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**Projectile Point
Analysis in the
American Southwest**

Todd W. Bostwick
Chris Loendorf
guest editors

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Painted Sinagua reed arrows, Dyck Cliff Dwelling, see Bostwick Figure 5.



Additional painted Sinagua reed arrows, Dyck Cliff Dwelling, see Bostwick Figure 6.

IN THIS ISSUE:

- 83 | *PROJECTILE POINT DESIGN: FLAKED-STONE PROJECTILE TIP SELECTION, FUNCTION, AND STYLE*
Chris Loendorf, R. Scott Plumlee, and Shari Tiedens
- 99 | *EVALUATING EARLY AGRICULTURAL PERIOD SOCIAL DYNAMICS IN SOUTHERN ARIZONA THROUGH PROJECTILE POINT TYPOLOGY*
R. Jane Sliva
- 113 | *PAINTED ARROWS AND WOODEN PROJECTILE POINTS: AN ANALYSIS OF SINAGUA ARROWS FROM THE DYCK CLIFF DWELLING IN THE VERDE VALLEY, ARIZONA*
Todd W. Bostwick
- 132 | *PROTOHISTORIC PROJECTILE POINTS AND OTHER DIAGNOSTICS: A PAN-REGIONAL SOUTHERN SOUTHWESTERN PERSPECTIVE*
Deni J. Seymour

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PROJECTILE POINT ANALYSIS IN THE AMERICAN SOUTHWEST

PREFACE

Todd W. Bostwick and Chris Loendorf, Guest Editors

Since its inception in 1977, the Arizona Archaeological Council (AAC) has worked as an advocate for the archaeological community in Arizona. The council has helped to address important problems in heritage management, while facilitating communication within the community, and also advancing research agendas. In order to further these goals, the AAC created the *Journal of Arizona Archaeology* (JAzArch), and this is the second issue of the fourth volume in that series.

This issue includes presentations from the first day of the ACC conference held in Sedona on November 6 and 7, 2015, and co-hosted by the Verde Valley Archaeology Center. The first portion of the conference focused on projectile point research in Arizona, a topic which has long taken a backseat to ceramic analysis in the region. The conference was organized through the efforts of Todd Bostwick, Chris Loendorf, and Eric Klucas. Ken Zoll provided valuable assistance to the organizing committee.

Stone and wooden points served as piercing tips for the three primary projectile weapon systems used in the Southwest for thousands of years. The ends of spears, atlatl darts, and arrows all utilized stone or wooden tips, as well as bone and other materials. Because they preserved well and were frequently worked into distinctive shapes, stone projectile points were a key artifact type used in defining culture history units and constructing chronological frameworks. The papers in this volume go beyond that to look at how the intended function of the point and the mechanics of the launching system were taken into consideration by those making the points, and researchers now address performance as well as stylistic criteria.

Although point types have been established in Arizona to some degree, their identification and description has not been standardized, resulting in a proliferation of point classification systems. Instead, a standard set of measurements and descriptions should be adopted that provide comparable data on all analyzed projectile points. But such an effort cannot be conducted independently of an examination of large collections of points in a search for patterned repetitions of attribute combinations, as discussed by Sliva. Nor should analysis be limited exclusively to typologies because by their very nature types will combine functional and stylistic traits, thereby precluding examination of the two factors independently. Analyzing attributes independently of types facilitates the distinction of performance and stylistic traits. Reported data also currently varies in scope and presentation. This limits comparative studies among and within regions. Furthermore, the various factors influencing the selection of point designs have often not been fully considered. There is a need for regional databases, and those databases can be built from the “bottom up” by compliance projects. Regional patterns are best interpreted through an understanding of the variability in local populations addressing their local engineering challenges and their expressions of style.

Importantly, considerable historical information exists regarding flaked stone points because Native Americans in the Southwest continued to employ them until the late 1800s; however, archaeologists have paid comparatively little attention to the implications of these data. There is clearly room for advancement within the field of projectile point study in Arizona, and the 2015 AAC conference was an effort to discuss issues and provide directions for development of projectile point analysis.

As part of this dialog, the 2015 AAC conference included a lively panel discussion that was moderated by Todd Bostwick, and included Glen Rice, Jane Sliva, John Marshall, and Chris Loendorf. The session was very well attended, and the audience actively participated in the wide-ranging conversation, which was productive and informative. One of the goals of the conference session was to improve communication among projectile point analysts in Arizona, and that was clearly achieved.

The four papers in this issue are based on six of the papers presented at the conference. The first paper by Loendorf, Plumlee, and Tiedens originated as three separate presentations given by each author. The papers were combined because they were all based on the projectile point research program undertaken by the Gila River Indian Community Cultural Resources Management Program. The resulting article

presents the analytical paradigm employed by these researchers, and summarizes a methodological approach for testing hypotheses regarding projectile point stylistic and functional characteristics.

The remaining three papers by Sliva, Bostwick, and Seymour each closely follow the conference's presentations that were given by the authors. Jane Sliva discusses Archaic period projectile point collections from southern Arizona and Northern Mexico and finds evidence for population movements among these regions. Silva argues that systematic splitting and cautious recombining of types is useful in evaluating technological adaptations and social relationships.

Bostwick's paper describes an important and previously unreported collection of well preserved arrows from a dry rockshelter in Central Arizona. His study examines reed arrow shaft manufacture, painted decorations, foreshaft types, and tip design employed in a collection of Sinagua arrows dating from the AD 1100-1300s. The vast majority of the foreshafts were used without stone points. This implies that archaeologists who are studying stone points need to understand that they probably are only seeing a small fraction of all projectile weapons. This research provides an essential perspective on perishable materials that are not often available to archaeologists in much of North America, and further enhances the importance of the Southwestern projectile point research that is presented here.

The paper by Deni Seymour focuses on variability in Protohistoric and Historic period points from the southern Southwest. Seymour discusses how analytical approaches affect the construction of cultural boundaries, and the challenges of addressing the issues of expansive and overlapping territories for some groups. With her systematic and contextual approach, Seymour is able to suggest projectile point varieties that are associated with historically referenced and archaeological defined groups in the southern Southwest.

We sincerely hope that you enjoy this issue. There are other important topics not covered in depth by the four papers presented here, but we believe the conference and the papers will stimulate further discussion regarding the analysis of projectile points not just from Arizona, but also from all regions where flaked-stone projectile points were made and employed.

PROJECTILE POINT DESIGN: FLAKED-STONE PROJECTILE TIP SELECTION, FUNCTION, AND STYLE

Chris Loendorf
R. Scott Plumlee
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ABSTRACT

This paper applies artifact design theory to the study of flaked-stone projectile points. The role of human engineering in the point production process is emphasized in this analytical perspective. As developed here, this research paradigm postulates that people make highly-shaped artifacts, such as flaked-stone projectile points, with the intent of performing one or more specific tasks. Both available materials and known manufacturing techniques limit the design process, while the production and performance of projectiles is constrained by the laws of physics. Although physical parameters limit variability, considerable room remains for individual or group expression, and projectile point characteristics are the product of both cultural identity and performance requirements. Projectile point design theory as developed here is not a replacement for previous analytical approaches including typological methods, and instead compliments this research.

INTRODUCTION

This paper examines the physical laws, theory, and conceptual matters needed for understanding the functional and stylistic properties of flaked-stone projectile points. North American archaeologists have previously offered many explanations for why the form of flaked-stone projectile points changed over time and varied across space (Shott 1996). Suggested sources of apparent synchronic or diachronic variation include: differences among cultural or social groups; raw material constraints; use-wear or reworking after breakage; variation in propulsion technology (e.g., atlatl versus bow); differences in the motor skills of the makers; low standards of conformity to ideals; random drift as a function of time or space; measurement or classification error by researchers; toy point variants (Bonnichsen and Keyser 1982); variation in prey size (Buchanan et al. 2011); pragmatic modifications to facilitate hafting (Flenniken and Raymond 1986:606); change in mechanical stress

factors (Shott 1996:281); non-utilitarian points (Sedig 2014); durability concerns (Cheshier and Kelly 2006); variation in cultural transmission modes (Mesoudi and O'Brien 2008); differences related to functional requirements such as hunting or warfare (Loendorf et al. 2015a); and change in ballistic performance requirements (Loendorf 2016).

These factors that may affect changes and differences in shape are not mutually exclusive. Instead, many if not most of them must have conditioned variation among stone points. Until relatively recently, however, prehistorians generally analyzed these artifacts using the assumption that patterns they could describe were essentially a direct reflection of differences among cultural groups (Mason 1894:655; Whittaker 1994:260–268). Comparatively little attention was paid to functional aspects of projectile points and the role that performance played in technological variation. However, during the last thirty years much of the research has shifted, and analysts now recognize that many factors affect point appearance (Azevedo et al. 2014; Bryce and Bailey 2015; Flenniken and Raymond 1986; Loendorf 2012; Mesoudi and O'Brien 2008; O'Brien et al. 2014; Shott 1996; Shott and Ballenger 2007; Sliva 2015; Walde 2014).

There are both physical and cultural aspects to technology (Carr 1995; Nelson 1997; Hichcock and Bleed 1997). When designing an artifact, such as a projectile point, physical parameters provide defined boundaries to the available design space. Within these limits, the functional requirements for the artifact further constrain design possibilities. Concurrently, cultural norms mean that designs also incorporate stylistic elements, including expressions of individual or group identity. In order not to conflate these design domains, researchers studying artifacts such as projectile points need to take into account how attributes, such as those used in typological classification systems, affect performance.

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Previous researchers have largely employed typological approaches to study projectile point variation, and distinctive attributes such as serration are commonly allowed to cross-cut categories in these classification systems (e.g., Justice 2002). Instead, research presented here examines attributes independently of typological categories. By focusing on point characteristics as design choices, made during the conscious production of an artifact for a specific task, the role of engineering in the point production process is emphasized (Nelson 1997:375-380). Although physical and cultural considerations went into the engineering of flaked-stone points used on the tips of projectiles, researchers have tended to focus on the latter to the frequent exclusion of the former. Too often regularities in point morphology are interpreted only as stylistic conventions shared by members of a single social group. Here we show that some morphological traits of stone points instead pertain to the intended function of the weapon, and had little to do with the cultural affiliation of the people who produced the points. We also provide an example of an attribute that is more closely associated with style. These examples illustrate why function and stylistic attributes have to be considered in the analysis of stone points, and we conclude by demonstrating our use of controlled laboratory experiments to empirically test the two.

FLAKED-STONE PROJECTILE POINT PHYSICAL CONSTRAINTS

Flaked-stone projectile tips are small portions of composite weapons, the remainders of which are rarely preserved in archaeological contexts. Although points are seemingly small elements, their design is constrained by forces involved in successfully launching an elongated projectile and having it successfully penetrate an intended target at range (Cotterell and Kamminga 1992; Klopsteg 1993; Kooi 1983; Loendorf 2012; Vanpool 2003). No single ideal design exists for projectiles because these weapons were used in a variety of contexts, and optimization of one trait usually results in compromising others (Knecht 1997:200). Effective projectile point design is therefore the result of compromise, the exact nature of which is largely dependent on the intended use of the weapon (Knecht 1997).

Contrary to a common misconception, stone tips are not necessary to “balance” shafts. Ethnographic observations and unusually well-preserved prehistoric artifacts demonstrate that projectiles commonly lacked stone points, and organic tips such as bone, antler, or wood were frequently employed (see Bostwick, this issue). In a cross-cultural study of over 100 preindustrial societies, Ellis (1997) observed that these different types of projectile tips were employed for separate purposes. While organic points were commonly employed in small game (<40 kg) hunting, stone tips were closely associ-

ated with either hunting large game animals (>40 kg) or warfare. The following discussion focuses on functional constraints that are common to both practices.

Wound size produced by the weapon is a fundamental aspect of projectile performance (Loendorf 2012:35-39; Shott 1993:435; Tomka 2013:554; Vanpool 2003:123). This variable can be measured by the depth of penetration and the cross-section (Christenson 1997). These two performance characteristics are inversely related such that all else being equal, projectiles with larger cutting areas will not penetrate as deeply (Pope 2000:43). Penetration, however, is more important than wound sectional area because the victim of a large but shallow wound is more likely to survive than one who receives even a minute injury to a critical internal organ, especially the heart (Bill 1862:385; Tomka 2013).

Penetration is the product of kinetic energy and momentum (i.e., impact energy), sectional-density (i.e., point cross-section), and projectile geometry including edge sharpness (cf. Christenson 1997:137; Kooi 1983:24; Vanpool 2003). Impact energy is a fundamental factor because without sufficient force a projectile will not penetrate regardless of how sharp it is or the nature of the cross-section. Kinetic energy and momentum are both functions of projectile mass and velocity, and they are positively related such that when one increases or decreases the other does as well (Grissom 2013). However, it is impossible for the launching mechanism to transfer all of its force to the projectile. For all bows types this is because energy is necessarily lost to friction, movement of the bow limbs, and other factors. Therefore, using a bow of a fixed propulsive force, heavier arrows have greater kinetic energy and momentum because more energy is transferred to heavier projectiles during launch, and compared to light arrows, less force is lost to other processes (Cotterell and Kamminga 1992:33-35; Grissom 2013; Klopsteg 1993; Kooi 1983:28; Tomka 2013:561). Not only does a heavier arrow have more energy when launched, it also decelerates at a slower rate (Kooi 1983:69). Therefore, a heavier arrow begins with more energy, and it retains a higher percentage of its impact force downrange (Grissom 2013:111-119). On the other hand, a lighter projectile will leave a given launching mechanism with a higher velocity than a heavier projectile (Grissom 2013; Kooi 1983:28; Tomka 2013:560).

