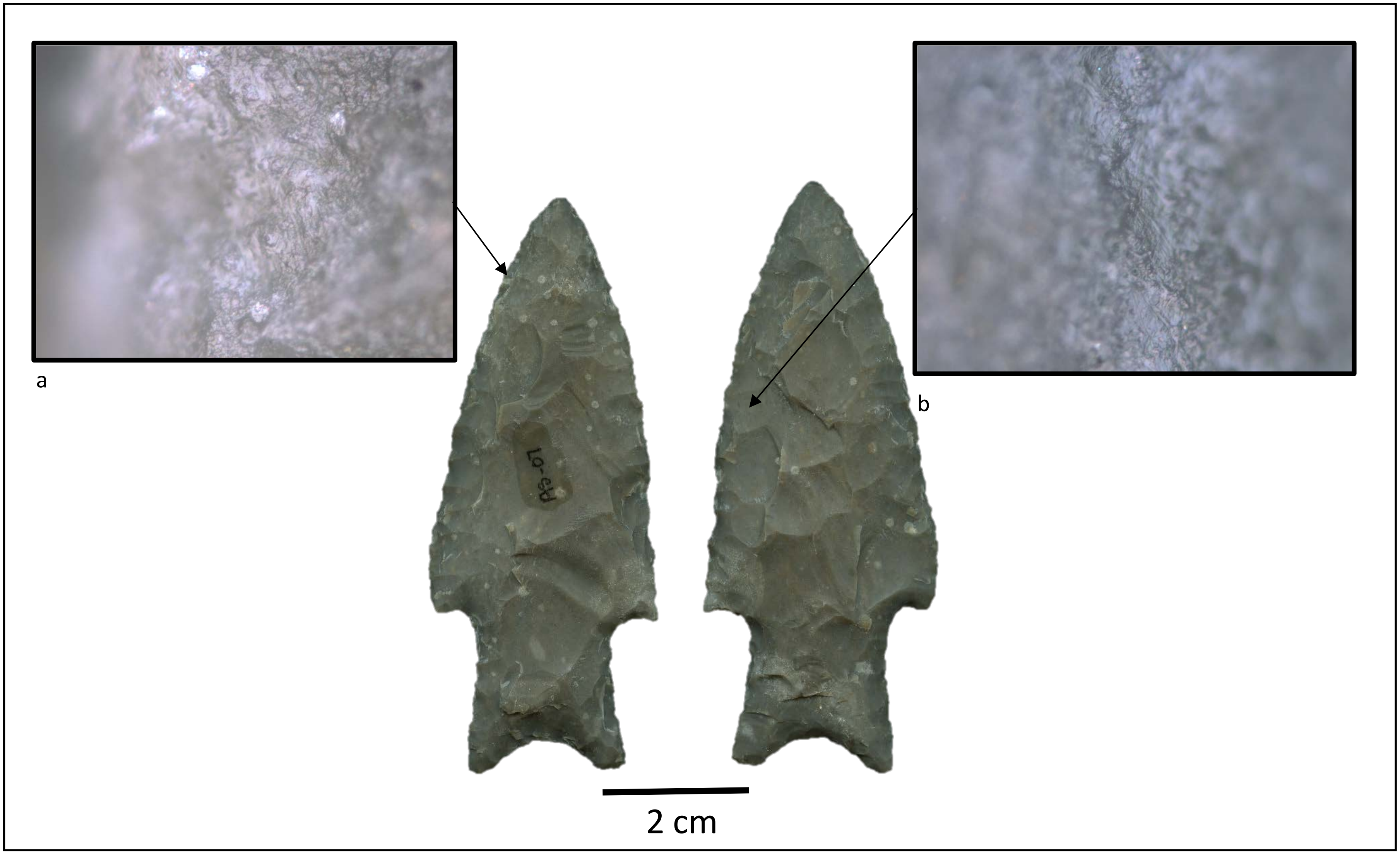
4.12 Photomicrographs of experimental specimen AS-01. Wear that results from whittling a fresh white tail deer ulna for 30 minutes. All photomicrographs at 500X original magnification. (a) Grainy, undulating polish with long, thin striations running parallel to the cutting edge. (c) Grainy undulating polish with long striations running perpendicular to the cutting edge. (b,d) Finger grease prior to cleaning.



4.13 **Photomicrographs of experimental specimen AS-10. Wear resulting from sawing eight V shaped grooves into a fresh white tail deer ulna for 30 minutes. All photomicrographs at 500X original magnification. (a) Coarse, textured polish with long, thin striations. (b) Finger grease prior to cleaning.**



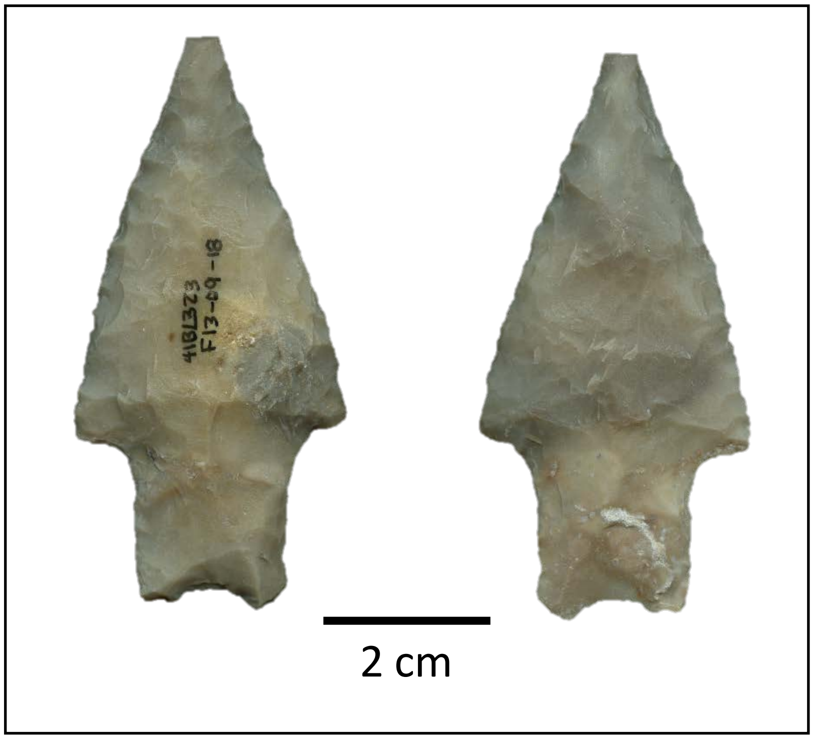
4.14 Photomicrographs of experimental specimen AS-07. Wear resulting from removing meat from a white tail deer ulna, followed by 30 minutes of cutting meat into strips. All photomicrographs at 500X original magnification. (a,b) Dull polish with a greasy luster exhibiting short, relatively deep, wide and crosshatched striations from cutting a mix of bone and meat.



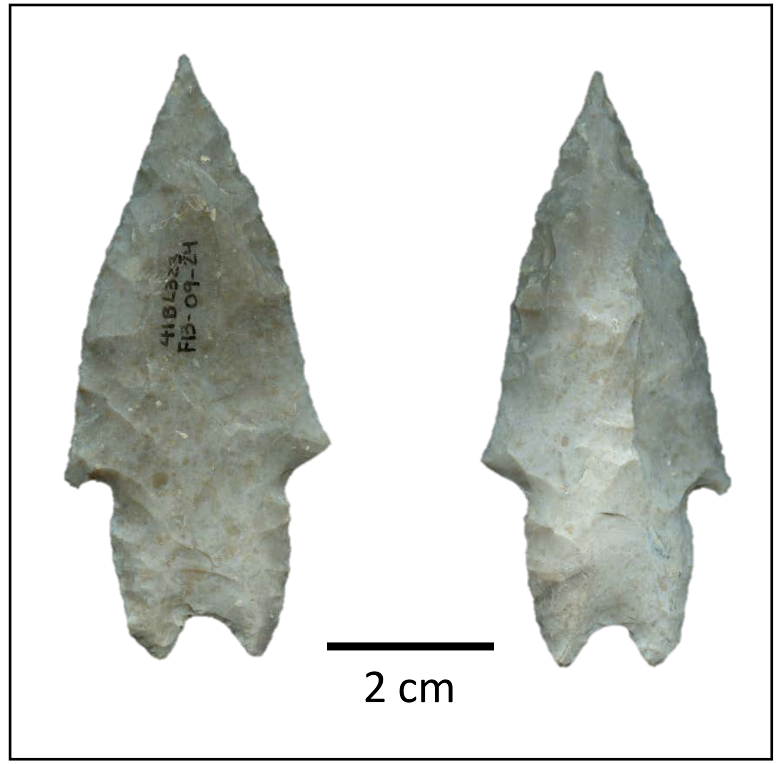
Plates for Chapter Five

Macroscopic and Photomicrographic Images of Prehistoric Specimens

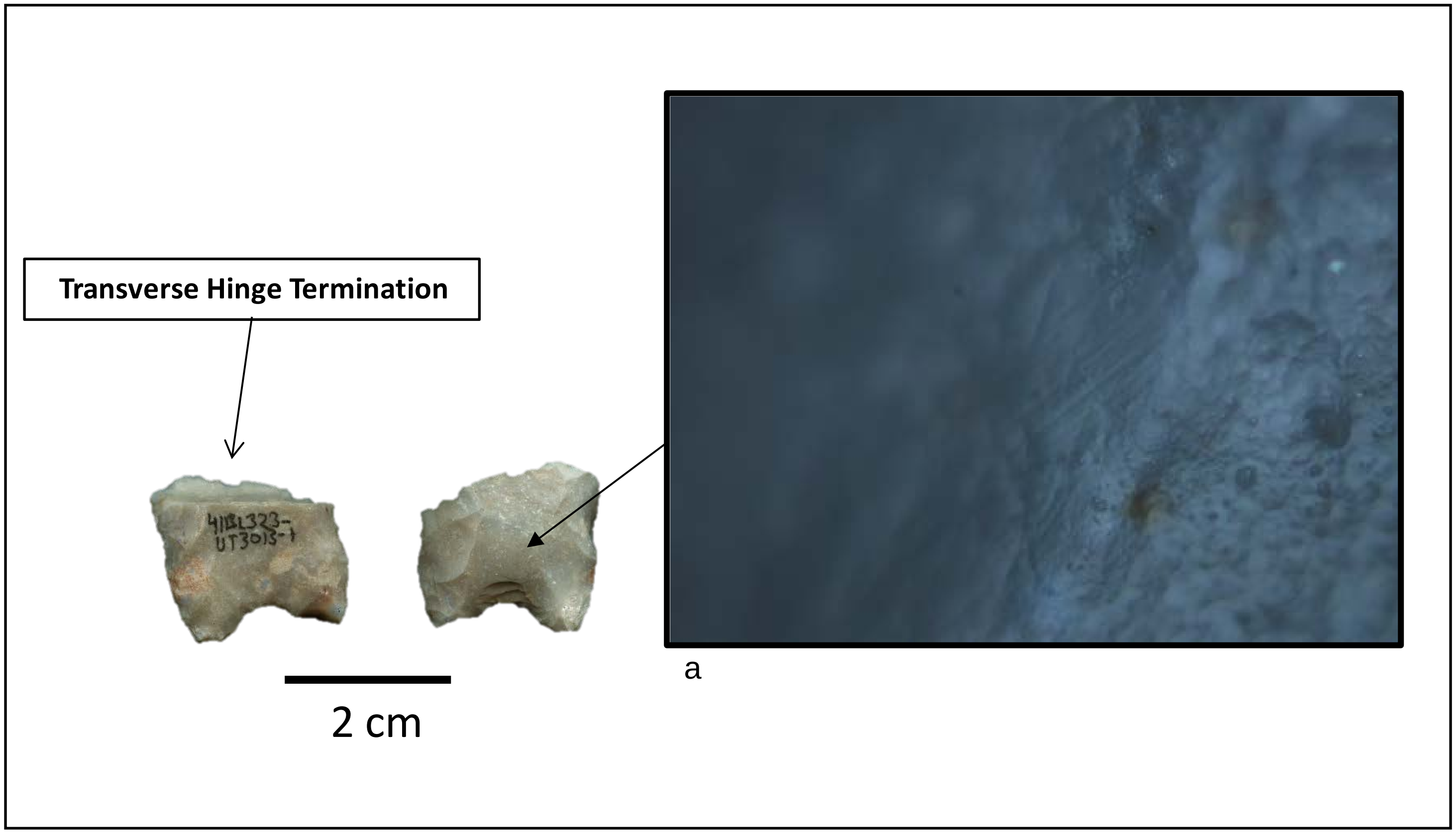
5.1 **Image to show the form of prehistoric specimen F13-09-18.**
Note: Series of small flake scars along both blade edges and weak shoulders indicative of reworking.



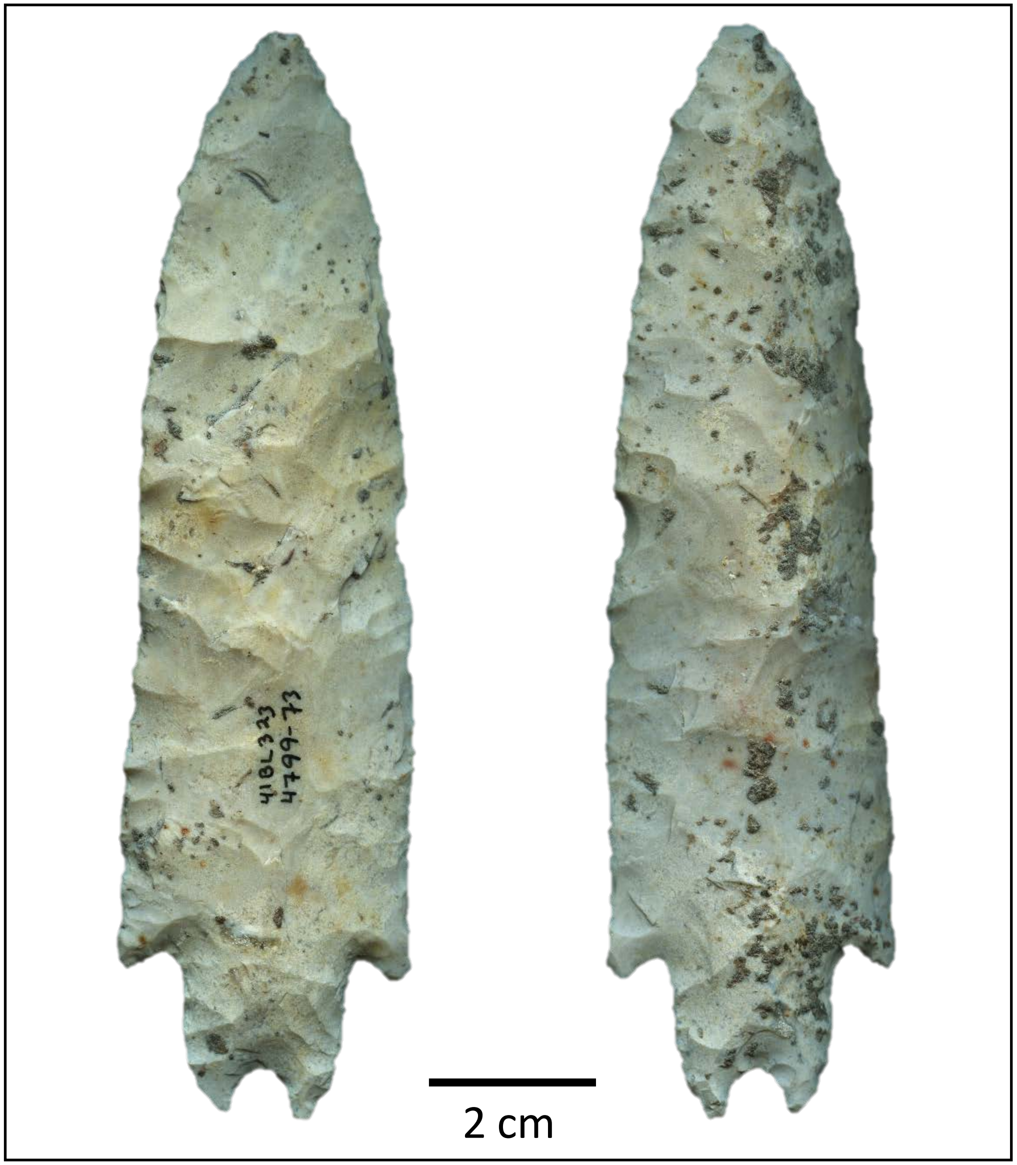
5.2 **Image to show the form of prehistoric specimen F13-09-24.**
Note: Series of small flake scars along both blade edges, weak shoulders, and flared barb indicative of reworking.