Increasing the velocity of projectiles has many performance advantages (Loendorf 2012). First, higher velocities allow greater range (Klopsteg 1993; Vanpool 2003:119; Ratzat 1999; Tomka 2013). Excluding friction, this is because regardless of their speed projectiles begin to fall as soon as they leave the launching mechanism, and are accelerated by gravity at the same rate. Consequently, the greater the forward velocity the longer the horizontal distance a projectile will travel before hitting the ground. Second, higher velocities allow greater accuracy because it is possible to aim more directly at tar-

gets, which is colloquially referred to as “flat-shooting” (Cotterell and Kamminga 1992; Kooi 1983:24). The lower the velocity the greater the necessity to aim above a target at a given range, and the maximum distance occurs at an approximately 45-degree angle above the target (Cotterell and Kamminga 1992:162–163). For the same reason, low velocity projectiles also require greater proficiency in estimating the distance to the target and in controlling the speed of the projectile in order to determine precisely how far above the target to aim (Klopsteg 1993:24). Third, the higher the velocity the less time will elapse between launching the projectile and its impact with the target. This makes hitting moving targets easier, and allows less time for an intended target to avoid the projectile (Tomka 2013).

At the same time, the mass of a stone tip attached to an elongated projectile is also constrained by the acceleration method employed to launch the missile. Hand thrown spears are held closer to the center of mass (i.e., balance point) during launch, while both atlatl darts and arrows are launched by accelerating the distal end, which alters constraints on the distribution of mass for these projectiles. For example, when an arrow is launched from a bow, the nock (i.e., notch for the bowstring) is accelerated before the tip. The greater velocity of the nock when combined with the inertia of a tip of higher density than the shaft and on its opposite end tends to rotate the distal portion of the projectile forward (Ratzat 1999:201). A heavy point also increases stresses that occur in the shaft when rapidly accelerated from the opposite end, which can shatter the shaft if severe. Fletching (e.g., feathers) near the nock slows this end and helps counteract these forces (Ratzat 1999:201). Fletching, however, is the primary source of drag that slows the projectile after launch (Klopsteg 1993:23), which would result in unacceptable performance even if large fletching and a massive shaft were used in an attempt to compensate for a heavy arrow point or atlatl tip.

Diachronic changes in launching technology also constrained the range of acceptable variation among projectile tips. With hand thrown spears and atlatls the thrower receives feedback during launching that within certain limits allows compensation for differences in the mass of individual projectiles. In contrast, once an arrow is released it is not possible to alter the rate of acceleration, and projectiles of varying mass will have different points of impact (Klopsteg 1993:11–22; Mason 1894:660). Moreover, arrow points are small portions of complex systems (including the arrow, bow, and archer) that must operate together in order to effectively function (Cotterell and Kamminga 1992). Points must be the correct size for projectile shafts, which in turn need to be the proper draw length and stiffness (i.e., spine) for a given bow and archer. Because arrows of different masses will have different points of impact when fired from the same bow, without some form of standardiza-

tion in the manufacturing process, projectiles will be inaccurate (Mason 1894:660). Consequently, customized arrows of consistent sizes were produced to match the body size of individuals, and arrows or points were not freely inter-changeable among bows or archers (Burns 1916; Russell 1908:96; Rea 2007). Therefore, although exceptions exist, it is unlikely that completed projectile points were regularly exchanged, and instead it is more probable that it was the raw materials necessary for point manufacture that were traded.

Archaeological data support these observations. For example, if completed points were regularly obtained through trade, scavenging, or gambling then debitage raw material frequencies should not match the point raw material frequencies in assemblages. In cases where this has been tested with obsidian source data, debitage and point raw materials usually do not significantly differ, and obsidian in all stages of reduction is present at sites (e.g., Peterson et al. 1997; Loendorf et al. 2013). Furthermore, if points were commonly obtained from earlier components then temporal patterns in obsidian source utilization would not occur. For example, obsidian frequencies for Historic points differ from obsidian frequencies at nearby prehistoric sites, which indicates the historic points were not generally scavenged from prehistoric sites (Loendorf et al. 2013:279). Although ethnographic examples exist where arrows were exchanged as part of specialized activities, examination of these artifacts shows they did not usually have stone points attached (Loendorf 2012). For example, arrows used by the Apache for gambling are decorated with unique and elaborate painted designs, but they lack stone points (Mason 1894).

To summarize, all else being equal, because heavier projectiles have more kinetic energy and momentum, while lighter projectiles have greater range and accuracy, it is necessary to balance the ability to reach a target with the wound that can be inflicted upon it. These constraints limit projectile point variability and create upper and lower limits for successful designs.

Performance Constraints on Points Used in Warfare and Large Game Hunting

Extensive ethnographic evidence and ethnohistorical accounts indicate that points intended for use in warfare were frequently designed differently from those made for hunting large game animals (Ahler 1992; Catlin 1975:109; Ellis 1997:45; Keeley 1996:52; Loendorf et al. 2015a; Stevens 1870:564). The goals of hunting and warfare differ fundamentally in that killing is undertaken to obtain food during the former practice, while the primary intent of the latter is simply to kill or wound adversaries. As a result, substantially different functional constraints exist for these two tasks. Because of the considerable effort required to track a wounded animal as well as the increased chance it will not be recovered for consumption, hunting points were made to

kill as rapidly and consistently as possible. In contrast, warfare points were designed to maximize the probability that injury or death resulted, regardless of how long this might require (Loendorf et al. 2015a).

Humans differ from other large animals in ways that constrain the design of stone projectile points intended to wound or kill them (Christenson 1997:134; Cotterell and Kamminga 1992:181). First, the upright posture of people alters effective shot placement areas. Second, humans can employ defenses such as shields, and this armor could potentially impede penetration of the projectile. Third, people are capable of firing projectiles in return, which substantially increases the importance of range and rate of fire. Most importantly, people are more adept at removing a projectile from their body than are other animals, either by themselves or with help from others. Therefore, in order to create a more serious wound warfare projectiles were commonly designed such that the stone tips readily detached within wounds (Ellis 1997:45; Keeley 1996:52).

In contrast, the most reliable and rapid way to kill a quadruped game animal with a projectile is to completely penetrate both lungs and the heart (Stevens 1870:564). Nearly any wound to the heart will quickly result in death, and a puncture to even a single lung may cause incapacitation through suffocation. The internal hemorrhaging caused by lung penetrations also makes strenuous activities such as running difficult or impossible. Furthermore, this area is a larger target than the head or neck, and is encased by less bone. This vital area, however, is still protected by the rib cage, a potentially effective barrier, and a lethal shot requires passing through or between the ribs. Loosely attached points are more likely to detach when they hit bone, resulting in a shallow and non-life threatening wound on the exterior of the rib cage. As a result, hunting points were designed to stay on arrows.

Problems arise in attaching a stone point to a projectile shaft if the portion in the haft is wider than the shaft (Christenson 1997:134–135). First, firmly fastening the point is difficult because the binding materials are cut by its sharp edges unless they are ground (Fauvelle et al. 2012; Géneste and Maury 1997:183). Second, the bindings necessarily extend over a larger perpendicular area to the cutting edges of the point, which increases the cross-sectional area and impedes penetration (Christenson 1997; Knecht 1997:201–202). Notching is one solution for reducing the width of the stem and facilitating secure hafting of the point (Christenson 1997:135). These observations suggest that triangular points designed for hunting have notches in that portion of the blade that is in the haft, while points intended for warfare may not have notches.

Table 1. Arrow Wound Locations and Fatality Rates (adapted from Bill 1882:107).

| Wound Location | Severe Injuries | Percent of Wounds | Died from Wounds | Percent Fatal |
|----------------|-----------------|-------------------|------------------|---------------|
| Arms | 46 | 30% | 2 | 4% |
| Legs | 18 | 12% | 1 | 6% |
| Neck | 13 | 8% | 1 | 8% |
| Chest | 30 | 20% | 15 | 50% |
| Head or Spine | 13 | 8% | 7 | 54% |
| Abdomen | 34 | 22% | 21 | 62% |
| TOTAL | 154 | 100% | 47 | 31% |

Ethnohistorical Observations of the Performance of Native American Projectile Points

The observations presented above are supported by data collected by US Army surgeons who treated arrow wounds received by unarmored US soldiers (Milner 2005). For example, Bill (1862, 1882) provided information regarding the location of injuries and survival rates for 154 men who were severely wounded by Native American arrows (Table 1). While less than one-third of arrow wounds were fatal, impacts to the chest, head, spine, and abdomen were most dangerous. Injuries to the arms were most common, and 42 percent of all wounds were to the extremities. Half of all chest injuries were fatal, but in 30 percent of other chest wounds the lungs and heart were not injured, and all of these patients survived their wounds. The two patients with injuries to the heart died, one instantly and the other within five minutes (Bill 1862). Bill also observed that “[a]n arrow sometimes goes through the chest and passes out. It would always do so if it were not that it can scarcely miss hitting a bone” (Bill 1862:376). These data also show that arrow injuries to the abdomen were most likely to be fatal. Ninety percent of the instances where the intestines were perforated resulted in death, but this generally took several days or even weeks (Bill 1862:385–386). As a result, Native Americans intentionally targeted the abdomen, and all arrow points that detached within wounds were likely to cause incapacitation and eventually death if they were not extracted (Bill 1862, 1882).

FLAKED-STONE PROJECTILE POINT SELECTION, FUNCTION, AND STYLE

Some theorists address the performance and social dimensions of technology using the concept of Darwinian selection (Bettinger and Eerkens 1997, 1999; Dunnell 1996; Hitchcock and Bleed 1997:348–350; O’Brien and Lyman 2003). This prompts the analyst to explicitly articulate the link between behavior and material form. It also draws attention to the transmission of technological knowledge, the mechanisms that generate vari-

ability, and the replacement of some traits over others through selection. Behaviors and traits that elevate the fitness of the individual or group have a greater chance of being repeated and transmitted; in contrast, those that decrease fitness have a lower chance of being repeated and transmitted and they will decline in frequency over time. Technological traits and behaviors that are affected by selection, thus increasing the fitness of the users, are referred to as functional, while traits that are neutral with respect to selection are termed stylistic (Dunnell 1996:120; O'Brien and Lyman 2003).

Selection will operate even if the makers of an artifact do not fully understand the ramifications of their design choices on performance, but for technological change to occur there needs to be a source of variation in the reproduction of the item. In the case of projectile points, variation can arise from many sources including errors made during copying existing templates, deliberate experimentation, and conscious copying of newly introduced traits. Unlike biological evolution, these sources of variability are not exclusively random because people are capable of evaluating performance and using this understanding to engineer improvements to their own designs, and people can therefore be consciously engaged in the process of selecting for technological change. Simultaneously, selection can also operate at such a gradual rate that it might not be perceptible to humans. People may also make choices that are less than advantageous, and this is an important source of variability in designs. However, to the extent that such decisions lessen the fitness of the group or individual in comparison to competing groups, selection will operate to eliminate the use of ineffectual designs.

With respect to stone points, the effect of selection on their form is related to the behavior involved in using the tool, and design characteristics that improve performance in hunting differ from those that improve performance in warfare because of the respective differences in the two types of behavior (i.e., differing functional constraints). Projectile points designed for warfare are expected to have a different set of traits compared to projectiles designed for hunting large animals. Changes in the form of projectile points that improve the killing of animals for food will tend to increase the longevity and social prominence of hunters, giving them more time and opportunities to transmit the behaviors responsible for the increased performance of their point designs (Bettinger and Eerkens 1999; McGuire and Hildebrandt 2005; Shott 1993:437-438). In warfare, the performance of projectile points directly affects the demographic fitness of the group. Warriors using higher performing weapons against combatants with less effective weapons will tend to survive engagements more often and, as a group, these individuals will have greater opportunities to transmit their weapon-making behaviors. Artifact traits that improve the survival of the user persist and increase in frequency over time at the ex-

pense of functional traits that do not.

However, manufacturing decisions can lead to choosing traits that have no impact on design performance. These traits are free to vary independently of function, raw material constraints, or other performance factors (Clark 1989:32). Attributes that are unrelated to performance and not subject to selection can nonetheless be repeated with considerable consistency through time and within a bounded segment of space. This is because the technical knowledge required to make projectile points is generally acquired in the restricted settings of local communities, and traits, both those related to function and those that are not, are learned and copied by novice artisans receiving instruction from more experienced knappers. Sets of co-occurring traits that are unrelated to performance but which are repeated over time are referred to as stylistic, and can be particular to specific groups (Hitchcock and Bleed 1997:350; Sliva 2015:101-105).

Further, lithic artifact style can be a passive and unintentional reflection of culture, or it can be a deliberate expression that has an invested symbolic component (Kooyman 2000:96). Point styles may develop and be transmitted within a social group as the product of habits adopted in restricted learning contexts (Bettinger and Eerkens 1999). The knappers may be unaware that their habits differ from those of neighboring groups, and in such cases the styles are an unintended reflection of their group membership (Carr 1995; Sliva 2015:102-103; Weissner 1983; Eerkens and Lipo 2005). Styles may also be actively manipulated as symbols of social group membership, but such usage is generally associated with highly visible artifacts employed in public contexts (Carr 1995; Hodder 1982; Wobst 1977). Small stone points would seem to fit this definition poorly; however, these artifacts were used in warfare, which is a public setting that is possibly the primary context of interaction for some social groups. Although small points may not have been visible from a distance, they were shot at the enemy thereby increasing the proximity of observation for other social groups. Furthermore, stone points used in warfare were designed to detach within wounds (Loendorf et al. 2015a), leaving behind a potent reminder of the maker's cultural affiliation. Finally, in some circumstances exceptionally large points were produced, which would have been more visible from a distance (Figure 1).

Sets of stylistic traits can spread beyond the area of their origin through cultural contact such as migration or the emulation of foreign styles (Sliva 2015). Furthermore, functional and stylistic traits can be transmitted together as a bundle or independently of each other. Without going into the details of transmission factors (see Bettinger and Eerkens 1997; Sliva 2015:102-105), one source of variability in the transfer of traits is the relative weight of individual experimentation versus cultural conformity (Bettinger and Eerkens 1997:181-182).

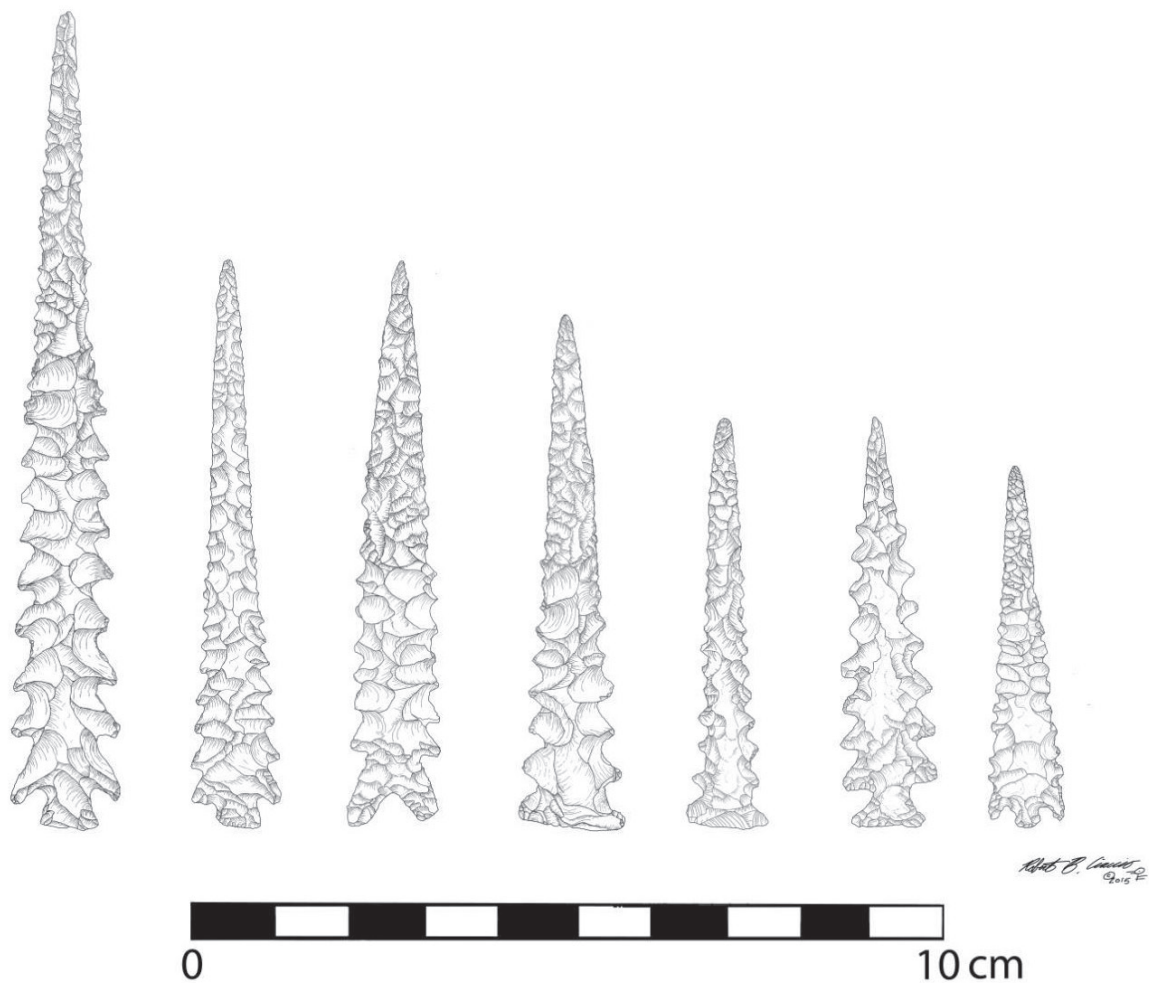


Figure 1. Artist reconstruction of points collected from Snaketown, by Robert Ciaccio following Haury 1976 and Sayles 1936 (outlines are exact, flaked-scars are approximated).

Similar functional traits can develop independently in different regions through the operation of selection alone without cultural contact, as a response to performance constraints. This is not the case for suites of stylistic traits, which are less likely to be independently developed in two separate cultural contexts without some form of direct or indirect cultural contact. Failure to separate functional traits from suites of stylistic traits can therefore result in fundamental misinterpretations of the archaeological record, and parallel technological solutions to the same performance constraints can be confused for a situation of cultural similarity.

CONTROLLED EXPERIMENT METHODS

We use the results of laboratory experiments to demonstrate how distinctions between functional and stylistic traits can be empirically tested. The first experiment compares the use of notches for attaching points to the arrow shafts versus the absence of notches, and the second compares the performance of serrated and

unserrated points. The experiments were performed in a laboratory established by the senior author at the Cultural Resource Management Program of the Gila River Indian Community.

The goal of these experiments was not to replicate the exact conditions of use for prehistoric technology, but instead was to provide a scientific assessment of point attributes. In order to assess projectile point characteristics two fundamental aspects of performance are reported: point durability and wound size (Christenson 1997; Cotterell and Kamminga 1992; Loendorf 2012; Shott 1993; Vanpool 2003). Projectile durability was recorded with respect to breakage and the frequency with which the stone point became detached from the shaft. In these experiments wound size was measured by holding the point size and cross-sectional area constant and measuring the depth of penetration.

In each experimental run, to the extent possible only one attribute (e.g., blade edge serration) was allowed to vary and all others were held constant. To control as many sources of variation as possible, commercially

Table 2. Metric attributes for the projectile points employed in the two rounds of experiments.

| | | N | Mean | Std. Deviation |
|-------------------|--------------|----|------|----------------|
| Point Length (mm) | Side-Notched | 24 | 21.7 | 3.3 |
| | Unnotched | 24 | 20.8 | 2.3 |
| | Unserrated | 12 | 19.2 | 1.9 |
| | Serrated | 12 | 19.7 | 1.0 |
| Thickness (mm) | Side-Notched | 24 | 3.8 | 0.4 |
| | Unnotched | 24 | 3.6 | 0.4 |
| | Unserrated | 12 | 3.4 | 0.3 |
| | Serrated | 12 | 3.4 | 0.4 |
| Base Width (mm) | Side-Notched | 24 | 13.3 | 2.8 |
| | Unnotched | 24 | 13.9 | 2.5 |
| | Unserrated | 12 | 10.7 | 1.3 |
| | Serrated | 12 | 11.8 | 1.4 |
| Weight (grams) | Side-Notched | 24 | 0.8 | 0.2 |
| | Unnotched | 24 | 0.8 | 0.2 |
| | Unserrated | 12 | 0.6 | 0.1 |
| | Serrated | 12 | 0.6 | 0.1 |

manufactured wooden arrows were employed. In addition, stone points were not attached to some arrows, which were used as controls. The tips of these arrows were sharpened, but they were otherwise identical to the arrows with the stone points. In order to control for differences in manufacturing technique, all projectile points were made from Government Mountain obsidian by Daniel Dybowski. This stone outcrops in north central Arizona, and was widely employed for the production of arrow points in the Southwest (Shackley 2005). All points approximated the average size of arrow tips in the Pima-Maricopa Irrigation Project (P-MIP) survey collection (Loendorf and Rice 2004). Table 2 presents metric attributes for the projectile points employed in the two sets of experiments, and although there is some variance, the points used within each experiment do not substantially differ. The experimental points were triangular forms with straight blade margins and straight bases.

The experiments comparing the performance of notched and unnotched points were conducted using only foam targets, and other target types were not employed because the necessary materials were not avail-

**Figure 2. Arley Simon (left) and Lynn Simon (right) using the bow bench rest.**

able in sufficient quantities when these initial experiments were conducted. These targets consisted of five layers of 70-mm thick polystyrene that were covered with a layer of 5-mm thick foam core poster board, and two layers of 0.15-mm thick plastic. These targets are analogous to human and other animals in the sense that the exterior consists of elastic materials (i.e., plastic and poster board), which covered a more inelastic material (i.e., foam) as is the case with skin and muscle. Although no artificial targets can perfectly replicate the characteristics of actual use, the targets that were employed have the advantage that they can be produced from readily available inexpensive materials and they are comparatively uniform. Although these targets are not exact proxies for living organisms, this does not mean that any variation in performance measured between point types is the product of the target media employed.

Six different uniform target media were used in the serrated point experiments. Increasingly inelastic targets were employed, beginning with foam blocks, then ballistics gel, next rawhide of different thicknesses, and finally polymethylmethacrylate or PMMA. The ballistic gel was made by Clear Ballistics™. This material matches the density of human tissue, and was either 15 or 20

cm thick. To examine impacts with less elastic materials, rawhide with three different thicknesses (0.2 mm, 2.6 mm, and 3mm) was placed in front of ballistics gel. Points were also fired at 20 cm of polystyrene covering a 5-mm sheet of PMMA.

All points were hafted as securely as possible using approximately 500-mm of 2-mm wide artificial sinew, and no adhesives were employed. To minimize shot-to-shot variability, all projectiles were fired using a fixed stand that maintained a uniform draw length and point of aim (Figure 2). Targets were placed an average of 2.3 m from the bow. The first arrow shot lacked a stone point, and this projectile was employed to establish the point of aim. Arrows with points of different designs were then alternately fired until all points detached, were broken, or the experimental run ended. To aid in controlling for intra-run variation, approximately every tenth shot was a control arrow.

PERFORMANCE OF NOTCHED AND UNNOTCHED PROJECTILE POINTS

A total of 350 arrow impacts were recorded to test notched and unnotched projectile points. These data were collected over the course of 28 days between July 10th, 2013, and March 29th, 2014. Forty-eight isosceles triangular points were used in the experiments. Half were randomly chosen and given side notches, while the other half were left unnotched.

Point Detachment Rates

Figure 3 compares the average number of times arrows in each category were fired before the points detached (Table 3). Points without side notches are significantly less likely to stay attached to arrow shafts than points with notches (unpaired t-test: $t = -2.69$, $df = 56$, $p = 0.009$). These results therefore suggest that points were notched in order to better secure them to projectile shafts, which is consistent with the expectations for tips that were designed for hunting large animals. At the same time, the large range of variation for side-notched points suggests that additional attachment methods such as the use of adhesives are necessary to insure firm point attachment.