5.3 Photomicrographs of prehistoric specimen 3013-1. All photomicrographs at 500X original magnification. (a) Oblique striations in a well developed polish, indicative of use in a haft.



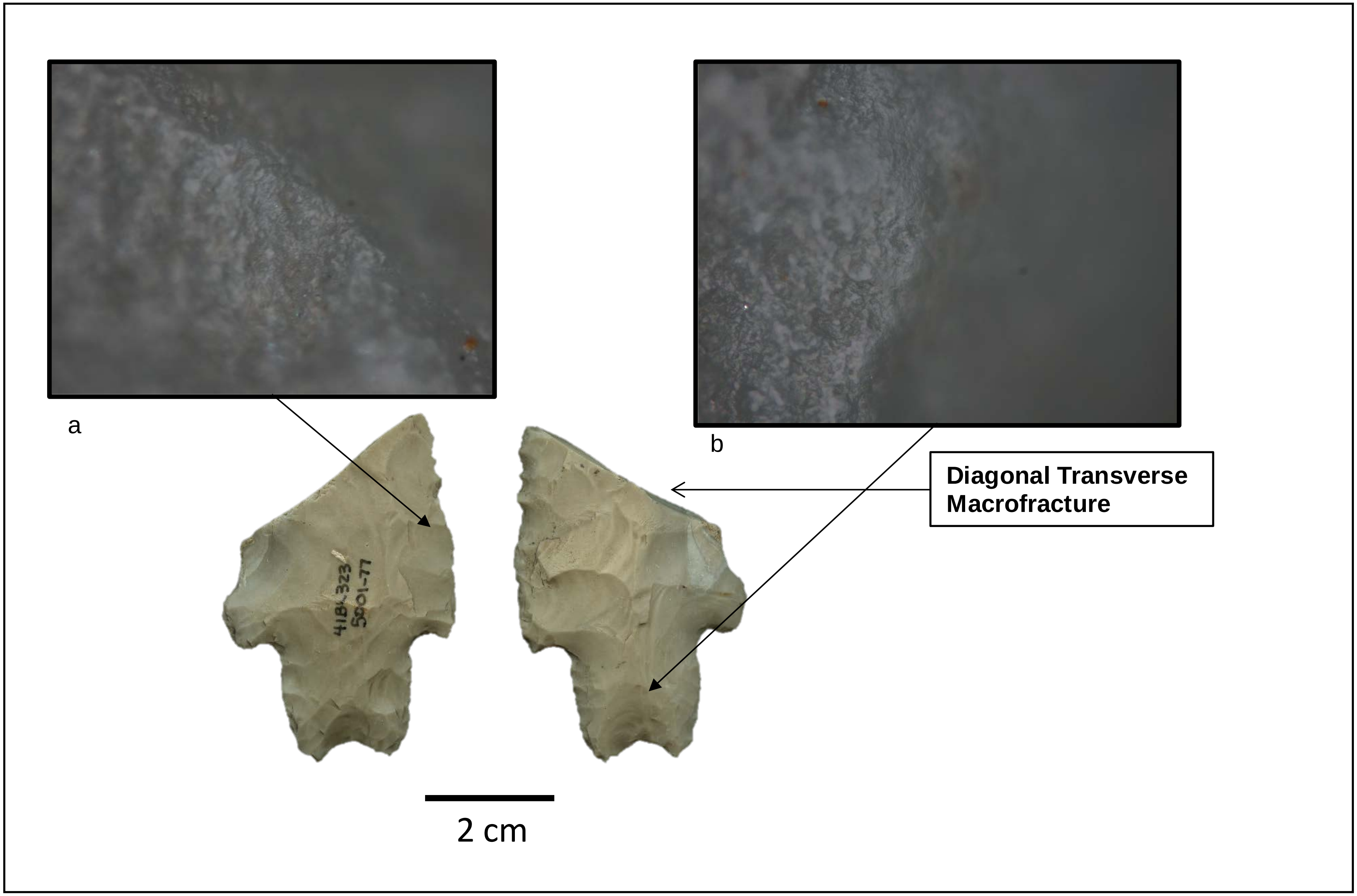
5.4 **Image to show the form of prehistoric specimen 4799-73.**



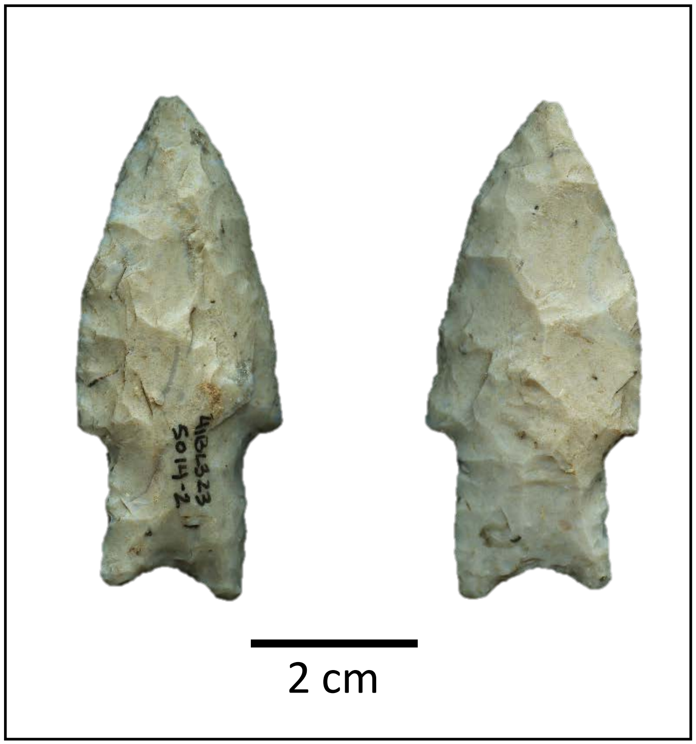
5.5 **Image to show form of Prehistoric Specimen 5001-21.**
Note: Series of small flake scars along blade edges, narrow blade, and weak shoulder indicative of reworking.

5.6 **Image to show the form of prehistoric specimen 5001-22.**
Note: Series of small flake scars along blade edges, weak shoulders, and shortened blade indicative of reworking.

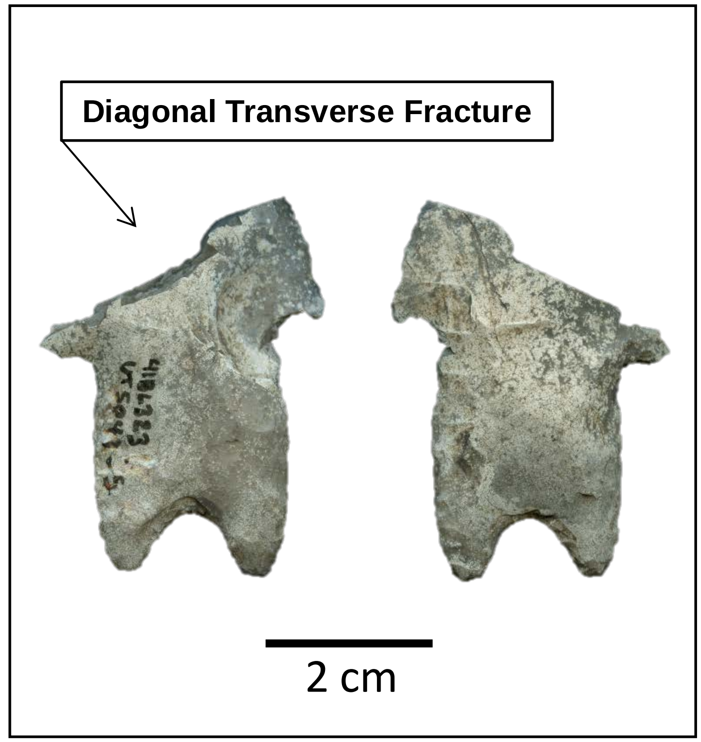
5.7 Photomicrographs of prehistoric specimen 5001-77. All photomicrographs at 500X original magnification. (a) Meat polish with a grainy texture and greasy luster exhibiting obliquely oriented striations. (b) Haft polish. Note: Beveled and partially serrated left blade edge indicative of reworking.



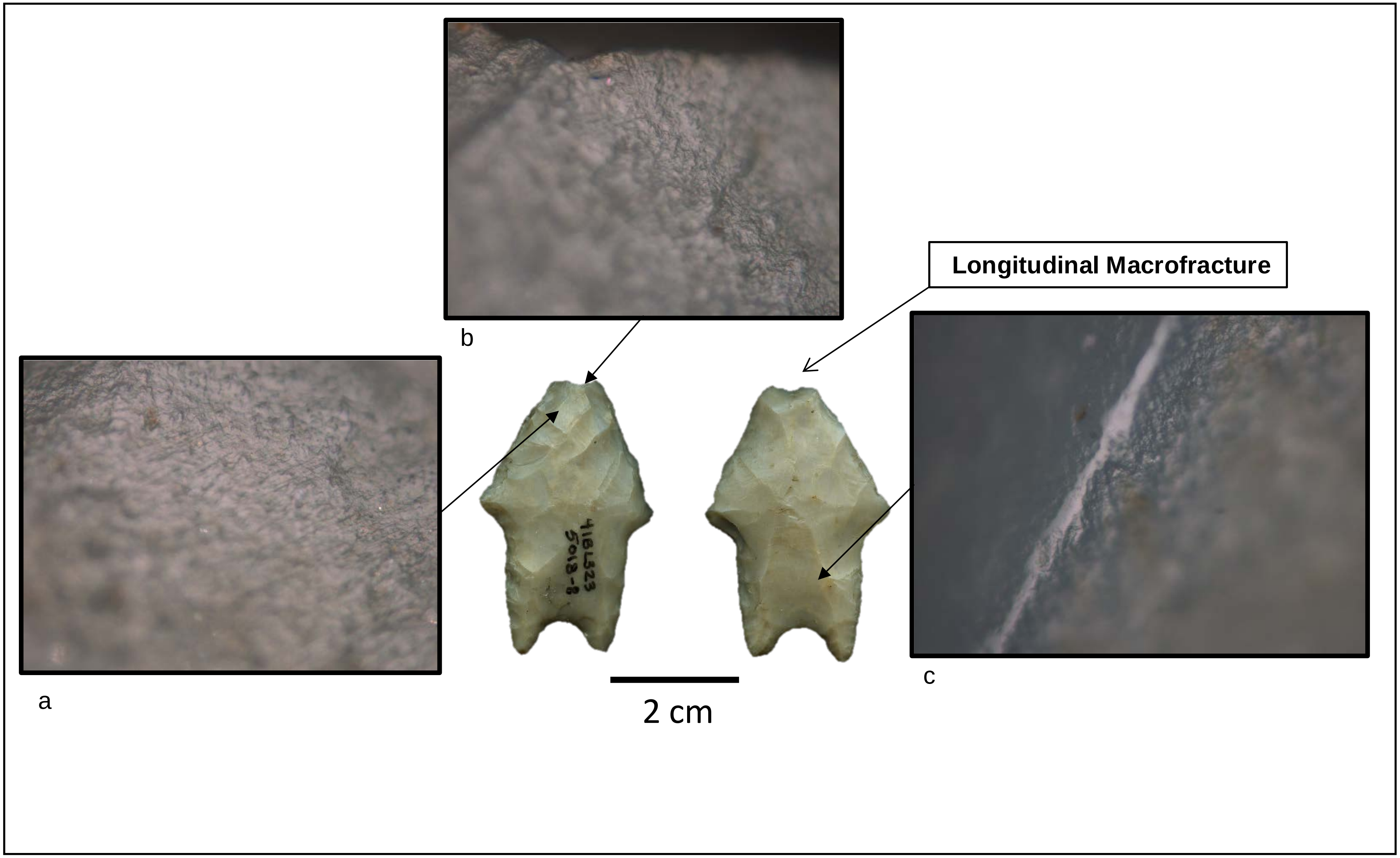
5.8 **Image to show the form of prehistoric specimen 5014-2-SF2.**
Note: Invasive flaking and weak shoulders indicative of reworking.



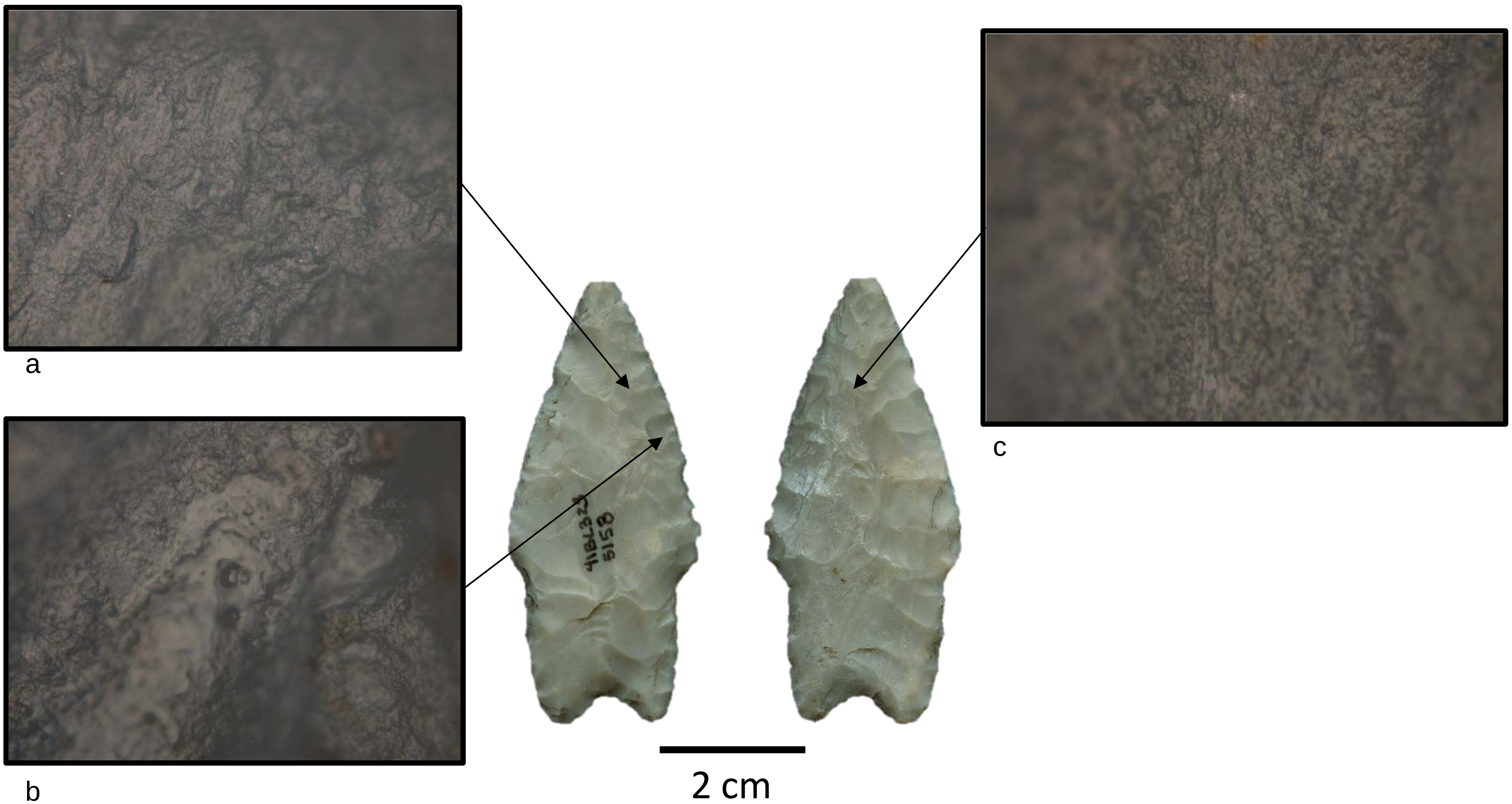
5.9 **Image showing fracture and extreme thermal damage of prehistoric specimen 5049-5.**