Table 3. Shot count before point detachment rates in foam targets by tip type.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|--------------|-----|---------|---------|------|----------------|
| Unnotched | | | | | |
| Shot Count | 108 | 1 | 19 | 4.4 | 4.3 |
| Side-Notched | | | | | |
| Shot Count | 189 | 2 | 62 | 11.4 | 14.8 |

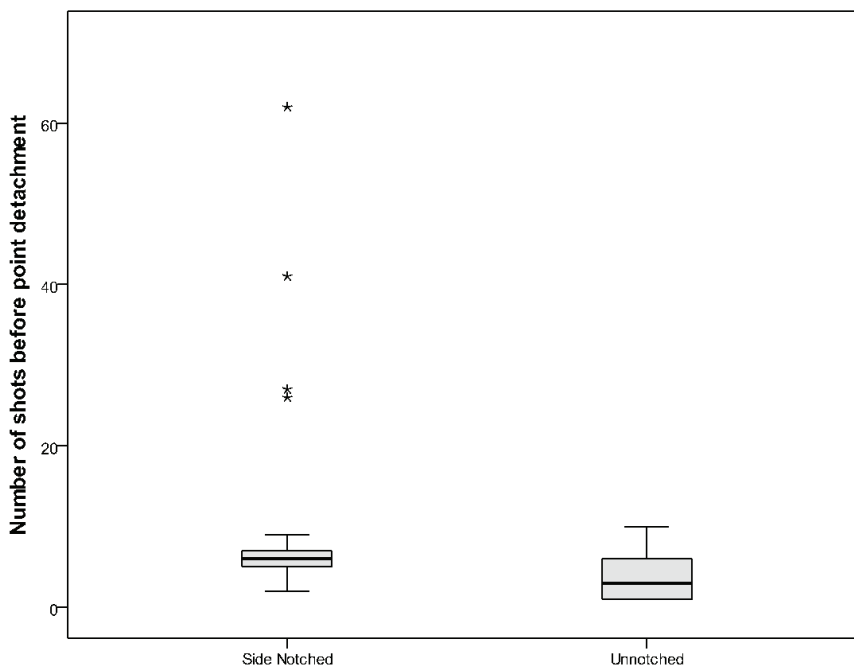
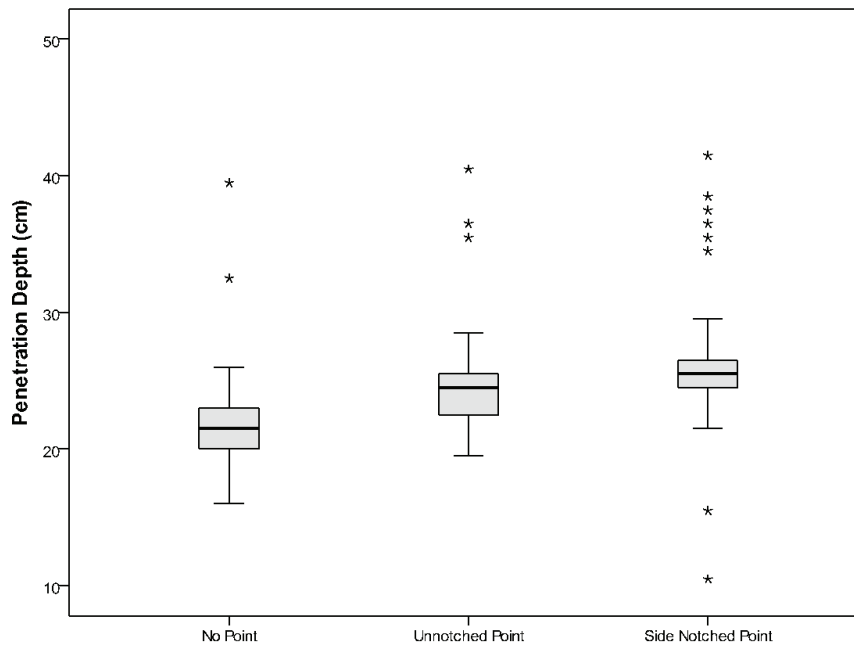


Figure 3. Side-notched and unnotched point detachment data for foam targets..

Table 4. Penetration depths in foam target statistics by tip type.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|------------------------|-----|---------|---------|------|----------------|
| Unnotched | | | | | |
| Penetration Depth (cm) | 108 | 16 | 40 | 24 | 3.5 |
| Side-Notched | | | | | |
| Penetration Depth (cm) | 189 | 10 | 41 | 26 | 3.6 |
| No Stone Point | | | | | |
| Penetration Depth (cm) | 58 | 14 | 39 | 22 | 4.3 |

**Figure 4. Penetration depth in foam targets by tip type.**

Wound Size (Depth of Penetration)

Table 4 summarizes penetration results for points with different designs. Figure 4 graphically compares these data, which show that side-notched points penetrated roughly 6 percent deeper than unnotched points, and this variation is statistically significant (unpaired t-test: $t = -3.53$, $df = 295$, $p < 0.001$). This difference appears to result from the fact that in order to securely haft unnotched points it was necessary to wrap around the blade margins, whereas side notches provide a recessed location where the ligatures were attached.

These results show that it is possible to attach unnotched points with some degree of security to a shaft using only ligatures (see also Fauvelle et al. 2012); however, this comes at the cost of decreased penetration and it is still not possible to attach points as firmly as can be accomplished with a side-notched design. These observations are consistent with the hypothesis that unnotched projectile points were designed for use in warfare, and as a result were attached to projectiles in a way that facilitated detachment within wounds. Features of side-notched points, on the other hand, facilitate secure attachment, a design that is consistent

with that hypothesized for hunting large animals.

Discussion

Patterning in the temporal and spatial distribution of projectile points with different attributes also supports the suggestion that points were designed differently for large game hunting and warfare. For example, projectile points designed for hunting are concentrated in areas where suitable big game habitat is present along the middle Gila (Loendorf 2012:97-101). In addition, the incidence of these two point designs varies over time, and by the late Historic period, big game hunting designs are entirely absent along the middle Gila River and only warfare point designs occur (Loendorf et al. 2015a). This is consistent with extensive ethnohistorical observations and ethnographic evidence that shows the Akimel O'odham who lived in the region during the Historic period rarely if ever hunted large animals, but intense warfare with Yavapai, Apache, and Yuman populations was documented (Loendorf 2012:47-66).

Furthermore, patterning in projectile point collections is also consistent with expectations based on ethnohistorical and ethnographic evidence (Loendorf 2012). For example, the circumstances of warfare are expected to result in a lower recovery rate for these arrows, whereas hunting arrows (with broken points attached) were more commonly retrieved for reuse of the shaft (Rea 1998:74). Even if the warfare arrows were recovered, the points are likely to have detached because they were intentionally loosely secured. In contrast, the bases of side notched points would be more readily retrieved because they were firmly attached to arrows. These points were then removed and discarded at habitation sites, where the artifacts were collected (Loendorf 2012:67). As a result, warfare points are more likely to be whole while points designed for hunting are more likely to be broken, and this observation is supported by archaeological data (Loendorf et al. 2015a).

Finally, side-notching is only one solution for achieving secure attachment of the point, and other approaches such as corner-notching and some stemmed designs may also produce similar results. Consequently, other hunting point designs are possible. Similarly, points intended for warfare may have had a variety of attributes.

For example, ethnographic evidence suggests that points with narrow contracting stems were designed to detach from arrows shafts and were made for use in warfare (Du Bois 1940). Furthermore, the experiments reported here considered only designs with the notches in the lower one-third of the blade, and it is unclear if points with side-notches in the middle or upper one-third of the blade will perform similarly. Conducting controlled experiments on notch placement along the blade margin is one method for assessing the implications of this variation in notch placement.

PERFORMANCE OF SERRATED AND UNSERRATED PROJECTILE POINTS

We collected data on the performance of serrated and unserrated projectile point in a series of 359 controlled arrow impacts. These observations were recorded over the course of 17 days between January 21st, 2015, and March 4th, 2015. A total of 24 isosceles triangular points were used, half of which were randomly chosen and serrated, while the other half were left without serrations.

Wound Size (Depth of Penetration)

Within the foam blocks, unserrated points have a larger range of variation in penetration values, but they penetrated slightly deeper on average (Figure 5; Table 5). However, this variation is not statistically significant (unpaired t-test: $t=-1.32$, $df=208$, $p=0.19$). These data show that serration did not substantially affect point penetration, and this characteristic may therefore be free to vary independently of function.

Durability

Figure 6 compares the number of times arrows were fired before the points detached for all target types. Both serrated and unserrated points have a large range of variation, and they are not significantly different (unpaired t-test: $t=-.42$, $df=33$, $p=0.68$). In this analysis, serration did not significantly alter the rates at which points became detached from the shafts.

Overall, breakage patterns for serrated and unserrated points

are similar (Table 6), and do not significantly differ (chi-square = 0.17, probability = 0.67). Not surprisingly, only one point had minor damage in the foam target impacts ($n=232$), and no points were damaged in the ballistics gel ($n=52$), although one serrated point did detach. Similarly, no points detached or were broken when impacting the ballistics gel covered with 0.2 mm of rawhide ($n=20$). However, points suffered high damage rates in the 2.6 and 3 mm rawhide impacts (Table 7). Although serrated points had slightly higher failure rates, the difference is not statistically significant (Fisher's Exact $p=0.62$).

Two serrated and two unserrated points were fired at PMMA that was covered with polystyrene foam, and all of them suffered catastrophic failures (Figure 7). The severe damage to the points may in part result from the lack of adhesives, which would help transfer the impact to the shaft and improve durability (Fauvelle et al. 2012). The low fracture toughness of obsidian also contributed to the severe damage, and these results show that obsidian points attached without adhesives are unlikely to

Table 5. Arrow penetration within ballistic gel by tip type.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|------------------------|-----|---------|---------|------|----------------|
| Unserrated | | | | | |
| Penetration Depth (cm) | 119 | 10 | 37 | 21 | 4.9 |
| Serrated | | | | | |
| Penetration Depth (cm) | 91 | 9 | 33 | 20 | 3.7 |
| No Stone Point | | | | | |
| Penetration Depth (cm) | 24 | 11 | 36 | 17 | 5.6 |

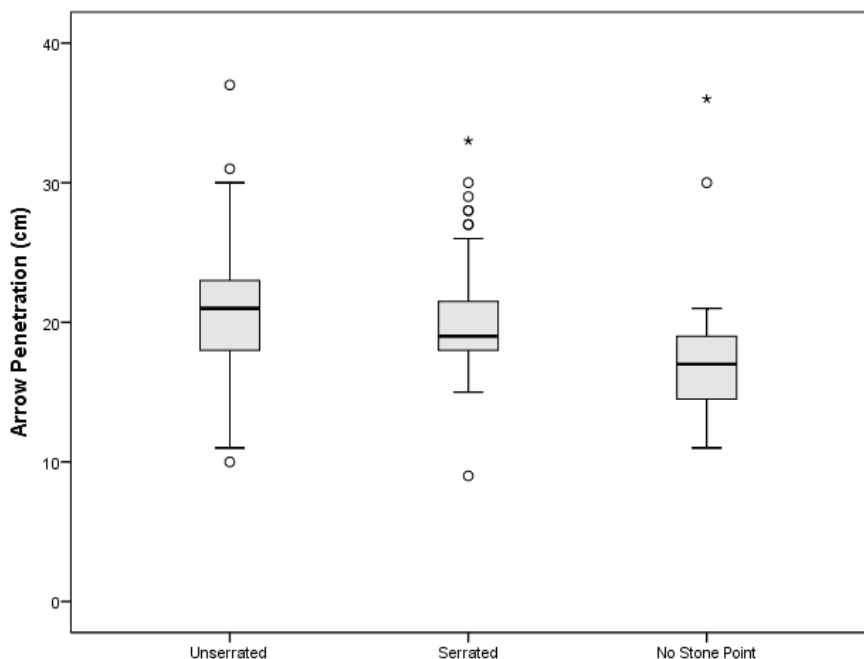


Figure 5. Normalized penetration data for ballistics gel by point tip type.

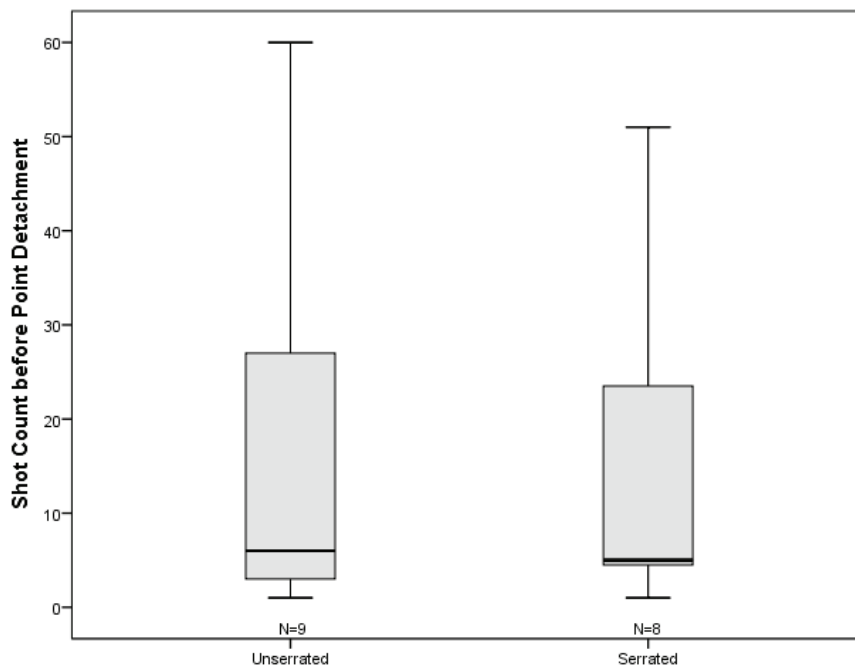


Figure 6. Shot count before point detachment by tip type for all target types.

Table 6. Point breakage patterns for serrated and unserrated points for all target types.

| Point Break | No | Yes | Total |
|--------------|------------|-----------|------------|
| Unerrated | 162 | 5 | 167 |
| Serrated | 149 | 7 | 156 |
| Total | 311 | 12 | 323 |

Table 7. Point breakage patterns serrated and unserrated points in 2.6 and 3 mm rawhide.

| Point Break | No | Yes | Total |
|--------------|----------|----------|-----------|
| Unerrated | 5 | 3 | 8 |
| Serrated | 3 | 4 | 7 |
| Total | 8 | 7 | 15 |

be used in circumstances where high durability was necessary for successful performance (Nelson 1997).

Discussion

Although serrated and unserrated points varied slightly in penetration, and it is possible that this characteristic may affect other aspects of performance, no substantial differences were measured in the experiments reported here. These results therefore suggest that this attribute is less constrained by performance requirements, and therefore may have varied independently of point function. As such, social segments could potentially have added serrated edges to their points as an intentional symbol of group membership. If this was the case, then temporal and spatial variation in point

margin treatment can be used to assess interactions among prehistoric and historic socio-cultural groups (Loendorf et al. 2015b).

Considerable temporal and spatial variability exists in the incidence of projectile point blade serration in North America. However, little work has previously been done on this subject, but Hoffman (1997) is one researcher who considered this variable, and he concluded that the Hohokam of southern Arizona used projectile point blade margin treatment including serration to intentionally signal group affiliations.

Patterning in the distribution and nature of serrated points in the archaeological record also supports the observation that the technique was employed

for stylistic reasons. For example, Hauray (1976:297) argued that the elaborate serrated points from the site of Snaketown were too exceptionally large and fragile to have been functional (see Figure 1; see also Sliva 2010). Furthermore, while 36 percent of all points from surface collections undertaken in the Snaketown area were serrated, this practice was six times lower in the Casa Blanca area, which is located on the south side of the Gila River, immediately opposite Snaketown (Figure 8; Table 8; Loendorf and Rice 2004; Loendorf 2012, 2014). These data include artifacts from throughout archaeological sequence from middle Archaic (ca. 5000 B.C.) through late Historic period Akimel O'Odham projectile

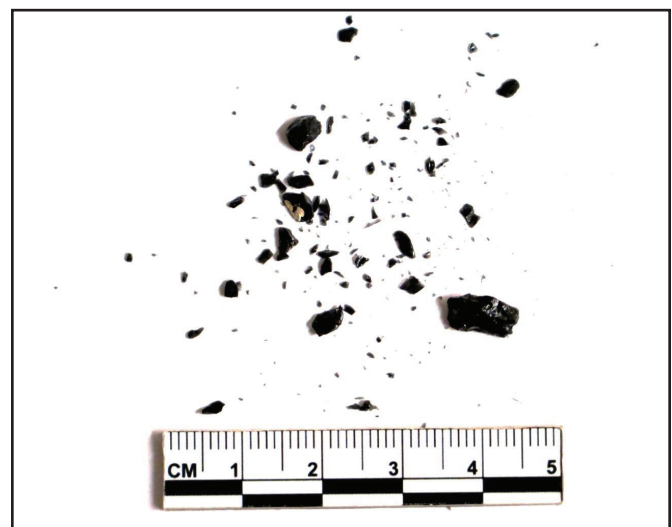


Figure 7. All fragments that were collected from a point that impacted PMMA.

points (ca. 1880). The immediate proximity of the two areas indicates that the practice was not a response to environmental or other performance constraints. In addition, the incidence of serration increases with distance from the Casa Blanca area.

Other researchers have also noted variation in the incidence of serration within the Southwest, including Sliva (2006:60) who argued that while serrated points were common during the pre-Classic Hohokam sequence (AD 600-1150), "serrated Puebloan points are rare in any time period." In contrast, Bryce and Bailey (2015) did not find substantial differences in the incidence of serration at northern and southern Sinagua sites, and respectively 23 and 22.8 percent of points from each region had this form of edge modification. Archaeologists have recorded patterning in projectile point serration data from other regions. For example, researchers have noted the elaborate nature and spatially restricted distribution of serrated points in California (Johnson 1940; Hester and Heizer 1973).

Some prehistorians have speculated that serrated blades increase tissue damage following penetration, either as a result of movement of the jagged edged in the wound or through attempts to pull the point from the wound (Sliva 2015:101). Pfefferkorn (1989) reported this as the purpose of serrations in his 18th century

record, and he appears to have been relaying O'odham beliefs. But these arguments, and the beliefs of the native users concerning the lethality of serrated points, are not supported by the archaeological evidence. The considerable variability in the distribution of serrated points over very short distances, literally between neighboring communities, demonstrates they were not more efficacious than non-serrated blades. If serrated points performed better than non-serrated points, they would have had a more consistent and widespread distribution. These observations are consistent with the experimental data and they show that serration was a stylistic and not a functional trait.

Finally, serration is only one aspect of point design and many other attributes such as blade and base treatment (e.g., straight, concave, or convex) must also be considered when defining the overall performance and style of stone points. Moreover, these design attributes can theoretically operate together in ways that alter the effects of individual variables. Therefore, defining functional or stylistic types requires the consideration of all relevant point characteristics. The methodological approach described here provides a way to assess and define the effects of individual attributes, and conducting carefully controlled experiments can provide another line of evidence regarding the degree to which these

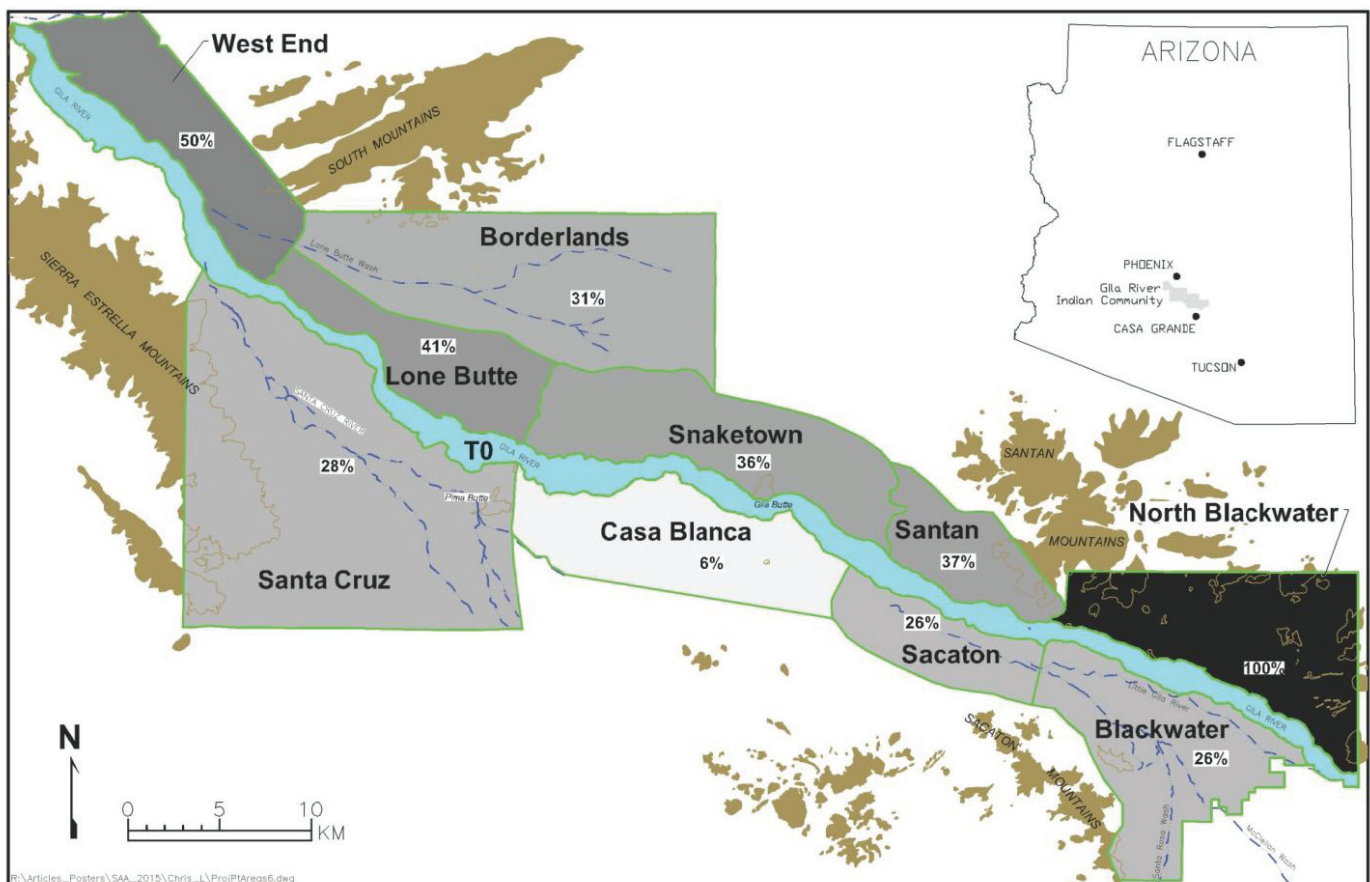


Figure 8. Proportions of serrated points by study unit, P-MIP survey collection. Units shaded based on serration proportions, with black being the greatest. Percentages listed are the serrated proportions.

Table 8. Projectile point serration data by location and time period, P-MIP survey collection (Loendorf and Rice 2004).

| Serration Absence/Presence by Time Period | | | | | | | | | | | | | | | |
|---|--------------------------|----|-----|-------------------|----|-----|--------------------|----|------|--------------------|----|-----|-------|-----|------|
| Site Group | ca. 5000 B.C. - A.D. 600 | | | ca. A.D. 600-1150 | | | ca. A.D. 1150-1500 | | | ca. A.D. 1500-1900 | | | TOTAL | | |
| | - | + | % | - | + | % | - | + | % | - | + | % | - | + | % |
| N. Blackwater | --- | | | --- | | | 0 | 1 | 100% | 0 | 1 | 100 | 0 | 2 | 100% |
| West End | 2 | 1 | 33% | 6 | 8 | 57% | 3 | 2 | 40% | --- | | | 11 | 11 | 50% |
| Lone Butte | 4 | 2 | 33% | 2 | 3 | 60% | 5 | 3 | 38% | 2 | 1 | 33% | 13 | 9 | 41% |
| Santan | 2 | 3 | 60% | 1 | 4 | 80% | 6 | 0 | 0% | 3 | 0 | 0% | 12 | 7 | 37% |
| Snaketown | 28 | 12 | 30% | 35 | 25 | 42% | 43 | 9 | 17% | 12 | 20 | 63% | 118 | 66 | 36% |
| Borderlands | 55 | 25 | 31% | 2 | 2 | 50% | 3 | 2 | 40% | 4 | 0 | 0% | 64 | 29 | 31% |
| Santa Cruz | 27 | 2 | 7% | 4 | 4 | 50% | 17 | 3 | 15% | 19 | 17 | 47% | 67 | 26 | 28% |
| Blackwater | 33 | 7 | 18% | 1 | 0 | 0% | 2 | 2 | 50% | 12 | 8 | 40% | 48 | 17 | 26% |
| Sacaton | 8 | 0 | 0% | 2 | 1 | 33% | 2 | 0 | 0% | 1 | 3 | 75% | 13 | 4 | 24% |
| Casa Blanca | 20 | 2 | 9% | 7 | 2 | 22% | 25 | 3 | 11% | 98 | 2 | 2% | 150 | 9 | 6% |
| TOTAL | 179 | 54 | 23% | 60 | 49 | 45% | 106 | 25 | 19% | 151 | 52 | 26% | 496 | 180 | 27% |

*Excludes isolated occurrences, and unfinished points (preforms).

characteristics are constrained by performance requirements. This will then allow us to better understand the implications of projectile point morphological variation, and not to simply assert or assume that all differences are stylistic.

CONCLUSIONS

In the past researchers have tended to assume that all flaked-stone points are functionally equivalent, and they have considered variation among traits to be the result of stylistic factors. However, both function and style are reflected in the forms of stone projectile points, and researchers need to take both factors into account. Conflating the two, and mistaking functional traits for stylistic traits or vice versa, can lead to erroneous conclusions about the past. In this paper we have presented a theoretical approach based on the application of artifact design theory to the study of projectile points. This analytical paradigm as developed here emphasizes the role of human engineering in the point production process, and it defines a basis for separating function and style that can be tested using controlled scientific investigations.

The experiments summarized here provide another line of evidence that serration of the blade margins does not significantly alter the performance of points. Although serrated points and unserrated points did differ slightly in penetration and it is possible this characteristic may affect other aspects, no substantial functional differences were identified. These data therefore suggest that this attribute is adaptively neutral, and is free to vary independently of performance. The experimental results and archaeological data both suggest

that some sociocultural groups such as the O'odham (i.e., Pima or Papago) of southern Arizona and their ancestors employed point serration as an active symbol of social affiliation (Loendorf et al. 2015b).

On the other hand, experimental results suggest that notching of the blade margin does significantly alter certain projectile point performance characteristics. Therefore, selection is expected to affect this characteristic, and it appears that this attribute is more closely related to functional constraints than stylistic norms. Specifically, side-notched triangular points remain firmly attached to shafts and were appropriate for use in large game hunting, whereas unnotched triangular points tend to detach from arrows and were appropriate in conflict with other people. On a large geographical scale, notching was independently employed as a solution for hafting by many different groups. Consequently, regional patterning in the distribution of these traits should not be misconstrued as an indication of social contact, and the distinction between notched and unnotched points is not directly related to differences among social groups. However, stylistic variation can still exist in other aspects of points such as details of notch design that do not greatly affect the performance of the point. These attributes are stylistic when they can be demonstrated to have a continuous spatial distribution in a circumscribed area, reflecting a cultural convention used by local populations in the production of projectile points.