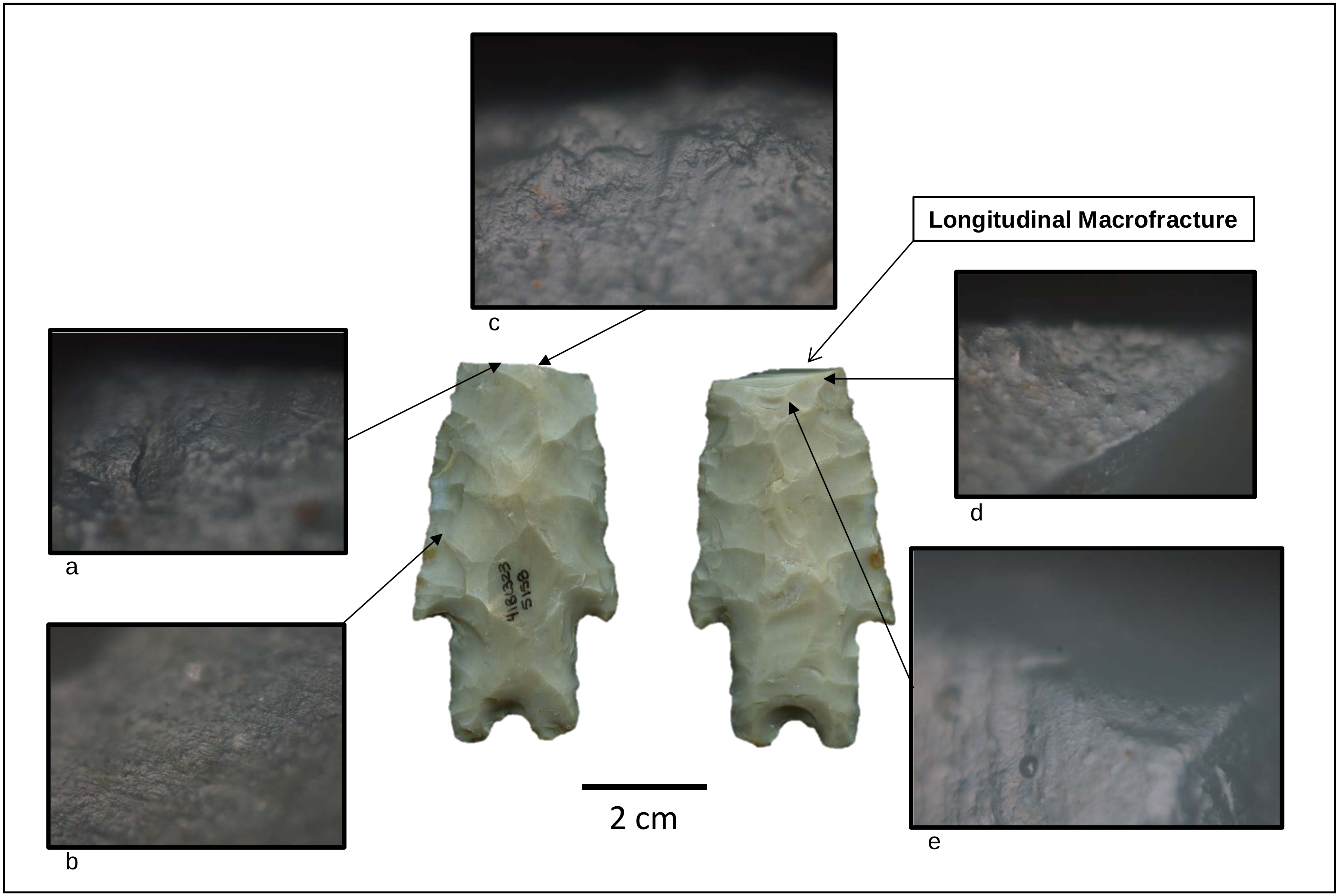
5.10 **Photomicrographs of prehistoric specimen 5018-8-SF3. All photomicrographs at 500X original magnification. (a) Well developed dull polish with a grainy texture and greasy luster with oblique striations. (b) Dull polish with a grainy texture and greasy luster. (c) Highly reflective, localized, haft polish.**
Note: Invasive pressure flaking on the dorsal face and shortened blade indicative of reworking.



5.11 **Photomicrographs of prehistoric specimen 5158-SF8. All photomicrographs at 500X original magnification. (a-c) Hard plant polish like wood, similar to experimental specimen BB-04. This polish is bright and smooth with a domed aspect.**
Note: Invasive pressure flaking along both blade edges and almost non-existent shoulders indicative of reworking.

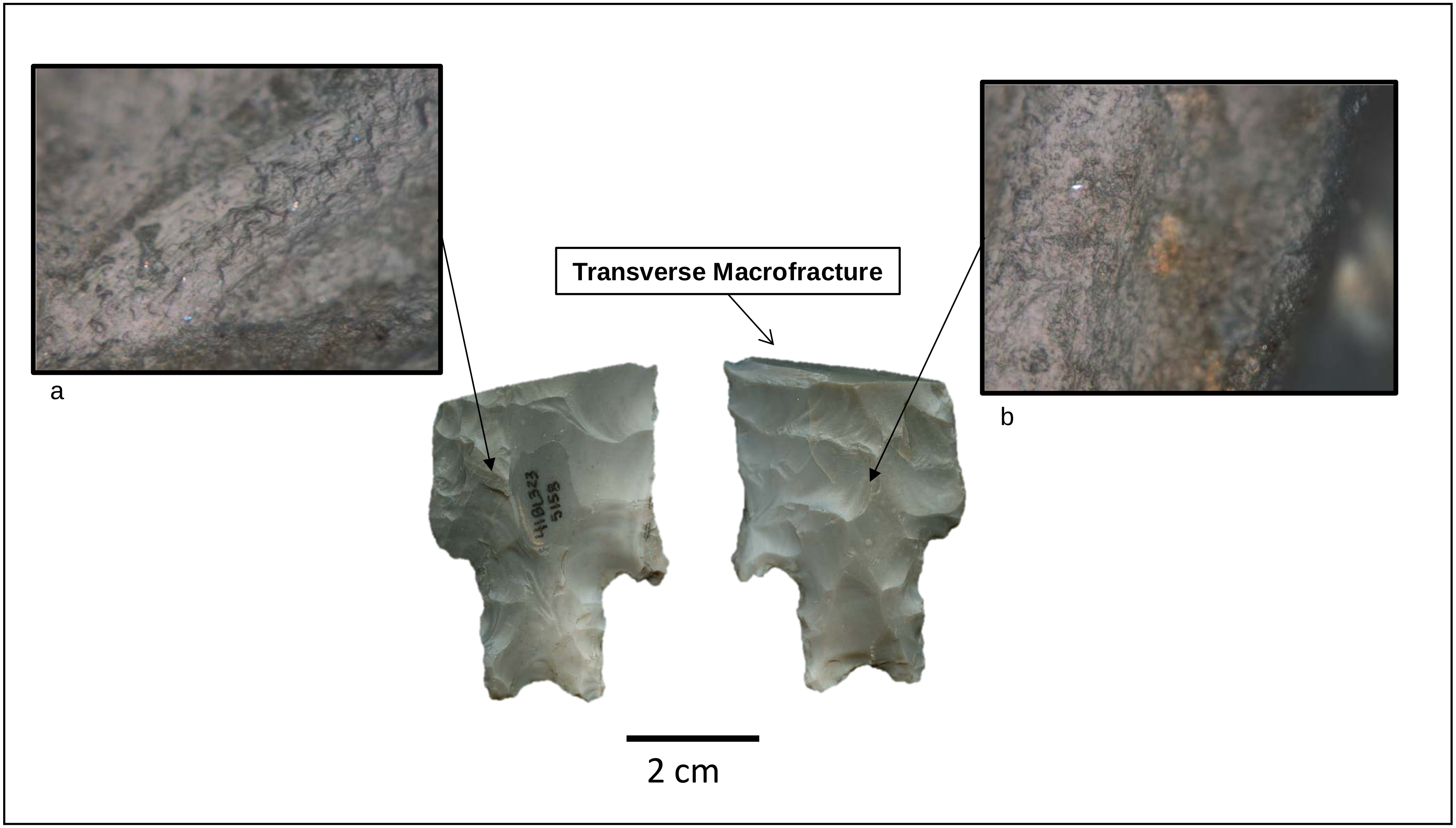


5.12 Photomicrographs of prehistoric specimen 5158-SF9. All photomicrographs at 500X original magnification. (a-e) Soft plant polish similar to experimental specimen BB-03. (c) Crosshatched striations in a soft plant polish. Note: Series of small flake scars on both left blade edges indicative of reworking.

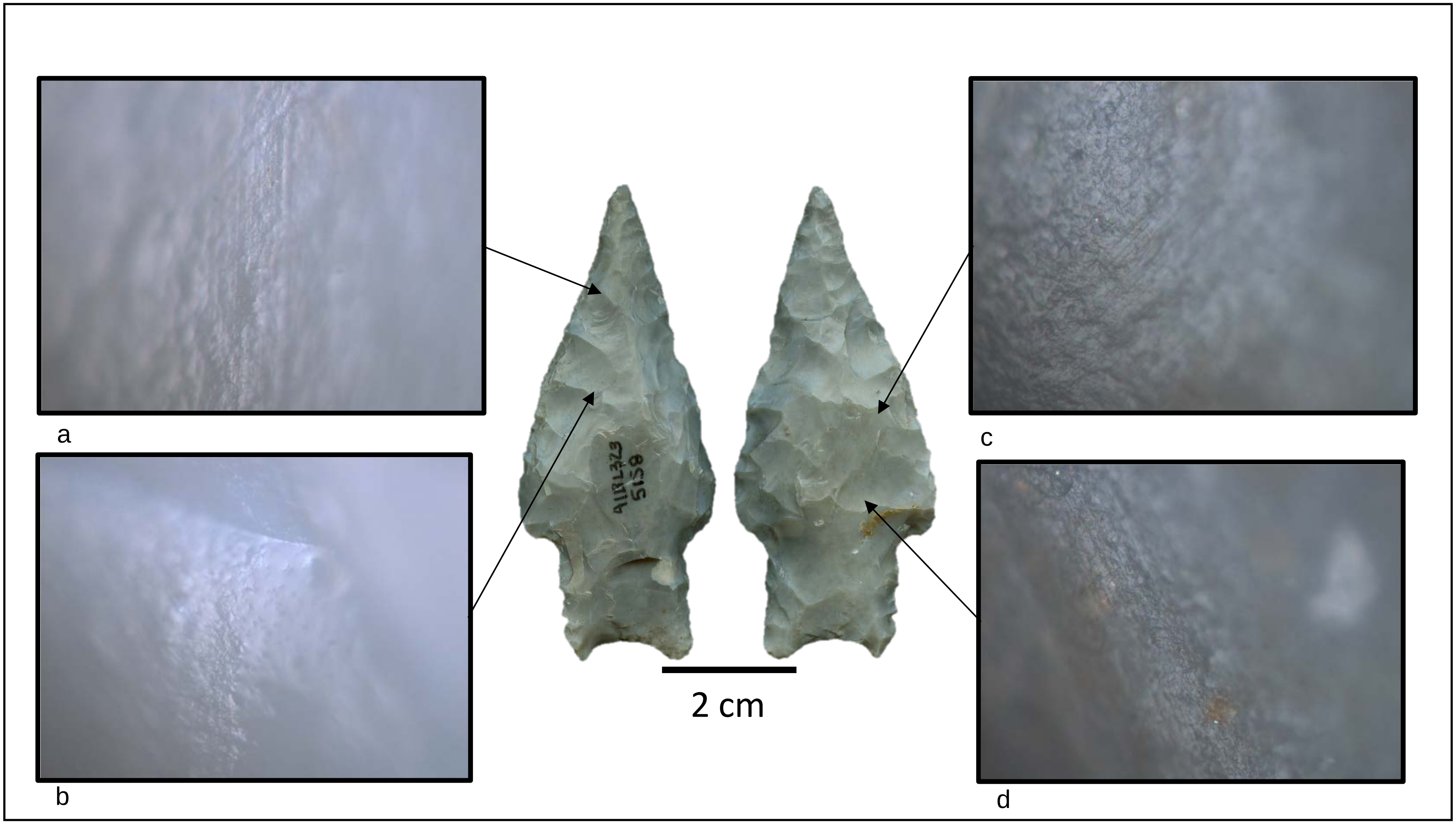


5.13 Photomicrographs of prehistoric specimen 5158-SF11. All photomicrographs at 500X original magnification. (a) Bright smooth polish with obliquely oriented striations consistent with butchery. (b) Moderately developed butchering polish with crosshatched striations.

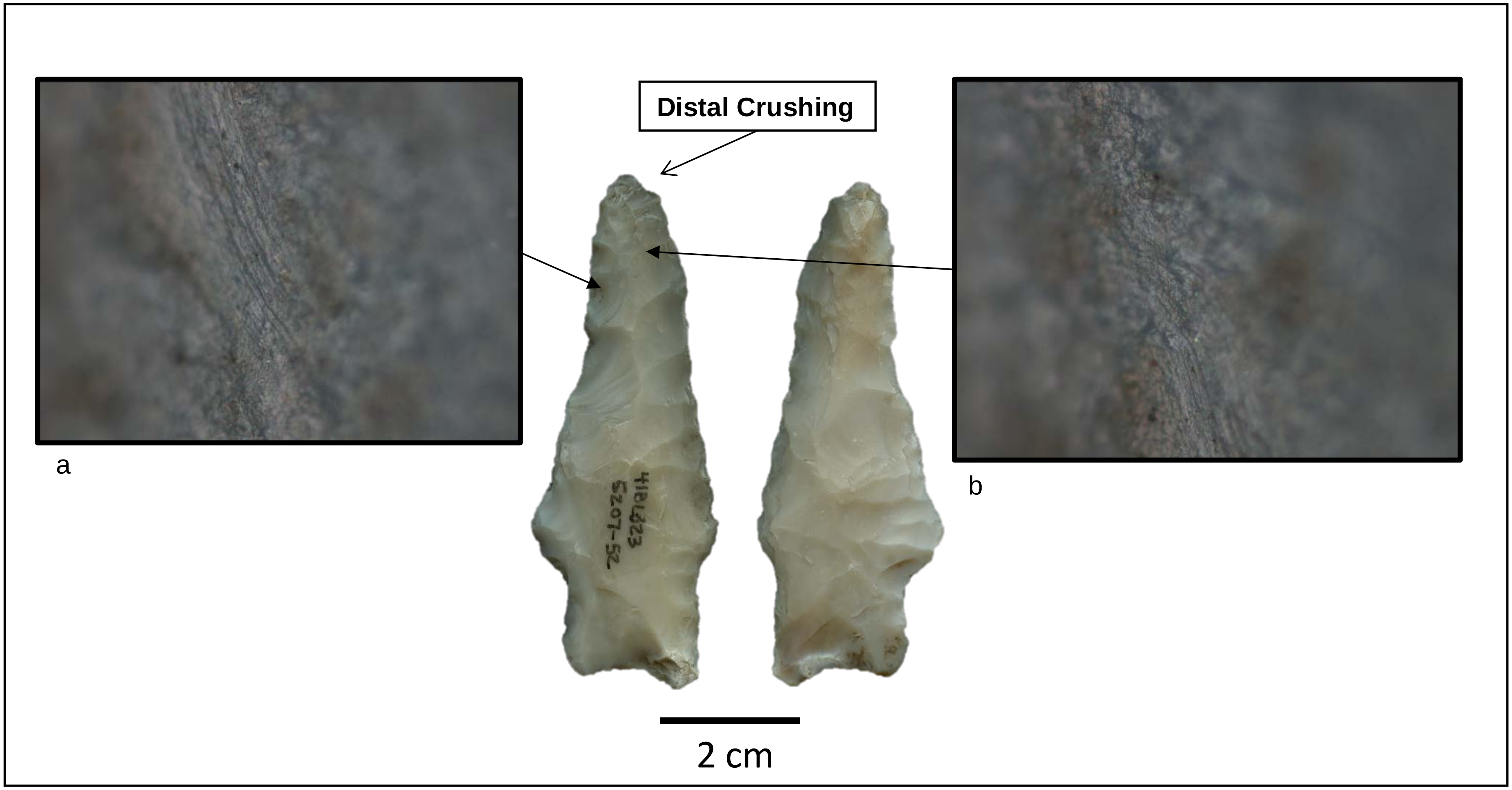
Note: Concave blade edge with invasive flaking and flared barb indicative or reworking.



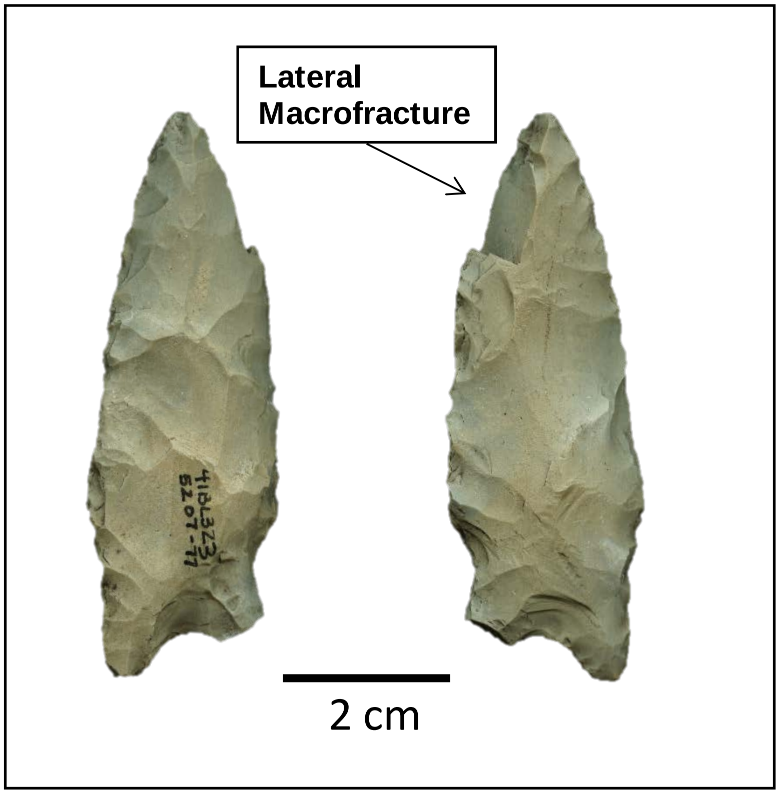
5.14 **Photomicrographs of prehistoric specimen 5158-SF12. All photomicrographs at 500X original magnification. (a,c,d) Hard plant polish similar to experimental specimen BB-05 exhibiting parallel and oblique striations. (b) Hard plant polish.**
Note: Invasive flaking, weak shoulders, and recurvate blade edge indicative of reworking.



5.15 Photomicrographs of prehistoric specimen 5207-52. All photomicrographs at 500X original magnification. (a,b) Hard plant polish exhibiting obliquely oriented striations. Wear is similar to experimental specimen BB-05. Note: Narrow, thick blade with invasive flaking indicative of reworking.

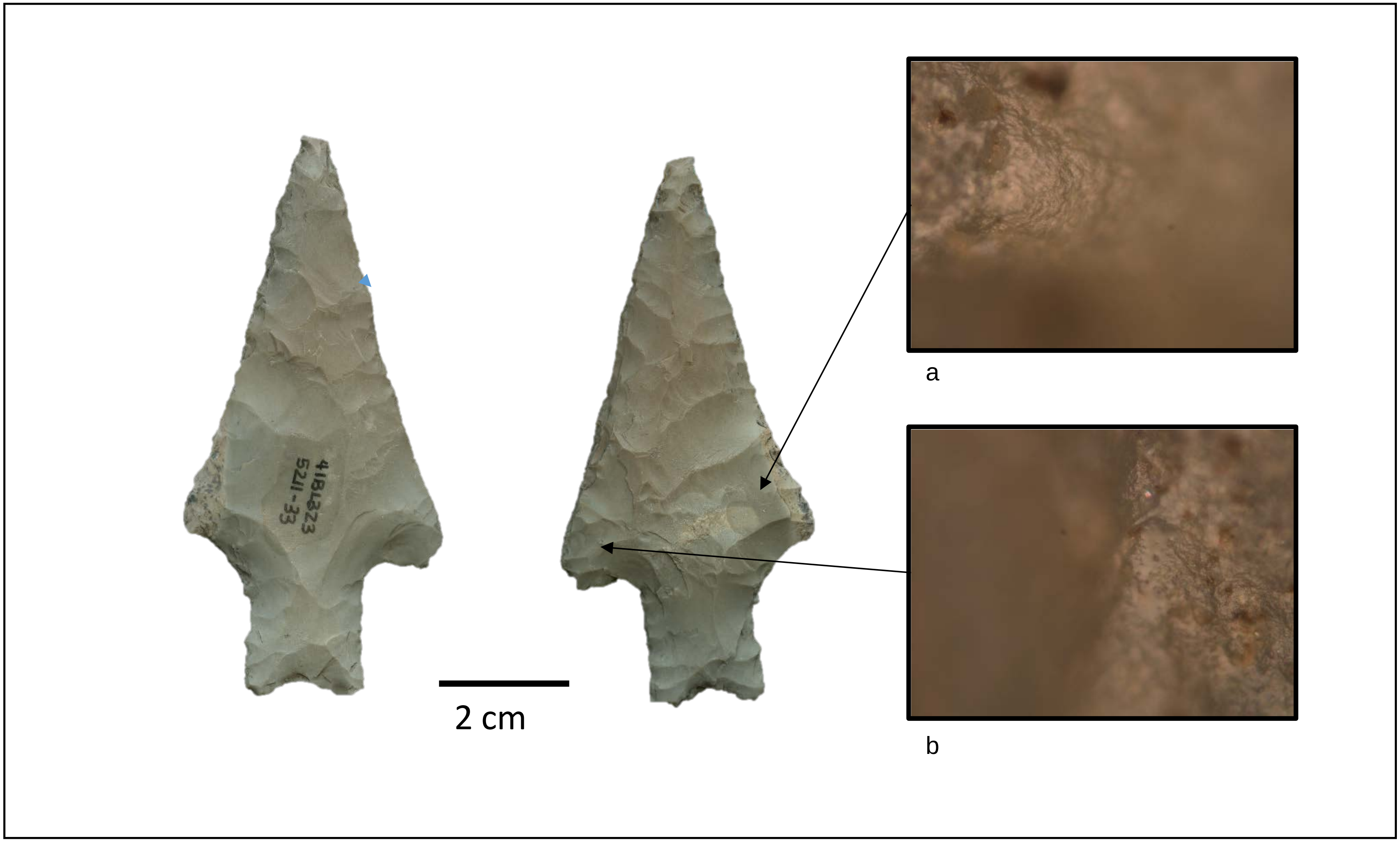


5.16 Image of prehistoric specimen 5207-77 to show fracture damage.
Note: Almost non-existent shoulders, narrow blade, and invasive flaking indicative of heavy reworking.

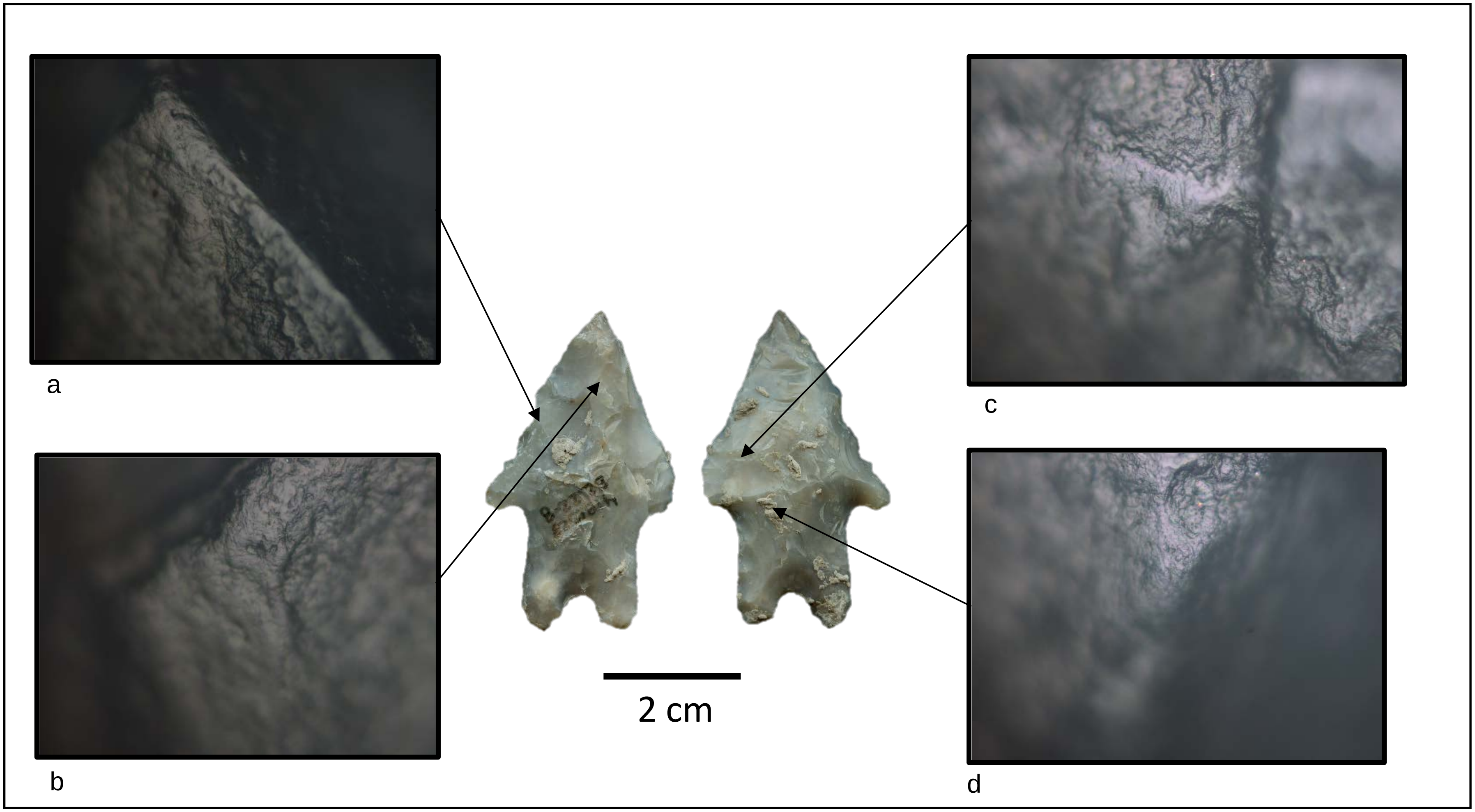


5.17 Example of the problems of viewing tool edges with PDSM, in this case red/brown staining from iron and manganese in the ground water and cloudy patina on Prehistoric specimen 5207-77. Photomicrograph at 500X original magnification.

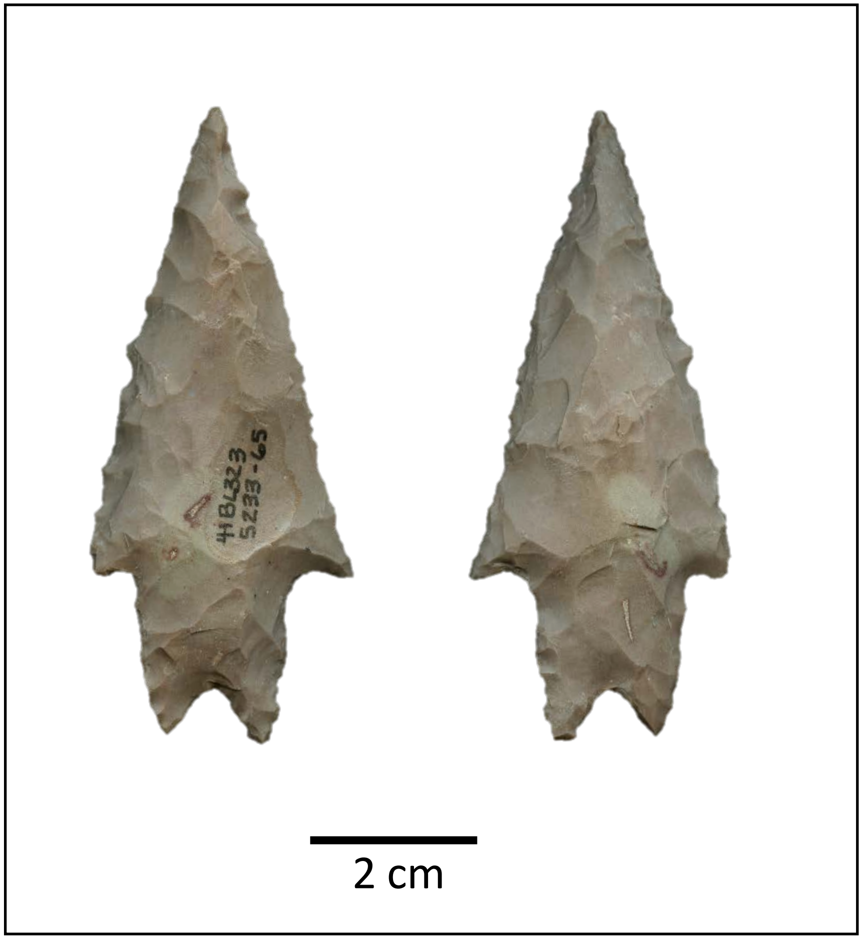
5.18 Photomicrographs of prehistoric specimen 5211-33. All microphotographs at 500X original magnification. (a,b) Hard plant polish similar to experimental specimen AS-09, partially obscured by iron and manganese staining. Note: Invasive flaking and slightly concave blade edges indicative of reworking.



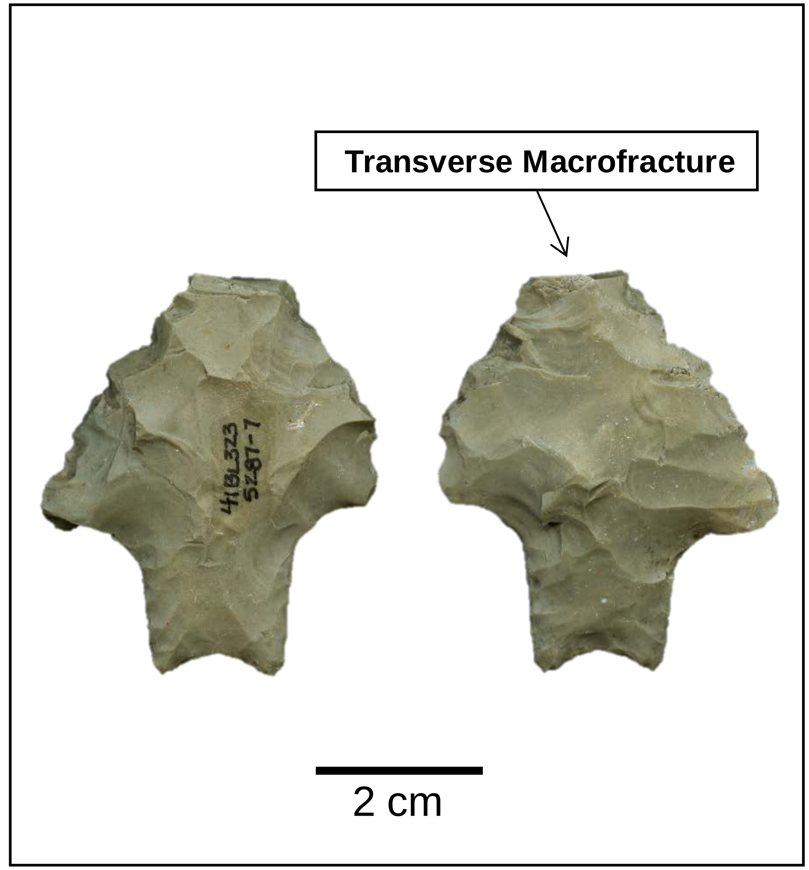
5.19 Photomicrographs of prehistoric specimen 5222-8. All microphotographs at 500X original magnification. (a-d) Butchery polish with a grainy texture and a greasy luster. Oblique striations can be seen in most patches of this polish.
Note: Invasive flaking and extremely exhausted blade indicative of reworking.