The experiments reported here represent a first step in assessing the functional traits of points, and additional testing, especially employing different target media, is necessary to more rigorously investigate relevant performance parameters of projectile points.

While it is possible that different results could be observed in dissimilar target media or under other conditions (e.g., using points made from raw materials other than obsidian), this is an empirical issue that needs to be addressed through the implementation of additional well controlled experiments. Finally, while the experimental data do unequivocally demonstrate that some point attributes effect function while others do not, the patterning observed in the experiments is supported by multiple additional lines of evidence, including ethnohistorical and ethnographic records, archaeological patterning in the spatial and temporal distribution of projectile points, and finally the morphology of the points themselves.

Archaeologists still commonly refer to categories in point classification schemes as “styles,” which implies that the attributes employed to separate types do not affect function. However, point varieties are invariably defined using attributes (e.g., side-notching), which ethnohistorical observations, ethnographic evidence, physical performance constraints, and experimental data all indicate do have a significant effect on function. Studying typological categories from a design perspective has the advantage that it prompts the analyst to consider if the classification criteria are indeed adaptively neutral, and objectively separate stylistic from functional traits. More importantly, defining functional characteristics of points allows researchers to address a much broader range of research questions than can be considered exclusively using a traditional stylistic research paradigm. For example, separating points that were designed for large game hunting from those made for warfare provides an analytical method for inferring diachronic and synchronic variation in both conflict and subsistence practices.

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REFERENCES CITED

- Ahler, Stanley A.
1992 Phase Classification and Manufacturing Technology in Plains Village Arrowpoints. In *Piecing Together the Past: Applications of Refitting Studies in Archaeology*, edited by J. L. Hoffman and J. G. Enloe, pp. 36–62. BAR International Series 578. Archaeopress, Oxford, England.
- Azevedo, Soledad de, Judith Charlin, Rolando González-José
2014 Identifying Design and Reduction Effects on Lithic Projectile Point Shapes, *Journal of Archaeological Science* 41(2014):297–307.
- Bettinger, Robert L. and Jelmer Eerkens
1997 Evolutionary Implications of Metrical Variation in Great Basin Projectile Points. In *Rediscovering Darwin: Evolutionary Theory and Archaeological Explanation*, edited by C.M. Barton and G.A. Clark, pp. 177–191. Archaeological Papers 7. American Anthropological Association.
- 1999 Point Typologies, Cultural Transmission, and the Spread of Bow-and-arrow Technology in the Prehistoric Great Basin. *American Antiquity*, 64(2):231–242.
- Bill, J. H.
1862 Notes on Arrow Wounds. In *The American Journal of the Medical Sciences*, edited by Isaac Hays, pp. 365–387. Blanchard and Lea, Philadelphia.
- 1882 Arrow wounds. In *International Encyclopedia of Surgery: a Systemic Treatise on the Theory and Practice of Surgery by Authors of Various Nation*, edited by J. Ashhurst, pp 103–118. New York, New York: William Wood and Company.
- Bonnichsen, B. R. and J. D. Keyser
1982 Three Small Points: A Cody Complex Problem. *Plains Anthropologist* 27(96):137–144.
- Buchanan, Briggs, Mark Collard, Marcus J. Hamilton, Michael J. O'Brien
2011 Points and Prey: A Quantitative Test of the Hypothesis that Prey Size Influences Early Paleoindian Projectile Point Form. *Journal of Archaeological Science* 38 (2011): 852–864.
- Burns, Michael
1916 Indian Troubles. In *History of Arizona: Volume III*, edited by Thomas E. Farish, pp. 286–355. The Filmer Brothers Electrotype Company, San Francisco, California.
- Bryce, William D. and Ashlee M. Bailey
2015 Bifacial Lithic Technology at Tuzigoot and Montezuma National Monuments: A Southern Sinagua Case Study. *Journal of Arizona Archaeology* 3(1-2):130–143
- Catlin, George
1975 *Letters and Notes on the North American Indians: In One Volume*, edited by M. M. Mooney, Gramercy Books, New York.
- Carr, Christopher
1995 A Unified Middle-Range Theory of Artifact Design. In *Style, Society, and Person: Archeological and Ethnological Perspectives*, edited by C. Carr and J. Neitzel, pp. 171–258. Plenum Press, NY.

- Cheshier, J., and R. L. Kelly
2006 Projectile Point Shape and Durability: The Effect of Thickness:Length. *American Antiquity* 71:353–363.
- Christenson, Andrew L.
1997 Side-Notched and Unnotched Arrowpoints: Assessing Functional Differences. In *Projectile Technology*, edited by Heidi Knecht, pp. 131–142. Plenum Press, New York.
- Clark, Geoff A.
1989 Romancing the Stones: Biases, Style and Lithics at La Rivera. In *Alternative Approaches to Lithic Analysis*, edited by D. O. Henry and G. H. Odell, pp. 27–50. Archaeological Papers of the American Anthropological Association. No. 1 Arlington, Virginia.
- Cotterell, B., and J. Kamminga
1992 *Mechanics of Pre-Industrial Technology*. Cambridge University Press, New York.
- Du Bois, Cora Alice
1940 Wintu Ethnography. In *University of California Publication in American Archaeology and Ethnography*, Volume 36:1-6.
- Dunnell, Robert C.
1996 Style and Function: A Fundamental Dichotomy. In *Evolutionary Archaeology: Theory and Application*, edited by Michael J. O'Brien, pp.112-122. University of Utah Press, Salt Lake City. Original published 1978 *American Antiquity* 43:192-202.
- Ellis, C. J.
1997 Factors Influencing the Use of Stone Projectile Tips: An Ethnographic Perspective. In *Projectile Technology*, edited by Heidi Knecht, pp. 37–74. Plenum Press, New York.
- Fauvelle, M., E. M. Smith, S. H. Brown and others
2012 Asphaltum Hafting and Projectile Point Durability: An Experimental Comparison of Three Hafting Methods. *Journal of Archaeological Science* 39(8):2802–2809.
- Géneste, J.-M. and S. Maury
1997 Contributions of Multidisciplinary Experiments to the Study of Upper Paleolithic Projectile Points. In *Projectile Technology*, edited by H. Knecht, pp. 165–190. Interdisciplinary Contributions to Archaeology. Plenum Press, New York, New York.
- Eerkens, Jelmer W. and Carl Phillip Lipo
2005 Cultural transmission, copying errors, and the generation of variation in material culture and the archaeological record. *Journal of Anthropological Archaeology* 24:316-334
- Flenniken, J. J., and A.W. Raymond
1986 Morphological Projectile Point Typology: Replication Experimentation and Technological Analysis. *American Antiquity* 51:603–614.
- Grissom, Thomas
2013 *Principles of Traditional Archery*. Sunstone Press, Santa Fe, New Mexico.
- Haury, Emil W.
1976 *The Hohokam: Desert Farmers and Craftsmen--Excavations at Snaketown*. University of Arizona Press. Tucson, Arizona.
- Hester, Thomas R. and Robert F. Heizer
1973 Arrow Points of Knives? Comments on the Proposed Function of "Stockton Points". *American Antiquity* 38(2):220-221.
- Hitchcock, Robert and Peter Bleed
1997 Each According to Need and Fashion; Spear and Arrow Use among San Hunters of the Kalahari. In *Projectile Technology*, edited by Heidi Knecht, pp. 345-368.
- Hodder, Ian
1982 *Symbols in Action: Ethnoarchaeological Studies of Material Culture*. Cambridge University Press, Cambridge.
- Hoffman, Charles M.
1997 *Alliance Formation and Social Interaction During the Sedentary Period: A Stylistic Analysis of Hohokam Arrowpoints*. Unpublished Ph.D. Dissertation, Arizona State University.
- Johnson, Ernest N.
1940 The Serrated Points of Central California. *American Antiquity* 6(2):167-170.
- Keeley, L. H.
1996 *War Before Civilization: The Myth of the Peaceful Savage*. Oxford University Press, New York, New York.
- Klopsteg, P. E.
1993 The Physics of Bows and Arrows. In *Physics of Sports*. Edited by Angelo Armenti, pp. 9–28. American Institute of Physics, New York, New York.
- Knecht, Heidi
1997 Projectile Points of Bone, Antler, and Stone: Experimental Explorations of Manufacture and Use. In *Projectile Technology*, edited by Heidi Knecht, pp. 191–212. Plenum Press, New York.
- Kooi, B. W.
1983 *On the Mechanics of the Bow and Arrow*. Unpublished Ph.D. Dissertation, Mathematisch Instituut, Rijksuniversiteit Groningen, Netherlands.
- Kooyman, B. P
2000 *Understanding Stone Tools and Archaeological Sites*. University of Calgary Press, Alberta, Canada.
- Loendorf, Chris
2012 *The Hohokam—Akimel O'Odham Continuum: Socio-cultural Dynamics and Projectile Point Design in the Phoenix Basin, Arizona*. Gila River Indian Community Anthropology Research Papers Number 5, University of Arizona Press, Tucson, Arizona.
2014 Historic Period Akimel O'Odham Projectile Points and Settlement Patterns. *The Kiva* 79(1):83-103.
2016 Akimel O'Odham and Apache Projectile Point Design. Chapter 10. In *Fierce and Indomitable: The Protohistoric Non-Pueblo World in the American Southwest*, edited by Deni Seymour, pp. 138-153. University of Utah Press, Salt Lake City.
- Loendorf, Chris, Craig M. Fertelmes, and Barnaby V. Lewis
2013 Hohokam to Akimel O'Odham: Obsidian Acquisition at the Historic Period Sacate Site (GR-909), Gila River Indian Community, Arizona. *American Antiquity* 78(2):266-284.
- Loendorf, Chris, Lynn Simon, Daniel Dybowski, M. Kyle Woodson, R. Scott Plumlee, Shari Tiedens, and Michael Withrow
2015a Warfare and Big Game Hunting: Flaked-Stone Projectile Point Designs along the Middle Gila River in Arizona. *Antiquity* 89 344(2015):1-14.
- Loendorf, Chris, Theodore J. Oliver, Shari Tiedens, R. Scott Plumlee, M. Kyle Woodson, Lynn Simon
2015b Flaked-stone projectile point serration: A controlled experimental study of blade margin design. *Journal of Archaeological Science: Reports* 3 (2015):437-443.