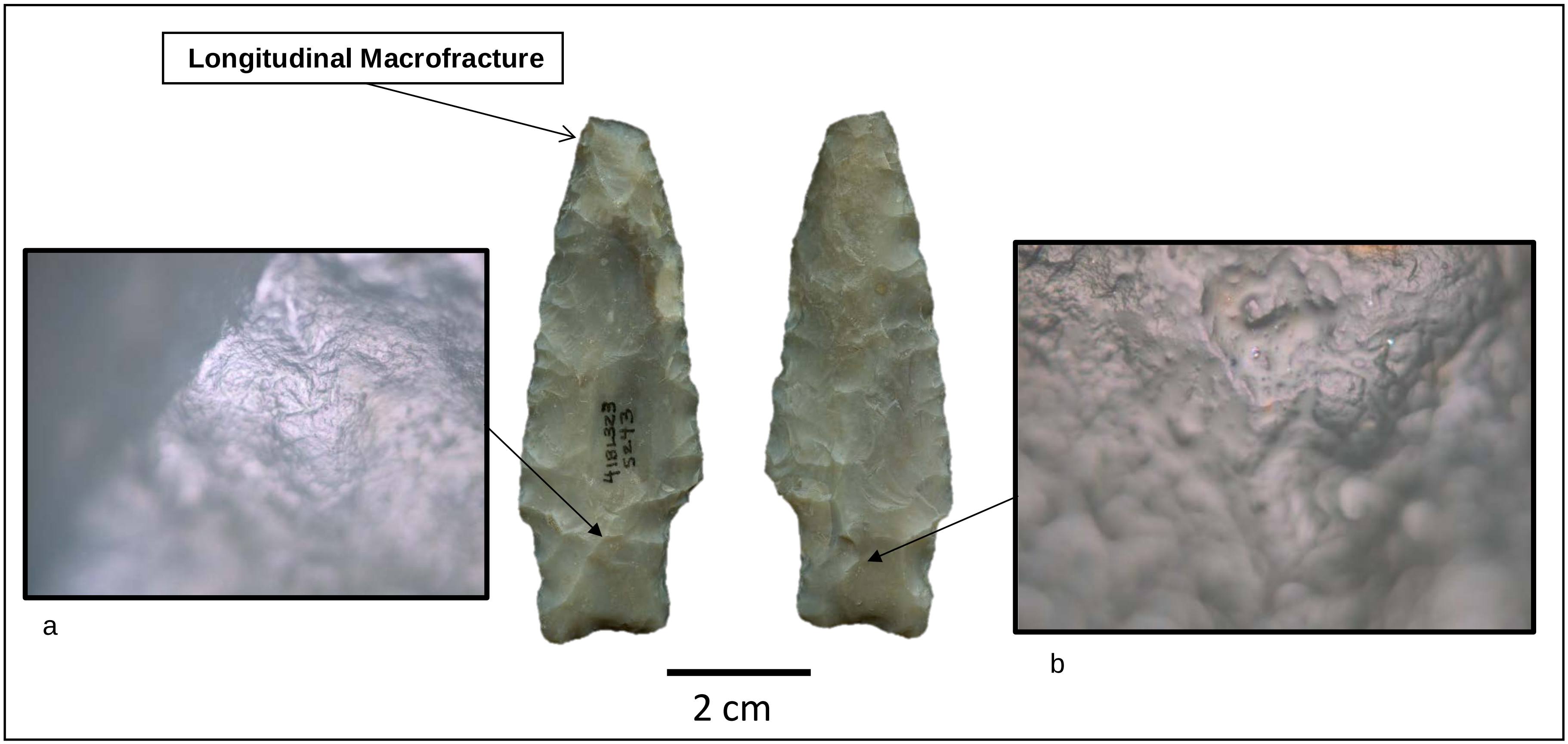
5.20 Image of prehistoric specimen 5233-65 exhibiting pink discoloration from thermal exposure.
Note: Invasive flaking and slight left beveling suggests this specimen has been reworked.



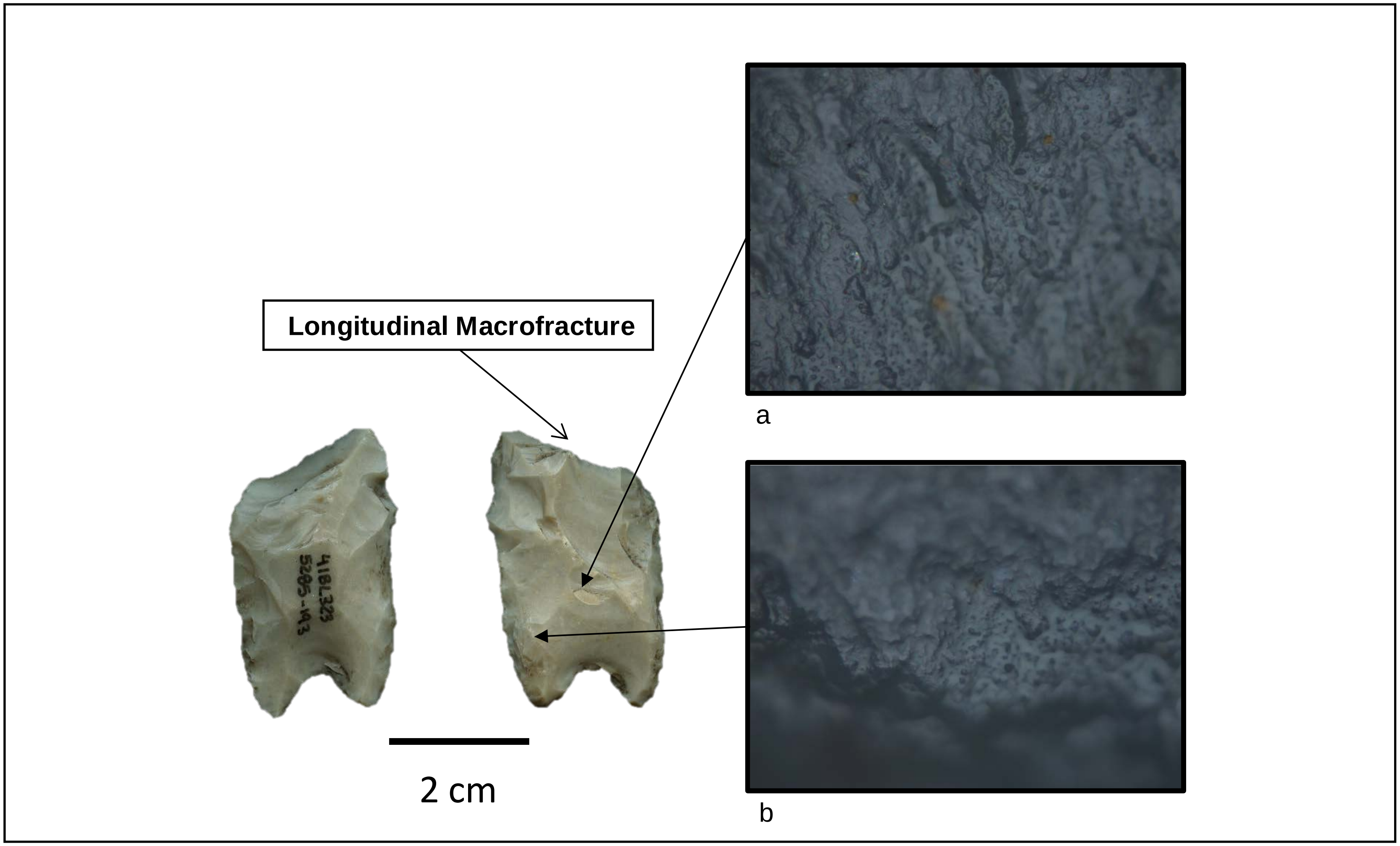
5.21 Image of prehistoric specimen 5287-7 to show fracture damage.



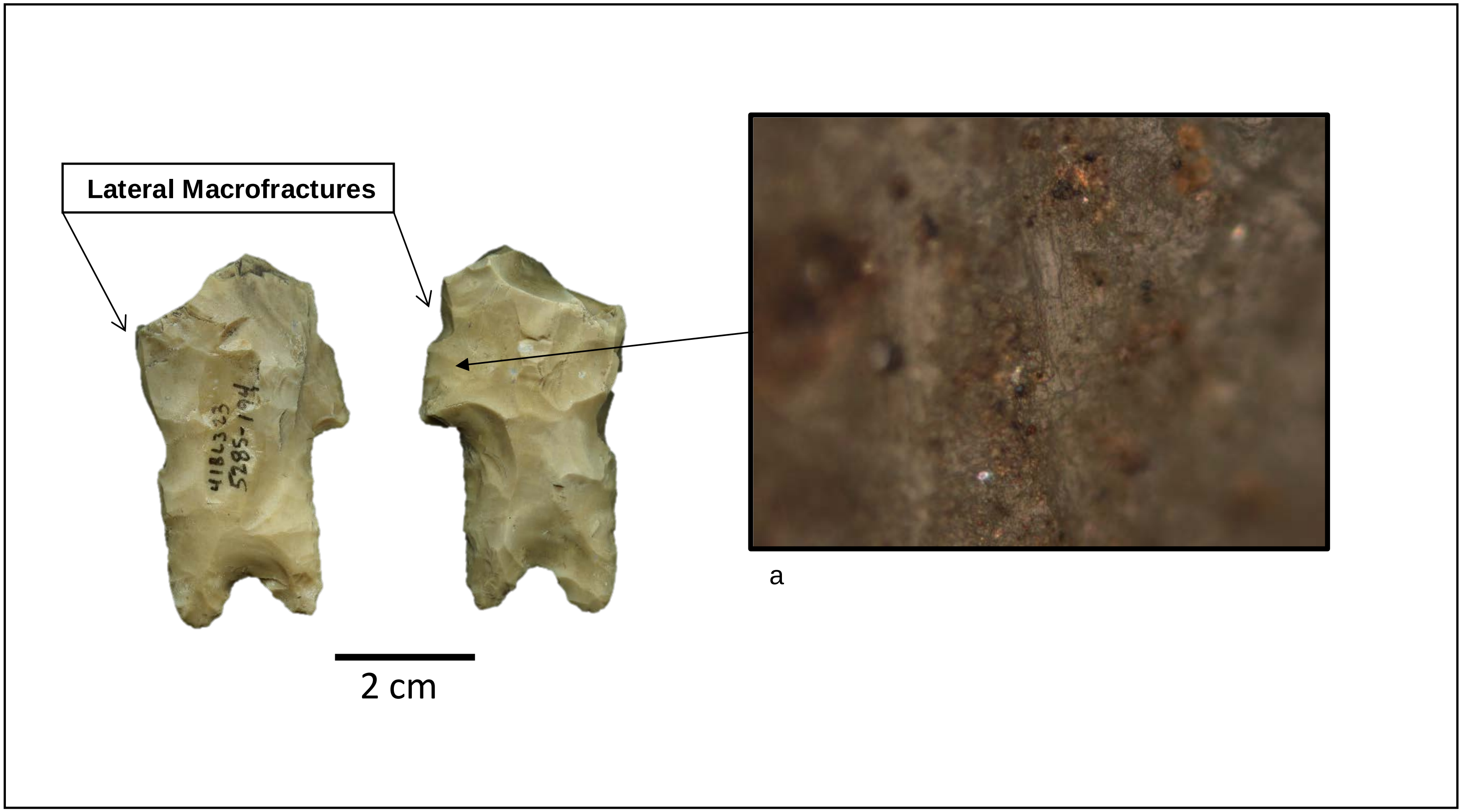
5.22 Photomicrographs of prehistoric specimen 5243. All photomicrographs at 500X original magnification. (a,b) Haft wear in the form of a bright smooth polish.
Note: Invasive flaking, very weak shoulders and lanceolet appearance indicative of reworking.



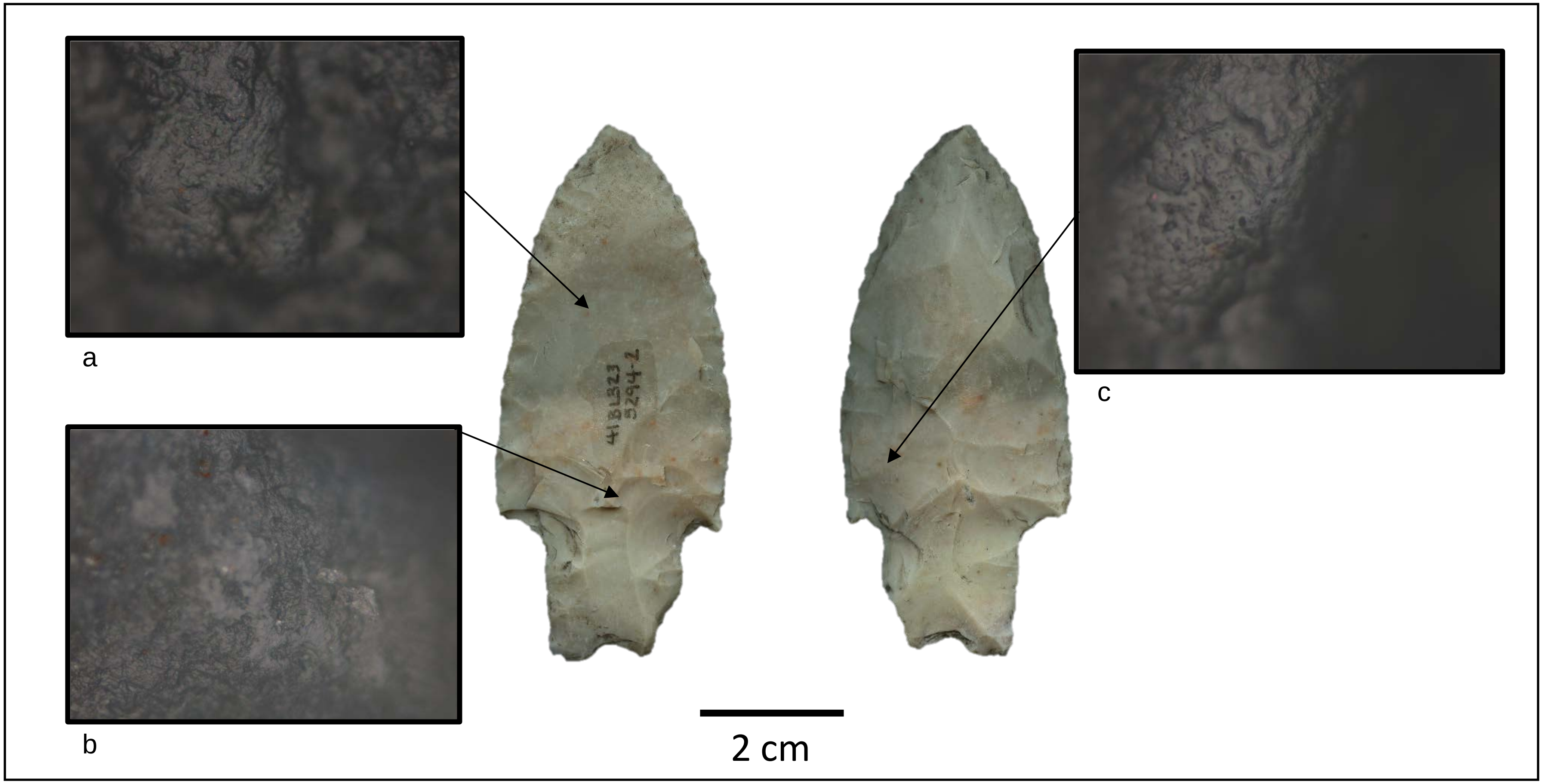
5.23 Photomicrographs of prehistoric specimen 5285-193-SF4. All photomicrographs at 500X original magnification. (a,b) Example of soil sheen, a form of mechanical PDSM. This can cover the entire artifact or appear in the form of isolated bright spots.