- Loendorf, Chris, and Glen E. Rice
2004 *Projectile Point Typology, Gila River Indian Community, Arizona*. Gila River Indian Community Anthropological Research Papers No. 2. University of Arizona Press, Tucson.
- Mason, Otis T.
1894 *North American Bows, Arrows, and Quivers*. Government Printing Office, Washington.
- McGuire, Kelly R. and William R. Hildebrandt
2005 Re-thinking Great Basin Foragers: Prestige Hunting and Costly Signaling during the Middle Archaic Period. *American Antiquity*, 70(4):695-712.
- Mesoudi, A. and M. J. O'Brien
2008 The Cultural Transmission of Great Basin Projectile Point Technology I: An Experimental Simulation. *American Antiquity*, 73(1), 2008, pp. 3-28.
- Milner, George R.
2005 Nineteenth-Century Arrow Wounds and Perceptions of Prehistoric Warfare. *American Antiquity* 70(1):144-156
- Nelson, Margret C.
1997 Projectile Points: Form, Function, and Design. In *Projectile Technology*, edited by H. Knecht, pp. 371-382. Plenum Press, New York.
- O'Brien, Michael J. and R. Lee Lyman (editors)
2003 *Style, Function, Transmission: Evolutional Archaeological Perspectives*. University of Utah Press, Salt Lake City.
- O'Brien, Michael J., Matthew T. Boulanger, Briggs Buchanan, Mark Collard, R. Lee Lyman, and John Darwent
2014 Innovation and Cultural Transmission in the American Paleolithic: Phylogenetic Analysis of Eastern Paleoindian Projectile-Point Classes. *Journal of Anthropological Archaeology* 34(2014):100-119.
- Peterson, Jane D., Douglas R. Mitchell, and M. Steven Shackley
1997 The Social and Economic Contexts of Lithic Procurement: Obsidian from Classic-Period Hohokam Sites. *American Antiquity* 62(2):231-259.
- Pfefferkorn, I.
1889 *Sonora: A Description of the Province*, translated and annotated by Theodore E. Treitlein. The University of Arizona Press, Tucson.
- Pope, Saxton T.
2000 *Hunting With the Bow and Arrow*. Originally published in 1923 edition. Sylvan toxophilite Classics.
- Ratzat, C.
1999 Atlatls: Throwing for Distance. In *Primitive Technology: A Book of Earth Skills*. Edited by David Wescott. The Society of Primitive Technology. Gibbs Smith, Layton, Utah.
- Rea, Amadeo M.
1998 *Folk mammalogy of the northern pimas*. Tucson, Arizona: University of Arizona Press.
2007 *Wings in the Desert: A Folk Ornithology of the Northern Pimas*. University of Arizona Press, Tucson.
- Sayles, E. B.
1938 Stone implements and Bowls. In *Excavations at Snaketown: Material Culture*, pp. 101-120. Medalion Papers No. XXV, Gila Pueblo, Globe, Arizona.
- Sedig, Jakob W.
2014 An Analysis of Non-utilitarian Stone Point Function in the US Southwest. *Journal of Anthropological Archaeology* 34(2014):120-132.
- Shott, Michael J,
1993 Spears, Darts, and Arrows: Late Woodland Hunting Techniques in the Upper Ohio Valley. *American Antiquity* 58(3):425-443.
1996 Innovation and Selection in Prehistory, A Case Study from the American Bottom. In *Stone Tools, Theoretical Insights into Human Prehistory*, edited by G. H. Odell, pp. 279-309. Plenum Press, New York.
- Shott, Michael J. and Jesse A. M. Ballenger
2007 Biface Reduction and the Measurement of Dalton Curation: A Southeastern United States Case Study, *American Antiquity* 72(1):153-175.
- Stevens, E. T.
1870 *Flint Chips: A Guide to Pre-Historic Archaeology*. Bell and Daldy, London, England.
- Tomka, Steve A.
2013 The Adoption of the Bow and Arrow: A Model Based on Experimental Performance Characteristics. *American Antiquity* 78(3):553-569.
- Shackley, M. S.
2005 *Obsidian: Geology and Archaeology in the North American Southwest*. University of Arizona Press, Tucson.
- Sliva, R. Jane
2006 Projectile Points in Regional Perspective. In *Sunset Crater Archaeology: The History of a Volcanic Landscape. Stone, Shell, Bone, and Mortuary Analyses*, edited by Mark D. Elson, pp. 31-63, Anthropological Papers No. 31. Center for Desert Archaeology, Tucson, Arizona.
2010 Virtuoso Hohokam Flintknapping in the Gila Bend Region, *Journal of the Southwest*. 52(2/3):237-253.
2015 *Projectile Points of the Early Agricultural Southwest: Typology, Migration and Social Dynamics from the Sonoran Desert to the Colorado Plateau*. Archaeology Southwest, Tucson.
- Vanpool, T. L.
2003 *Explaining Changes in Projectile Point Morphology: A Case Study from Ventana Cave*. Unpublished PhD. Dissertation, University of Arizona, Tucson.
- Walde, Dale
2014 Concerning the Atlatl and the Bow: Further Observations Regarding Arrow and Dart Points in the Archaeological Record. *American Antiquity* 79(1):156-161.
- Wiessner, P.
1983 Style and Social Information in Kalahari San Projectile Points. *American Antiquity* 48(2):253-276.
- Whittaker, John C.
1994 *Flintknapping Making and Understanding Stone Tools*. 3rd edition. University of Texas press, Austin.
- Wobst, H. M.
1977 Stylistic Behavior and Information Exchange. In *Papers for the Director: Research Essays in Honor of James B. Griffin*, edited by C. E. Cleland, pp. 317-342. University of Michigan, Museum of Anthropology, Anthropological Papers no. 61. Ann Arbor.

EVALUATING EARLY AGRICULTURAL PERIOD SOCIAL DYNAMICS IN SOUTHERN ARIZONA THROUGH PROJECTILE POINT TYPOLOGY

R. Jane Sliva

ABSTRACT

Because overly broad projectile point typologies lead to overly broad chronological, cultural, and behavioral inferences, the range of variation observed within established Early Agricultural period point types must be systematically categorized. This is achieved by splitting general types into subgroups or variants based on details of attribute execution, evaluating spatial distributions within earlier and later intervals of the San Pedro and Cienega phases, and looking to functional and social dynamics explanations for observed patterning. The data show migration from northern Mexico into the Tucson Basin during both the San Pedro and Cienega phases, but with different outcomes for the earlier and later immigrant groups. The projectile technology brought by the San Pedro phase migrants did not provide enough of a performance advantage to be adopted by indigenous groups, preventing the migrants from integrating into the local social economy. In contrast, the Cienega phase migrants brought a revolutionary projectile system that greatly outperformed the local technology, accruing social capital to the migrants and forcing a substantial shift in the primary indigenous point design. Systematic splitting and cautious recombining is key to evaluating technological adaptations and social relations at different times in prehistory.

INTRODUCTION

The Early Agricultural period (1200 B.C. – A.D. 50) in southern Arizona was characterized by groups living in pithouse settlements and practicing mixed foraging, hunting, and increasingly intensive agriculture in riparian and floodplain environments within the Basin and Range province of southern Arizona (Gregory 2001; Huckell 1996). The projectile point types that were originally defined for the period encompass a wide range of morphological variation, and have only loosely been tied to phase-level chronology. This has resulted in interpretations of fairly straightforward linear and in situ developments in style and technology through time. This paper explores methods for categorizing this

variation on the basis of specific attribute execution, and tracks those differences across space and time to reveal a more complex picture of the social dynamics behind the introduction, adaptation, and rejection of technological developments. Datasets are drawn from both excavated and survey collections from the Tucson Basin, the Cienega Valley, and the San Pedro Valley of southeastern Arizona and the Rio Magdalena drainage of northern Sonora, Mexico. Changes in the distributions of general point types and recently defined subtypes or variants are traced across the landscape from the early San Pedro phase (1200-1000 B.C.) through the Late Cienega phase (400 B.C.-A.D. 50). The Early Agricultural period data ultimately tell a story of repeated population movement into the Tucson Basin, with different outcomes for migrant populations and introduced projectile technologies at different times.

A BRIEF HISTORY OF EARLY AGRICULTURAL PERIOD PROJECTILE POINT TYPOLOGY

Three main projectile point types are associated with the period: San Pedro, Cienega, and Empire (Figure 1). For most of the last half of the 20th century, the projectile point typology for the period was encapsulated in a single term: San Pedro. Originally defined by Sayles and Antevs (1941) as “straight base and wide, lateral notches,” and subsequently refined by Haury (1950) as “expanding stem, sharp lateral barb, shallow lateral notches often creating a stem with a long neck,” San Pedro points long were held as the sole diagnostic point design for what at the time was conceptualized as the San Pedro stage of the Cochise culture (Haury 1950; Huckell 1988; Sayles and Antevs 1941).

Haury described a second early agriculturalist point design at Ventana Cave, AZ Z:12:5 (ASM), as triangu-

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lar, with an expanding stem narrower than the blade, a straight or convex base, and sharp oblique barbs (Hau-ry 1950:288-290, Figure 65a-d). Thirty-five years later, Huckell (1984:197) reported similar “unnamed corner-notched points” from two sites in southeastern Arizona that postdated the San Pedro phase. He soon thereafter formally named them “Cienega,” defining them as a “triangular-bladed form with a deeply, diagonally corner-notched base” (Huckell 1988:56).

The final major component of the Early Agricultural period typology was added in 2002, when surveys of the Cienega Valley in southeastern Arizona recovered numerous points that vaguely resemble San Pedro, but are clearly different. These points were named “Empire” and described as unnotched points with relatively long, narrow blades that are often finely serrated, stems that are slightly narrower than the blade, and straight to slightly convex bases. Several similar but stemless specimens from the site of La Playa, SON F:10:3 (ASM), located in northern Sonora, Mexico, were noted at the time but assumed to be preforms for stemmed Empire points (Stevens and Sliva 2002:304).

THE BROAD-BRUSH PROBLEM AND A FINE-TOOTHED COMB SOLUTION

As originally defined, the three point types roughly corresponded to the general phase divisions of the Early Agricultural period and were assumed to have been more or less evenly distributed across the region. Empire points were associated with the early portion of the San Pedro phase (1200-1000 B.C.), San Pedro points with the entire Early Agricultural period (1200 B.C.-A.D. 50), and Cienega points with the Cienega phase (800 B.C.-A.D. 50). Leaving the analysis at this level creates a picture of three monolithic chronological distributions across southern Arizona.

Two problems are evident with this classification. First, the original type definitions were based on a limited number of attributes that were occasionally vaguely defined. As a result, when applied to archaeological assemblages by different researchers, single types ultimately encompassed divergent point morphologies. Second, the San Pedro and Cienega phases cover substantial periods of time, meaning points that

were assigned to a single phase and thus treated as chronologically equivalent may actually have been manufactured as much as 800 years apart. Combining these broadly constructed typological and chronological elements into an explanatory framework for Early Agricultural period points has masked significant technological (functional) and stylistic (social) variation across space and time.

How do we get at that variation? Even a cursory examination of point collections from Early Agricultural period sites in the Tucson Basin is sufficient to notice the range of intra-type morphologies. In order to apply morphology to questions of both point function and

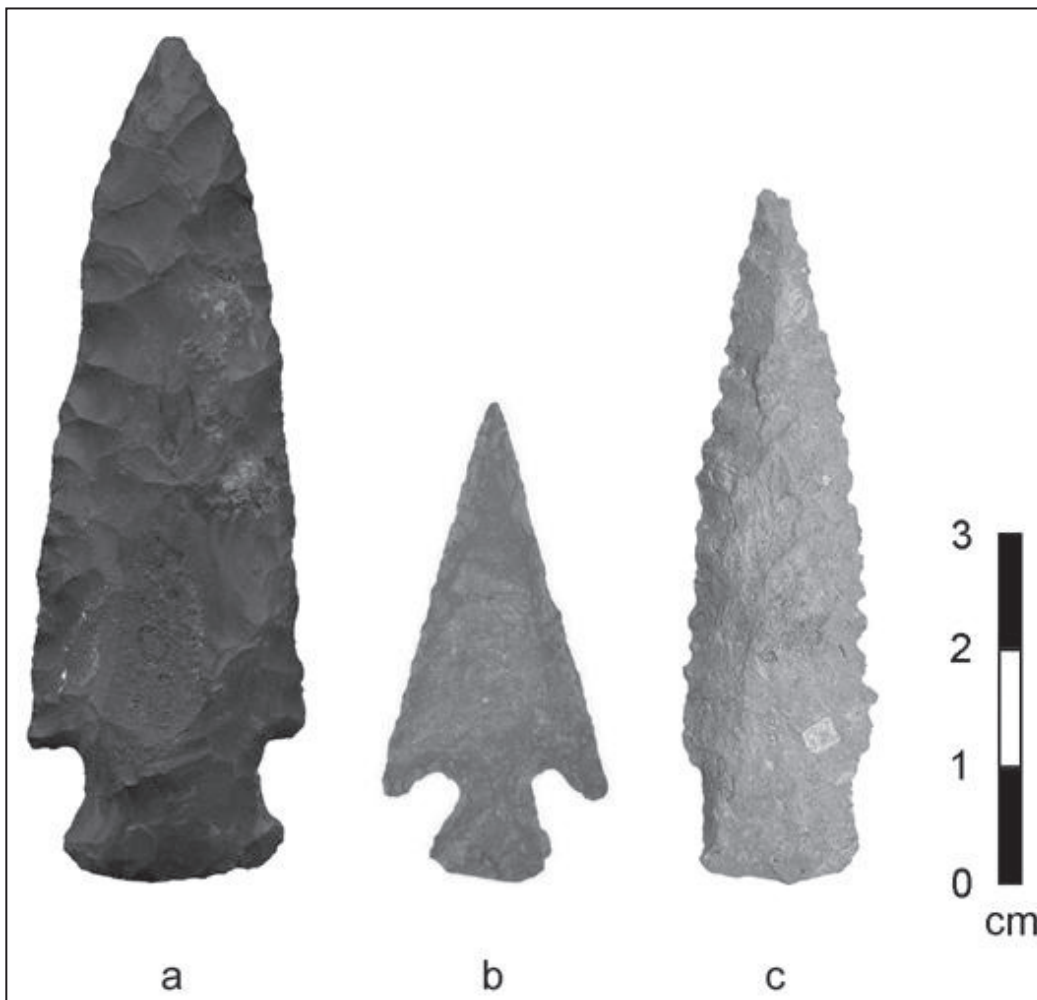


Figure 1. Examples of the three general projectile point types associated with the Early Agricultural period in southern Arizona. (a) San Pedro; (b) Cienega; (c) Empire.