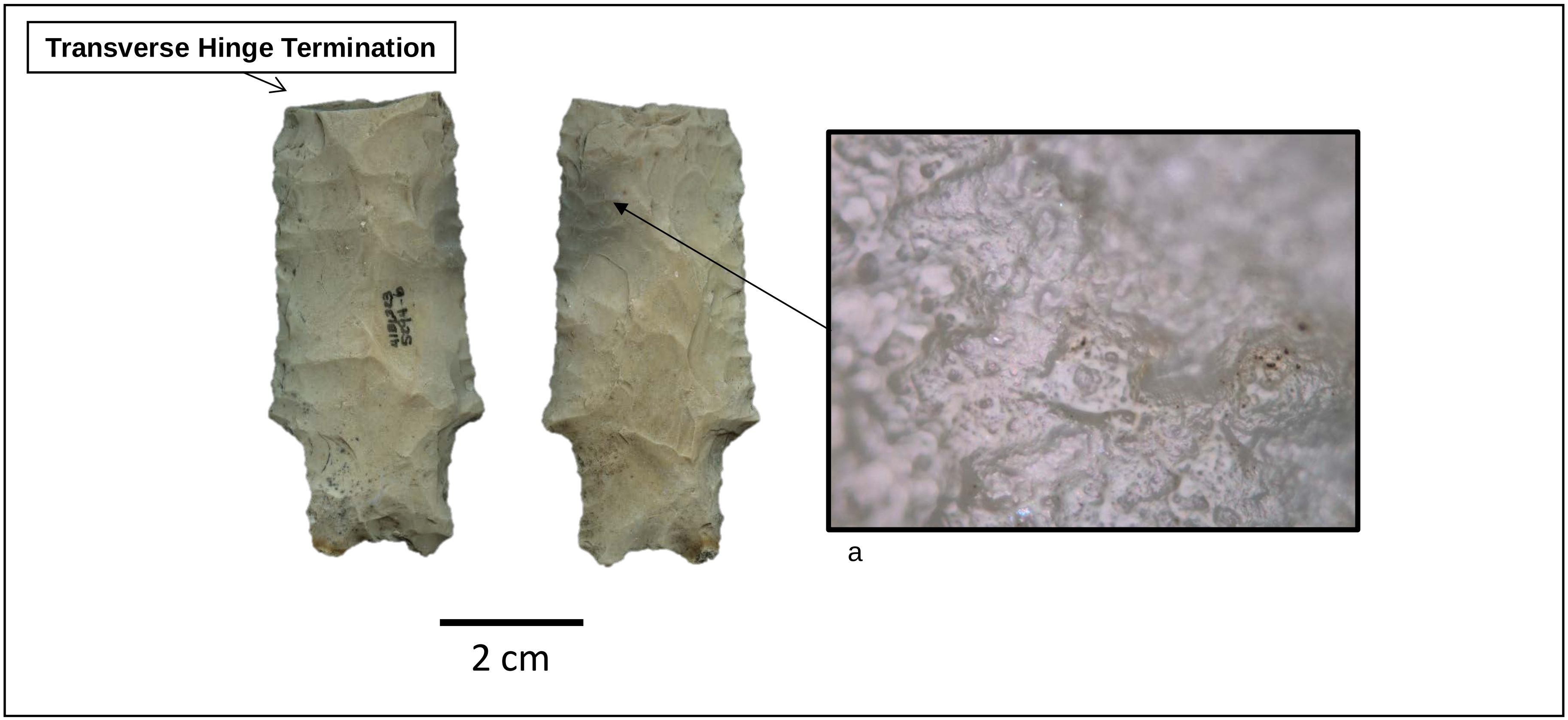
5.24 Photomicrographs of prehistoric specimen 5285-194-SF5. All photomicrographs at 500X original magnification. (a) Impact striations.



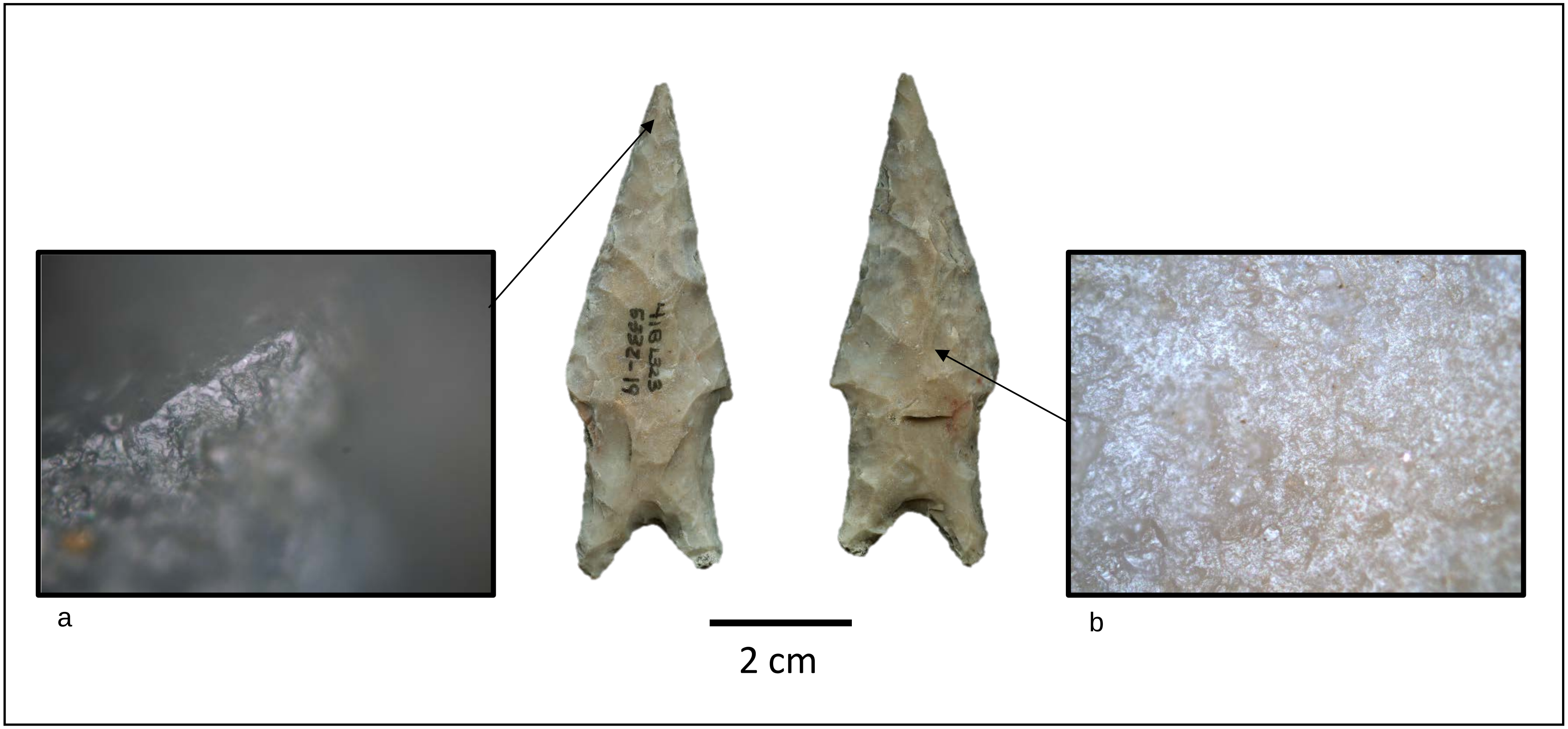
5.25 Photomicrographs of prehistoric specimen 5294-2. All photomicrographs at 500X original magnification. (a,c) Hard plant polish. (b) Localized haft polish with obliquely oriented striations.



5.26 Photomicrograph of prehistoric specimen 5294-6. Photomicrograph at 500X original magnification. (a) Soil sheen.
Note: Weak, flared shoulders and series of small flake scars along both blade edges indicative of reworking.

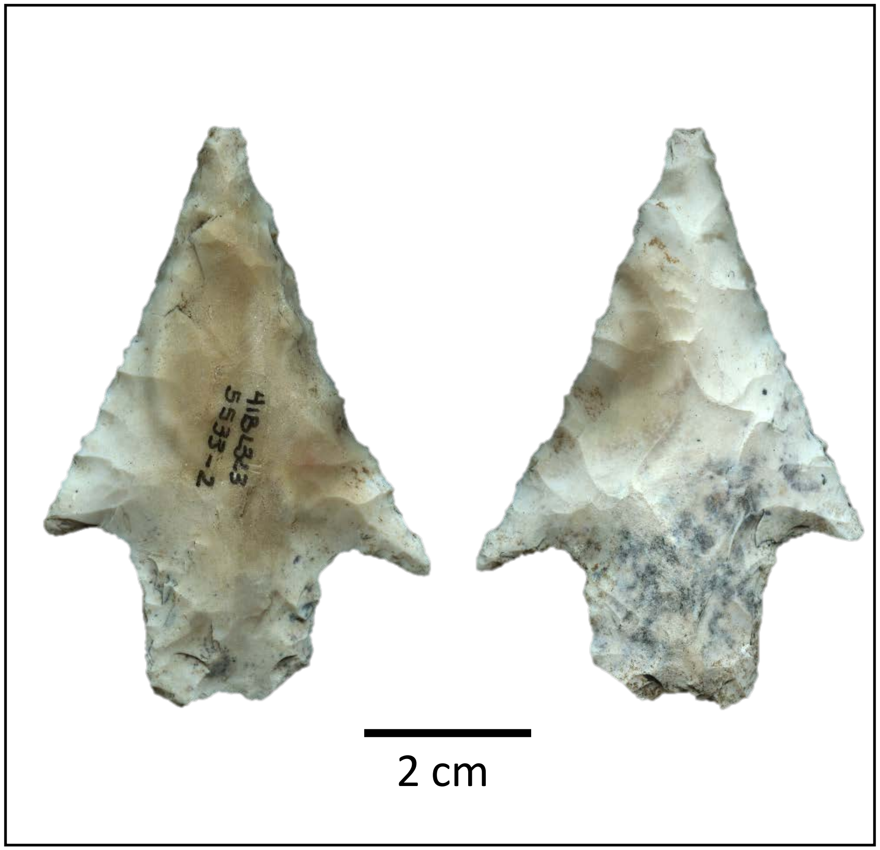


5.27 Photomicrographs of prehistoric specimen 5332-19. All photomicrographs at 500X original magnification. (a,b) Examples of PDSM in the form of soil sheen. Soil sheen can vary in its degree of intensity from very faint to very glossy.
Note: Slight beveling, invasive flaking and concave blade edge indicative of reworking.

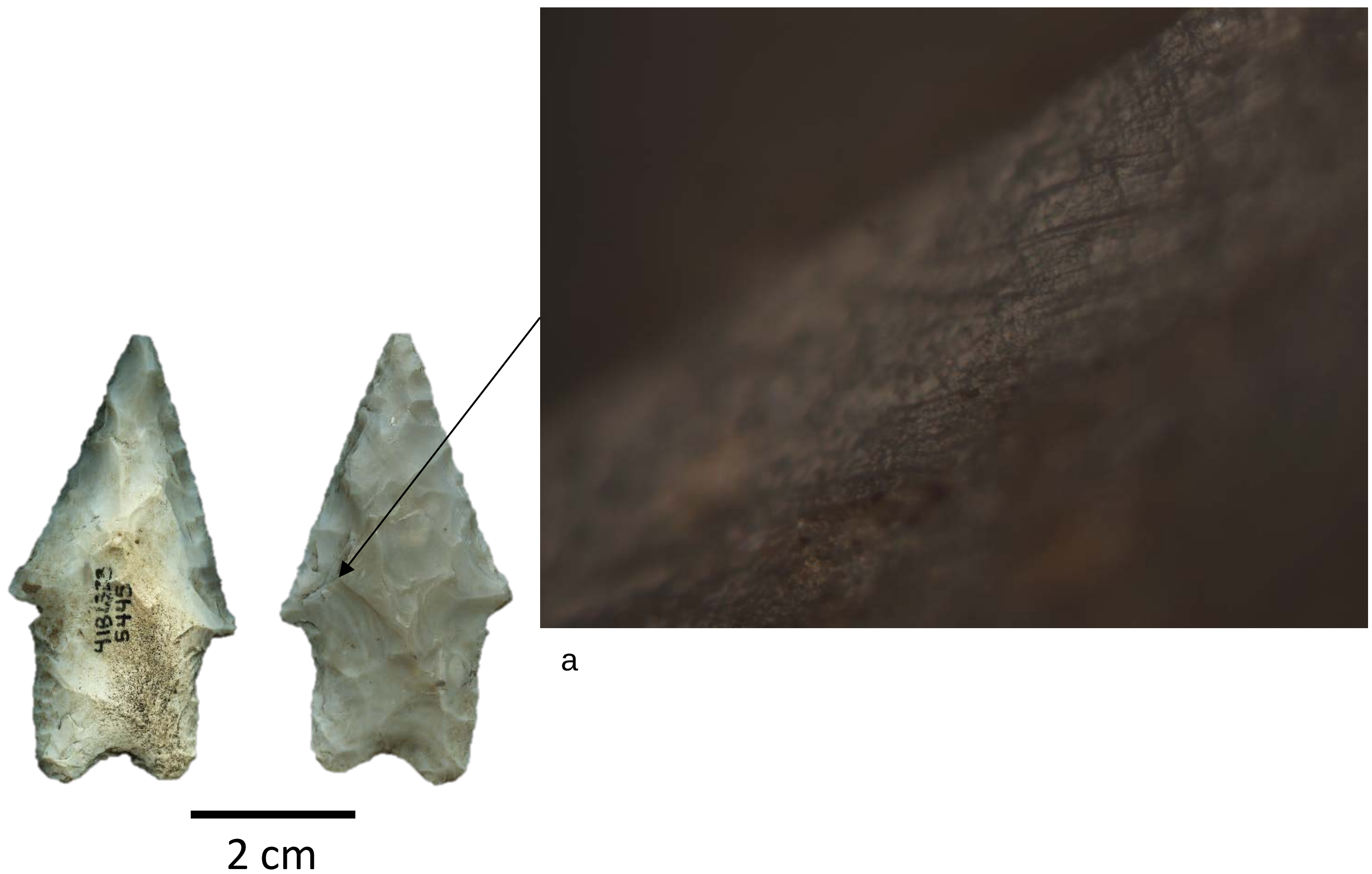


5.28 **Image of prehistoric specimen 5373 showing form and thermal damage.**
Note: Series of small flake scars along both blade edges indicative of reworking.

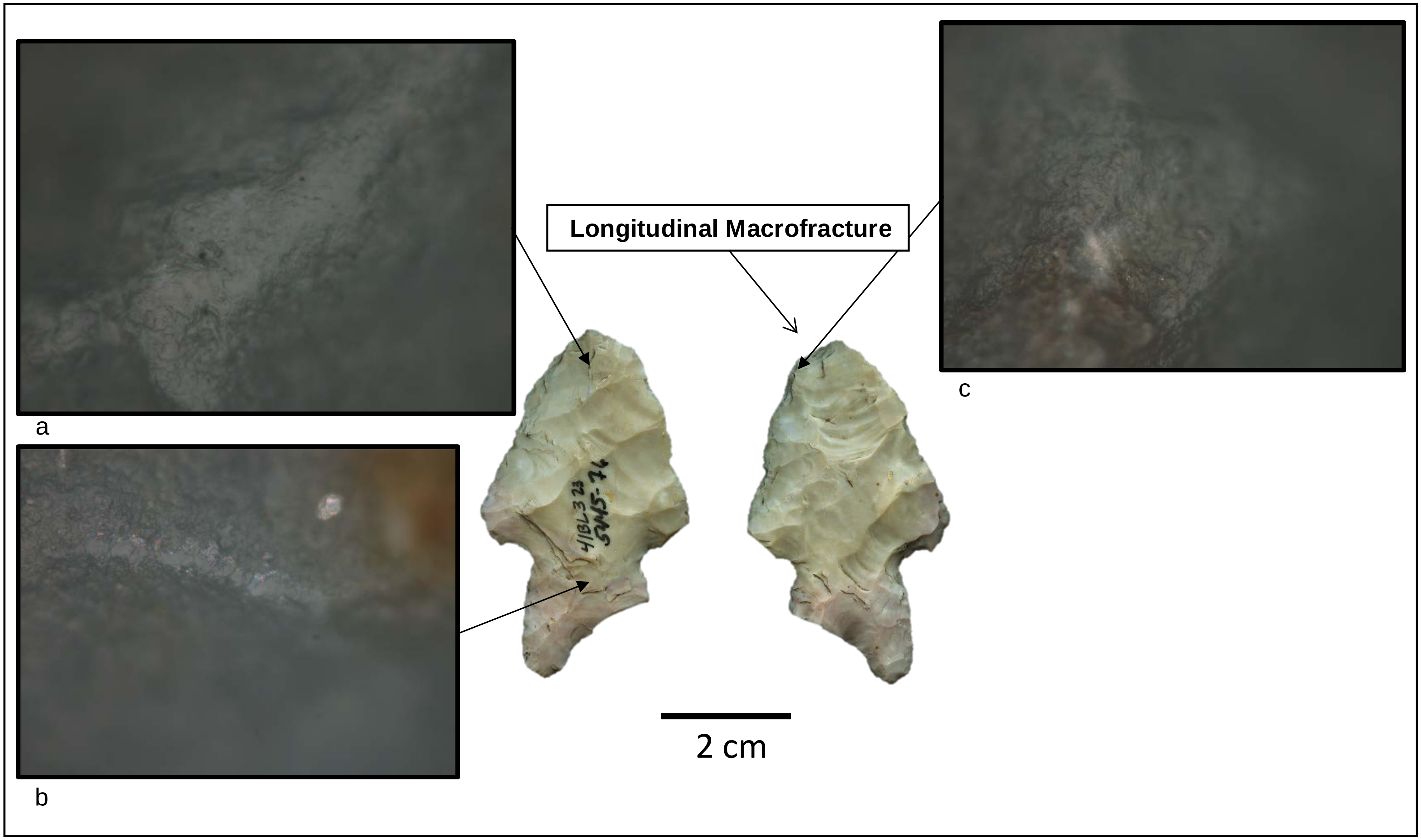
5.29 **Image to show the form of prehistoric specimen 5533-2.**
Note: Invasive flaking and concave blade edge indicative of reworking.



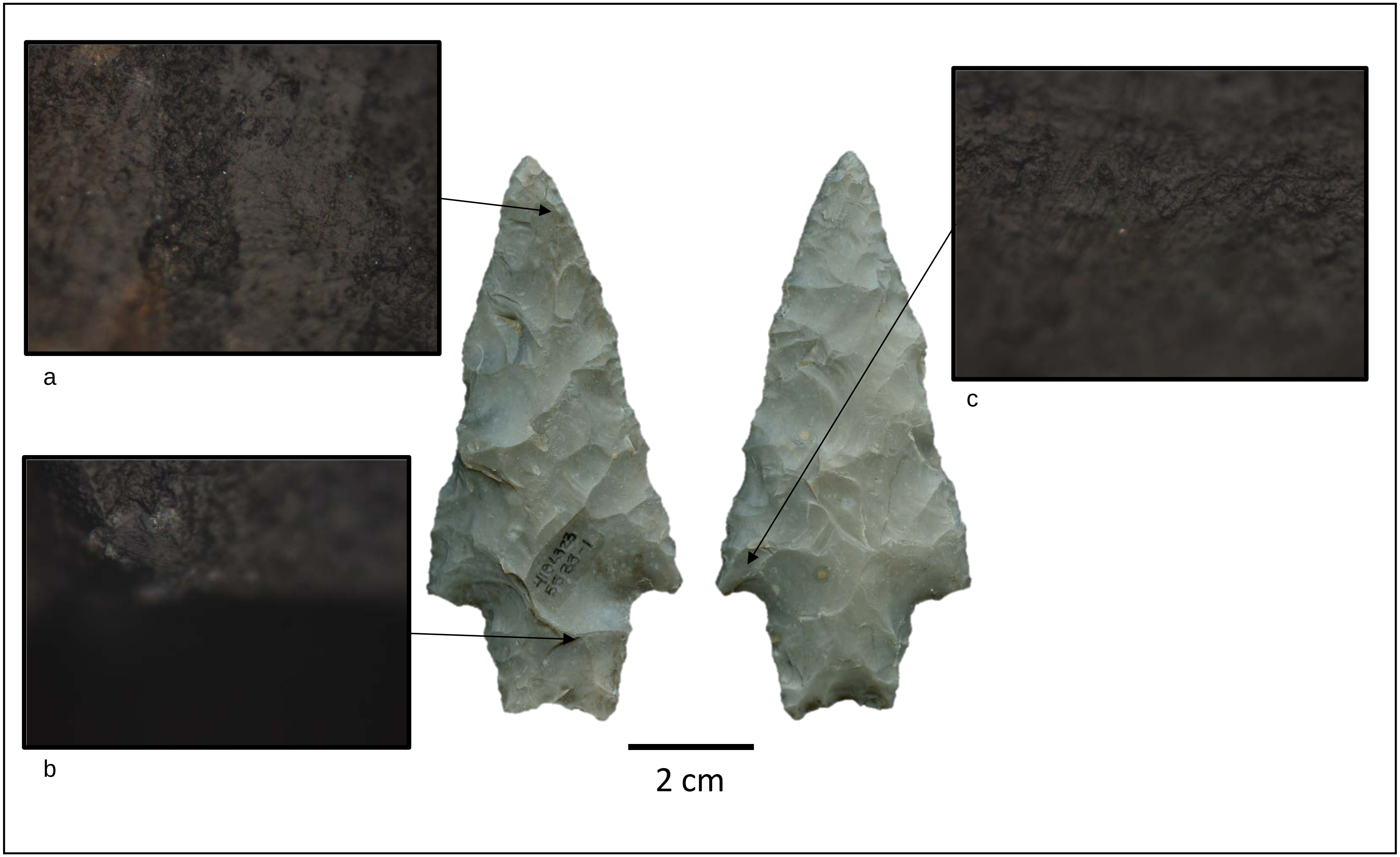
5.30 Photomicrographs of prehistoric specimen 5445-SF7. All photomicrographs at 500X original magnification. (a) Grainy meat polish with faint oblique striations.
Note: Series of small flake scars along both blade edges and shortened blade indicative of reworking.



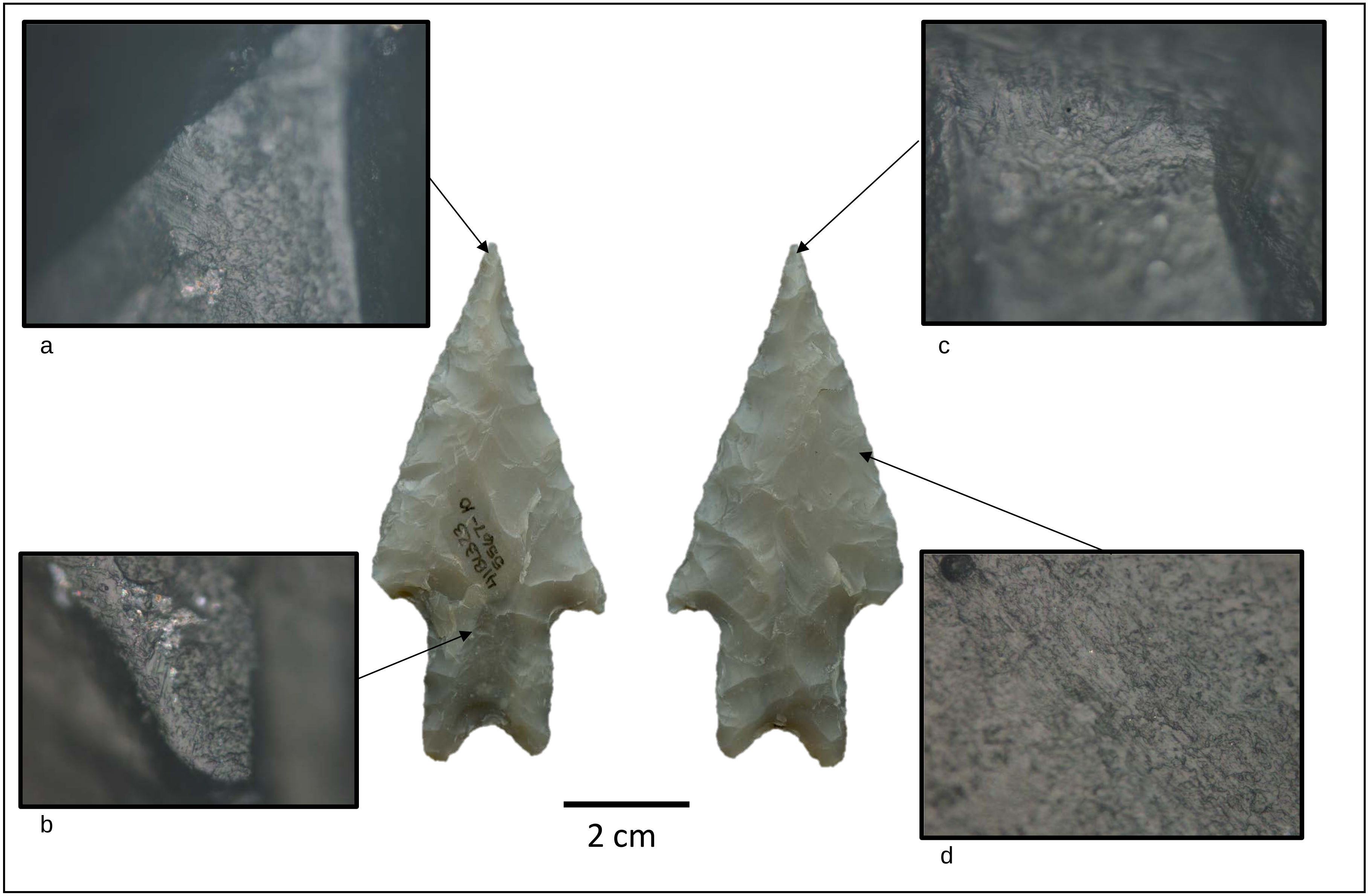
5.31 Photomicrographs of prehistoric specimen 5445-76-SF6. All photomicrographs at 500X original magnification. (a) Well developed antler polish with a grainy texture similar to specimen AS-08. (c) Haft polish. Note: Invasive flake scars and shortened blade indicative of reworking.



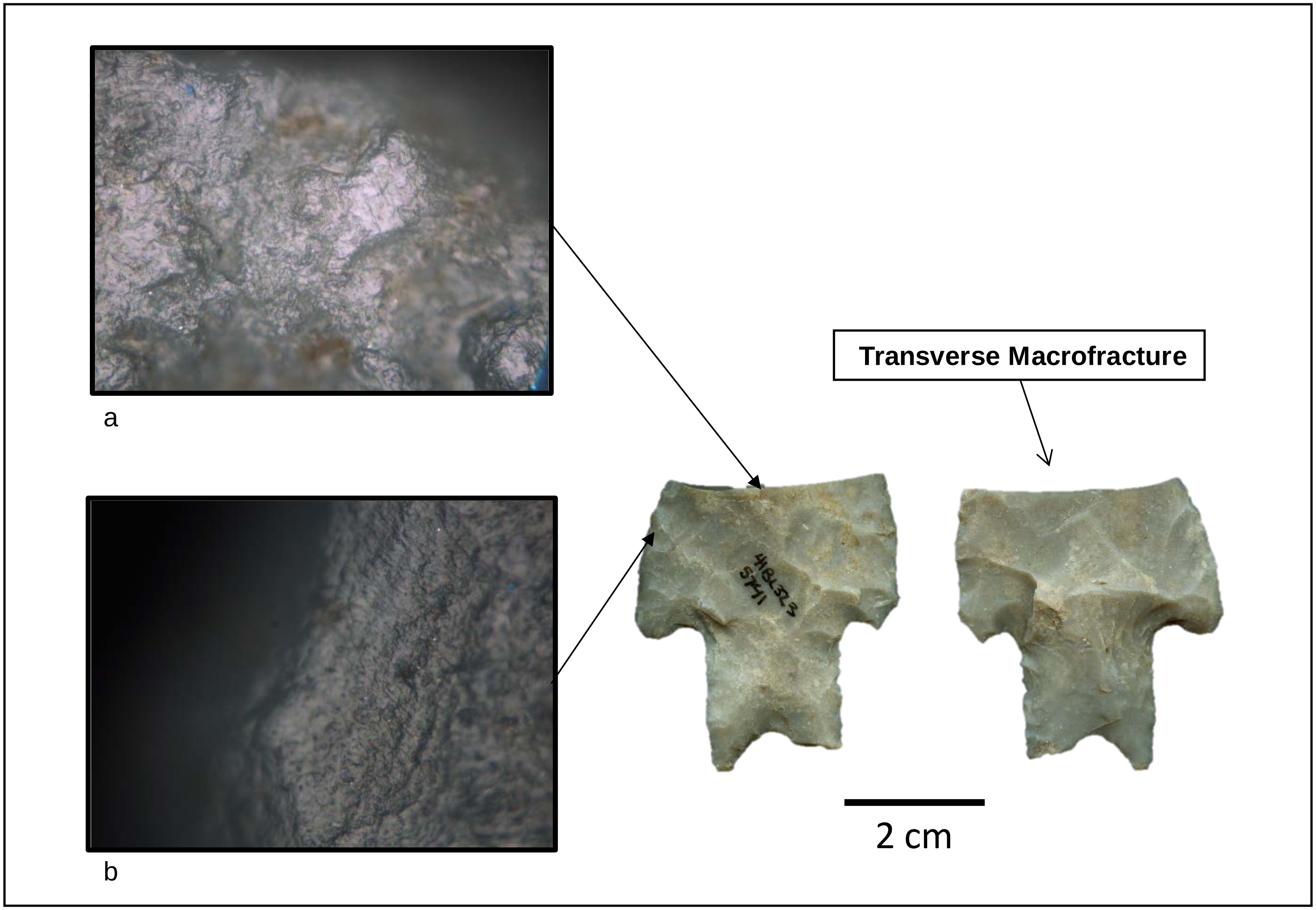
5.32 Photomicrographs of experimental specimen 5533-1. All photomicrographs at 500X original magnification. (a,c) Grainy, pitted, antler polish similar to specimens AS-10 and AS-08 both used to work antler. Parallel to slightly oblique striations are present. (b) Haft polish with crosshatched striations.



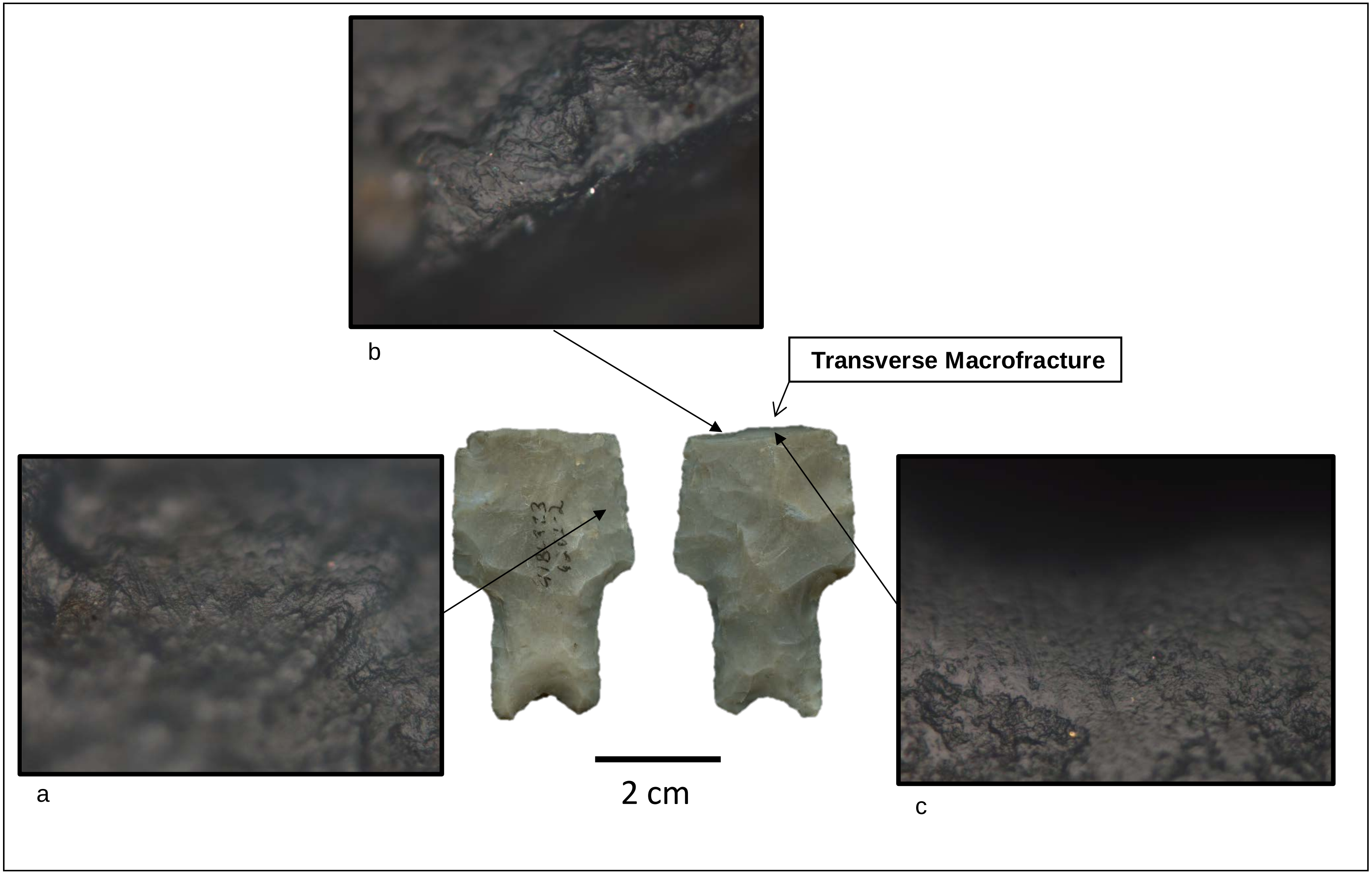
5.33 Photomicrographs of prehistoric specimen 5567-10. All photomicrographs at 500X original magnification. (a,d) Bone polish with oblique striations similar to experimental specimen AS-01. (b) Haft polish with oblique striations, also exhibiting abrasive microparticles. (d) Bright, smooth, meat polish with oblique striations.
Note: Invasive flaking and concave blade edge indicative of reworking.



5.34 **Photomicrographs of prehistoric specimen 5741-10. All photomicrographs at 500X original magnifications. (a) Soil sheen. (b) Hard plant polish.**



5.35 Photomicrographs of prehistoric specimen 6202-2. All photomicrographs at 500X original magnification. (a,c) Well developed bone polish. (b) Bright spotty polish, likely soil sheen.
Note: Series of small flake scars and weak shoulders indicative of reworking.



Bibliography

Ahler, S. A., 1971, 'Projectile Point Form and Function at Rodgers Shelter, Missouri', *College of Arts and Science University of Missouri-Columbia and Missouri Archaeological Society,* Missouri, no. 8, pp. 81-87.

Anderson, P 1980, 'A Testimony of Prehistoric Tasks: Diagnostic Residues on Stone Tool Working Edges', *World Archaeology,* vol. 12, no. 2, pp. 181-194.

Binford, L. R., & Binford S. R., 1966, 'A Preliminary Analysis of Functional Variability in the Mousterian of Levallois Facies', *American Anthropologist,* vol. 68, no. 2, part 2: Recent Studies in Paleoanthropology, pp. 238-295.

Black, S., 2002, *The Gault Site*. Electronic Document, Viewed 15 August 2013, http://www.texasbeyyondhistory.net.

Black, S., Creel, D., Ellis, L., & Goode, G., 1997, '*Hot Rock Cooking on the Greater Edwards Plateau: Four Burned Rock Midden Sites in West Central Texas'* , Texas Archeological Research Library, Studies in Archeology, vol. 1, Austin.

Bradley A. B. & Frison C. F., 1987 'Projectile Points and Specialized Bifaces from the Horner Site' in Frison C. F. & Todd C. L., (ed.), *The Horner Site: The Type Site of the Cody Cultural Complex,* United Kingdom, Academic Press Inc., Florida, pp. 199-231.

Burroni, D., Donahue, R., & Pollard A., M, 2002, 'The Surface Alteration Features of Flint Artefacts as a Record of Environmental Processes', *Journal of Archaeological Science,* vol. 29, pp. 1277-1287.

Cahen, D., Keeley, L. H., & Van Noten F. L., 1979, 'Stone Tool Kits, and Human Behavior in Prehistory', *Current Anthropology,* vol. 18, no 1, pp. 87-94.

Collins, M., 1994, ‘Comprehensive Lithic Studies: Context, Technology, Style, Attrition, Breakage, Use-wear, and Organic Residues’, *Lithic Technology,* vol. 20, no 4, pp. 661-683.

Collins, M., 1995, ‘Forty Years of Archeology in Central Texas’, *Bulletin of the Texas Archeological Society,* vol. 66, pp. 383-390.

Collins, M., 2004, ‘Archeology in Central Texas’, In *The Prehistory of Texas’,* ed. T.K. Pertulla pp. 101-126, Texas A&M University Press, College Station.

Collins, M., 2002, ‘The Gault Site, Texas, and Clovis Research’ *Athena Review: Peopling of the Americas,* vol. 3, no 2, pp. 2.

Collins, M., 1994, ‘Late Archaic Evidence In The Project Area’, *Human Ecology in the Middle Onion Creek Valley, Hays County, Texas,* Texas Archeology Research Laboratory, Austin, pp. 101-205.

Collins, M., & Fenwick J. M., 1974, ‘Heat Treating of Chert: Methods of Interpretation and Their Application’, *Plains Anthropologist,* vol. 19, pp. 134-145.

Collins, M., et al., 2011, ‘”Realms,” A Look at Paleoclimate and Projectile Points in Texas’, *Bulletin of the Texas Archeological Society,* vol. 82, pp. 3-30.

Courtesy of the Gault Project, 2012 ‘A Short History of the Gault Project’ pp. 1.

Del Bene, T. A. 1979 ‘Once Upon a Striation: Current Models of Striation and Polish Formation’ in Hayden B (ed.), *Lithic Use-Wear Analysis,* United Kingdom, Academic Press Inc., London, pp. 167-178.

Diamond, G 1979 ‘The Nature of So-Called Polished Surfaces on Stone Artifacts’ in Hayden B (ed.), *Lithic Use-Wear Analysis,* United Kingdom, Academic Press Inc., London, pp. 159-166.

Dockall, J. E., 1997, 'Wear Traces and Projectile Impact: A Review of the Experimental and Archaeological Evidence', *Journal of field Archaeology,* vol. 24, no. 3, pp. 321-331.

Ensor,B. H, et al., 1988, *Excavations At the Bull Pen Site 41BP280 Colorado River Drainage Bastrop County, Texas,* Report no. 3, State Department of Highways and Public Transportation, Austin.

Ford, J. A., & Spaulding J. H., 1954, 'On the Concept of Types', *American Anthropologist,* vol. 56, no. 1, pp. 42-57.

Goode, G. T., 2002, *The Anthon Site: A Prehistoric Encampment in Southern Uvalde County, Texas,* Report no 38, Texas Department of Transportation, Texas.

Greiser, S. T. 1977, 'Micro-Analysis Of Wear-Patterns On Projectile Points And Knives From The Jergens Site, Kersey Colorado', *Plains Anthropologist,* vol. 22, no. 76, pp. 107-116.

Hayden, B 1979, *Lithic Use-Wear Analysis,* Academic Press Inc., London.

Hayden, B., & Kamminga, J 1979, 'An Introduction to Use-Wear: The First CLUW' in Hayden B (ed.), *Lithic Use-Wear Analysis,* United Kingdom, Academic Press Inc., London, pp. 1-13.

Hiscock, P., & Clarkson, C., 2000, 'Analyzing Australian Stone Artefacts: An Agenda for the Twenty First Century', *Australian Archeology,* No 50(1), pp. 98-108.

Hurcombe, L. M. 1992, *Use Wear Analysis And Obsidian: Theory, Experiments And Results,* J.R. Publications, Department of Archeology and Prehistory, University of Sheffield.

Johnson, L., 1995, '*Past Cultures and Climates at Jonas Terrace 41ME29 Medina County, Texas'*, report no. 40, Texas Department of Transportation and Historical Commission, Austin.

Johnson, L., 2000, '*Life and Death as Seen at the Bessie Kruze Site (41WM13) on the Blackland Prairie of Williamson County, Texas'*, report no. 22, Texas Department of Transportation.

Johnson, L. & Goode G. T., 1994, 'A New Try at Dating and Characterizing Holocene Climates, as Well as Archeological Periods, on the Eastern Edwards Plateau', *Bulletin of the Texas Archeological Society,* vol. 65, pp. 1-51

Kamminga, J 1979 'The Nature of Use-Polish and Abrasive Smoothing on Stone Tools' in Hayden B (ed.), *Lithic Use-Wear Analysis,* United Kingdom, Academic Press Inc., London, pp. 143-157.

Kay, M., 1996 'Microwear Analysis of Some Clovis and Experimental Stone Tools' in Odell G. H., (ed.), *Stone Tools: Theoretical Insights into Human Prehistory,* Plenum Press., New York and London, pp. 315-344.

Keeley, L. H., 1980, *Experimental Determination of Stone tool Uses,* The University of Chicago Press, Chicago and London.

Keeley, L. H. and Newcomer, M. H., 1977, 'Microwear Analysis of experimental flint tools: A Test Case', *Journal of Archaeological Science,* vol. 4, no. 1, pp. 29-62.

Keller, C. M., 1966, 'The Development of Edge Damage Patterns on Stone Tools', *Journal of the Royal Anthropological Institute,* vol. 1, no. 4, pp. 501-511.

Kelley, J. C., 1947, 'The Cultural Affiliations and Chronological Position of the Clear Fork Focus', *American Antiquity,* vol. 13, no. 2, pp. 97-109.

Lafayette L. M. & Smith G. M., 2012, 'Use-Wear Traces on Experimental (Replicated) and Prehistoric Stemmed Points from the Great Basin', *Journal of California and Great Basin Anthropology,* vol. 32, no. 2, pp. 141-160.

LBJ School of Public Affairs 1978. Preserving Texas Natural Heritage, LBJ School of Public Affairs Research Project Report 31.

Lassen R. & Collins M., 2014 'Synopsis of the Prehistoric Occupations at the Gault Site (41BL323), Bell County, Texas', Poster.

Levi-Sala, I., 1986 'Use Wear And Post-depositional Surface Modification: A Word of Caution' *Journal of Archaeological Science,* vol. 13 pp. 51-57.

Levi-Sala, I., 1996, *A Study of Microscopic Polish on Flint Implements,* TEMPVS REPARATVM Archaeological and Historical Associates Limited, England.

McMahan, CA, Frye, RG & Bown, KL 1984, *The Vegetation Types of Texas, Including Cropland,* Texas Parks and Wildlife Department, Texas.

Moore, G., 2005, 'Lithic Reduction, Manufacture or Tool Usage. A Hypothesis from Han Held to Hafted Point Type', *Central States Archaeological Journal,* vol. 52, No. 3, pp. 156-158.

Odell, G., 1980, 'Butchering With Stone Tools: Some Experimental Results', *Lithic Technology,* vol. 9, pp. 38-48.

Odell, G., 1981, 'The Mechanics of Use-Breakage of Stone Tools: Some Testable Hypotheses', *Journal of Field Archeology,* vol. 8, No. 2, pp. 197-209.

Odell, G. H. & Cowen F., 1986, 'Experiments with Spears and Arrows on Animal Targets', *Journal of Field Archeology,* vol. 13, No. 2, pp. 195-212.

Odell, G., & Odell-Vereecken, F., 1980, 'Verifying the Reliability of Lithic Use-Wear Assessments by "Blind Tests": The Low-Power Approach', *Journal of Field Archaeology*, vol. 7, no. 1, pp. 87-120.

Outram, A. K., 2008, “Introduction to Experimental Archeology”, *World Archeology,* vol. 40, no. 1, pp. 1-6.

Prewitt, E., 1981, ‘Cultural Chronology in Central Texas’, *Bulletin of the Texas Archeological Society’,* vol. 52, pp. 65-89.

Rots, V., 2005, ‘Wear Traces and the Interpretation of Stone Tools’, *Journal of Field Archeology,* vol. 30, pp. 61-73.

Rots, V., 2004, ‘Prehensile Wear on Flint Tools’, *Lithic Technology,* vol. 29, No. 1, pp. 7-32.

Rots, V., Pirnay, L., Pirson, P., & Baudoux, O., 2006, ‘Blind Tests Shed Light on Possibilities of Interpreting Prehistoric Stone Tool Prehension and Hafting’, *Journal of Archeological Science,* vol. 33, pp. 935-952.

Seminov, S.A. 1964, *Prehistoric Technology.* Translated by M. W. Thompson. London: Cory, Adams and Mackay.

Shea, J. J., 1992, ‘Lithic Microwear Analysis in Archeology’, *Evolutionary Anthropology,* vol 1, no. 4, pp. 143-150.

Shoberg, M. 2010, ‘Functional Analysis of Stone Tools’, in Bradley, B. et al., *Clovis Technology,* International Monographs in Prehistory, Michigan, pp. 138-156.

Spaulding, A. C., 1953, ‘Statistical Techniques for the Discovery of Artifact Type’, *American Antiquity,* vol 18, no. 4, pp. 305-313.

Sorrow, W. M., 1969, *Archeological Investigations at the John Ischy Site: A Burnt Rock Midden in Williamson County, Texas,* Texas Archeological Salvage Project, no. 18, The University of Texas at Austin, Texas.

Texas Beyond History, *Kincaid Shelter,* Viewed 14 January 2014, https://www.google.com/#q=texas+beyond+history+kincaid+shelter

Texas Parks and Wildlife Department, 2011, *Natural Regions of Texas,* Texas Parks and Wildlife GIS Lab, Austin, Texas.

Texas Parks and Wildlife Department, *Texas Ecoregions,* Viewed 15 August 2013, http://www.tpwd.state.tx.us/outdoor-learning/hunter-education/online-course/wildlife-conservation/texas-ecoregions.

Tomka, S, A, Shafer, H, J & Mauldin R, P, TxDot & CAR-UTSA, 2003, *Data Recovery Excavations at 41mm340, A Late archaic Site along Little Milam County, Texas, Lithic technology 41MM340,* Archeological Studies Program report no. 54, Environmental Affairs Division, Texas Department of transportation.

Toomey, R.S., Blum, M.D., Valvatore, Jr. S. 1993, 'Late Quaternary Climates and Environments of the Edwards Plateau, Texas', *Global and Planetary Change,* vol. 7, pp. 299-320.

Tringham, R., Cooper, G., Odell, G., Voytek, B., & Whitman, A. 1974, 'Experimentation in the Form of Edge Damage: A New Approach to Lithic Analysis', *Journal of Field Archaeology,* vol. 1, pp. 172-196.

Turner, E.S., & Hester T.R, 1999, *A Field Guide to Stone Artifacts of Texas Indians*, 3rd edn, Taylor Trade Publishing, Lanham, MD.

Turner, E.S., Hester T.R., & McReynolds R.L., 2011, *Stone Artifacts of Texas Indians,* Completely Revised 3rd edn, Taylor Trade Publishing, Lanham, MD.

Weir, FA 1976, 'The Central Texas Archaic', PhD Thesis.

Wernecke, C., (2012) *A Short History of the Gault Project.* Unpublished Manuscript.