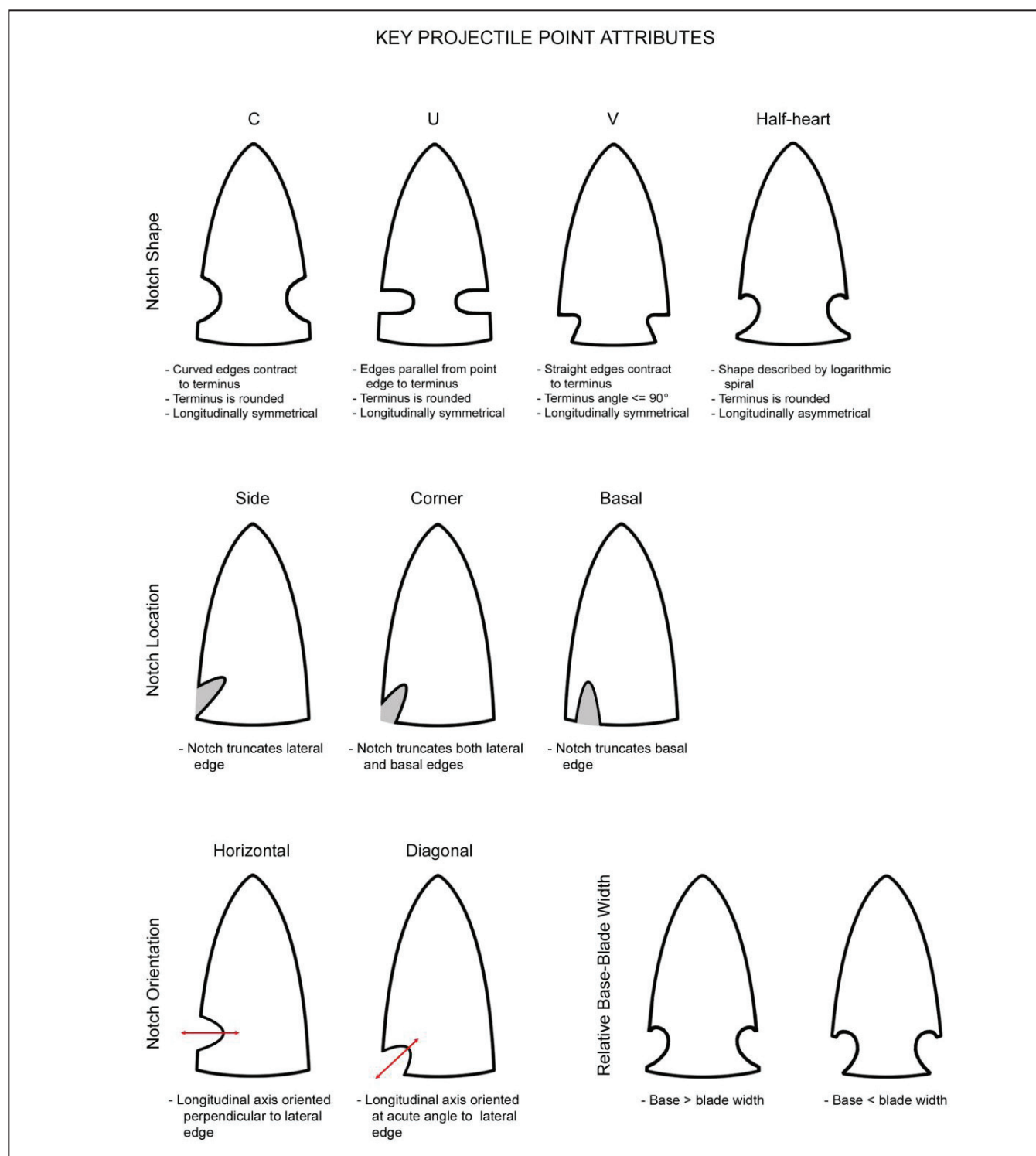


Figure 2. Key attributes used to categorize morphological variation of Early Agricultural period projectile points.

point style, typologies need to be constructed at fine-grained levels of detail, so that salient patterns may be revealed rather than concealed.

The Analytical Approach

The following procedure is recommended for projectile point study: (1) identify the general types that are present; (2) within each general type, define mor-

phological subcategories using to key attribute states (Figure 2), absolute metrics (linear and mass), and relative dimensions (width of blade, neck, base; length of stem); (3) record the chronological and spatial distributions of the observed variants (I use "variant," "subtype," and "subcategory" interchangeably here); and (4) evaluate the identified patterns on the basis of functional and social factors.

Where designs change from one time period to another, is there evidence supporting developmental change of the initial design to the subsequent design, or was the initial design replaced by an unrelated one? Does the subsequent design represent improved functionality over the initial one? Where different designs are contemporaneous, their relative functionality, spatial distributions, and associations with specific contexts and with other classes of artifacts must be evaluated. If functionally different designs co-occur with each other, can they be explained by different hunting or warfare tactics, and/or propulsion systems? If functionally equivalent designs are spatially segregated, do separate lines of evidence such as architecture or associated distinctive artifacts support social group differences?

When functionality does not adequately explain the observed morphological variation, social factors must be considered. Within a given population, these include diachronic change, design drift, differences in teaching lineages, and the effects of differential social status among different knappers. Between social groups, these include varying levels of expression of group affiliation and technology transfer conditioned by the context of intergroup contact. These factors include encounters in neutral territory, transfer from an immigrant group to an indigenous group, transfer from an indigenous group to a migrant group, all of which are conditioned by relative levels of social capital, economic power, and adversarial versus amicable relations.

Distinguishing migration from exchange when artifacts reflecting non-indigenous technological traditions are found on a site is a complex endeavor. Ethnographic accounts suggest trade, gambling (although data from Apache groups, at least, indicate that this is not a likely mechanism of exchange for stone points [Loendorf 2012:56]), gift-giving (Griffen 1969:123-124; Hallenbeck 1940:91, 228; Hoffman 1997:24-25; Loendorf 2012:56), and intermarriage (Bettinger 1982:125) are also mechanisms by which non-indigenous projectile points could have been moved from one region to another. The presence of non-indigenous designs is best evaluated within the context of the complete site assemblages, as well as within their social contexts of use. Given an assemblage of 50 projectile points exhibiting an indigenous design and made on local raw materials, a single point of a foreign design that is rendered in nonlocal stone is more likely to represent acquisition than migration. If the same assemblage includes 20 points of a single non-indigenous design that are made of local materials, and are found in association with other artifacts reflecting the same foreign culture core area, the scale tips toward the presence of migrants as an explanation. As yet, there is no simple inferential template that can be overlain on the data to produce tidy results. Ultimately, the narrative constructed to explain the demographic composition of a site depends upon simultaneously

evaluating stone artifacts alongside other classes of material culture.

The Refined Early Agricultural Period Typology

The broad-brush problem became increasingly evident between 1999 and 2014, as a more detailed chronological structure was developed for the Early Agricultural period in southern Arizona (Gregory 2001; Mabry 2005; Vint 2015a). Following the analytical structure outlined above, I recognized several subcategories of the three main point types associated with both geography and the revised chronological system that differentiate the San Pedro and Cienega phases into earlier and later intervals (Figure 3). It is important to note that, although subcategories are defined for each type, the range of variation is such that not every point can be categorized beyond the level of general type. I also recognized that individual differences in visual perception add a layer of subjectivity in applying any typology, resulting in some level of inter-analyst variation.

The primary distinctions observed within the general San Pedro type correspond with phase. San Pedro variants (Norte and Centro) made during the San Pedro phase are lighter, truly side-notched, and tend to have basal widths equal to or greater than blade width, while the variant made during the Cienega phase (San Pedro Finado) is corner-notched, resulting in basal widths that are narrower than the blade, and heavier (Sliva 2015a:16). The two San Pedro phase variants (Norte and Centro)—are defined on the basis of notch shape. The Cienega phase variant (San Pedro Finado) is identified primarily on the basis of relative blade and basal widths, and corner notches that vary among rounded shapes but never exhibiting V-shaped notches.

Empire points also exhibit a wide range of variation, although far more Empire than San Pedro points can be sorted into defined subtypes. Empire point subtypes fall within a more compressed timeframe. Six Empire variants were defined, four with stems and two without. Currently available dates indicate that in southern Arizona, these were first manufactured during the early San Pedro phase (1200-1000 B.C.) and continued to be made and used through the end of the phase (800 B.C.) (Sliva 2015a:17-29).

Cienega points retain their originally posited Cienega phase associations, with the Short variant limited to the Early Cienega phase (800-400 B.C.), Flared and Stemmed associated with the Late Cienega phase (400 B.C.-A.D. 50), and Long in use throughout the phase (Sliva 1999, 2015:65-77).

Interlude: Caveat Lector

Before proceeding, a word on sampling and splitting. In order to acquire robust numbers, the study sample was drawn from multiple sources, including points excavated from well-dated contexts, museum collections, and artifact illustrations in published re-

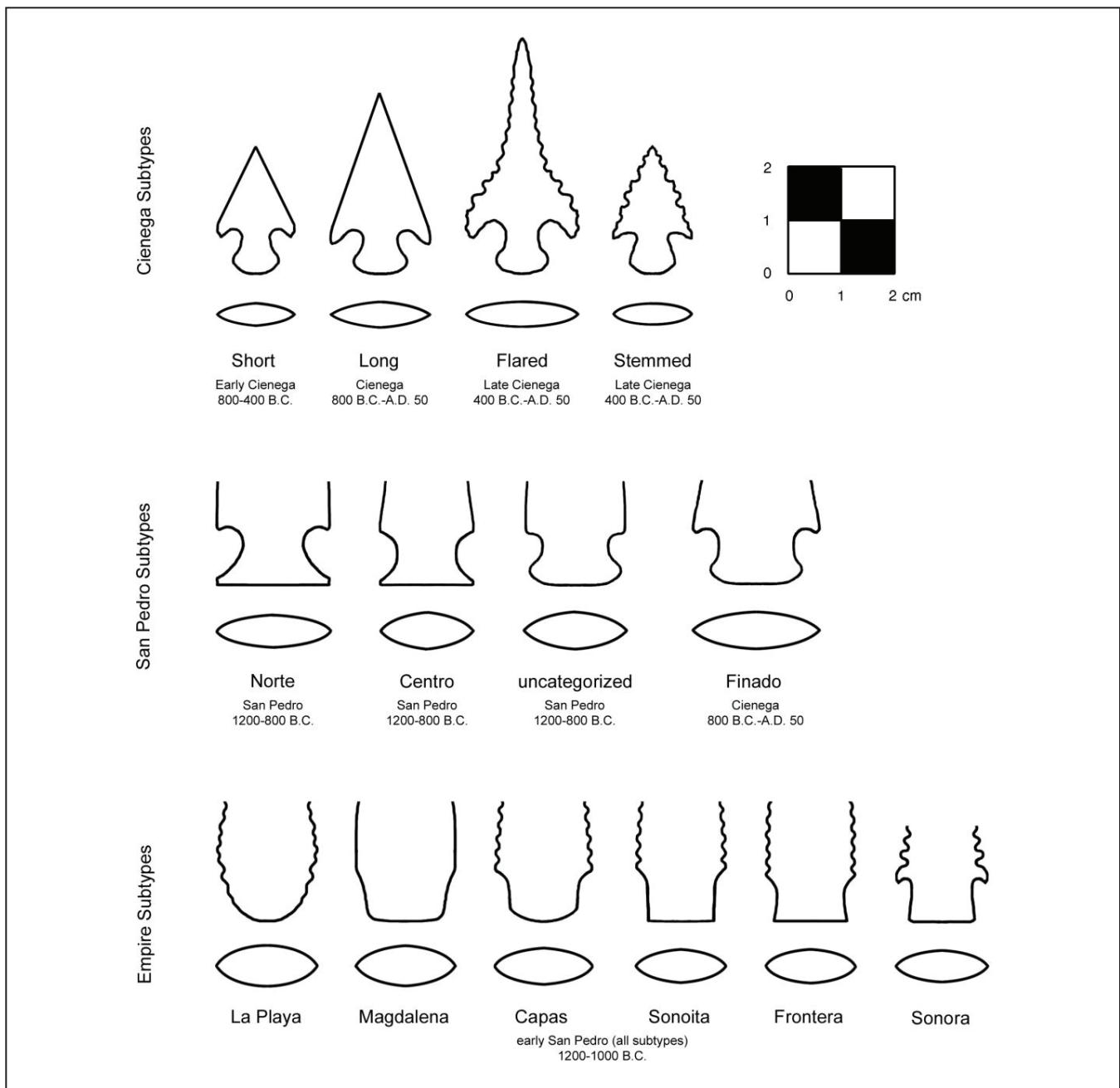


Figure 3. Schematic representations (based on mean dimensions) of variants defined within the three major general point types associated with the Early Agricultural period in southern Arizona.

ports that may or may not report associated dates. The aggregated sample is large by archaeological standards, but the numbers for certain subtypes or directly dated specimens certainly can be smaller than is optimal. For example, the San Pedro subtypes were defined using attribute data from the 401 San Pedro points currently recorded in the Desert Archaeology, Inc., database. Slightly more than half of these are from 38 sites excavated by the company, with most of them dated through either direct association with absolute dated materials or stratigraphic relationships. The balance are from other cultural resources management or academic excava-

tions and surveys covering 46 sites in addition to isolated occurrences, with direct observations taken from collections curated at the Arizona State Museum. Where direct access to artifacts was not possible, data were drawn from published reports. The best-case scenario in all instances was an artifact excavated from a securely dated context. The worst case, thankfully limited, was an artifact that simply exists, independent of space and time, and can serve only as a presence/absence tally. Within each defined subtype, the sets of artifacts suitable for the metric characterizing of certain attributes were further reduced by their degree of fragmentation.

As a consequence, the sample sizes in Table 1 are small because mass and sectional density measures were limited to complete specimens.

The typology presented here will strike some researchers as involving excessive splitting of attributes and based on distinctions among attribute states that are too minor to be real, given the vagaries of human behavior and innumerable external complicating factors. I freely acknowledge that not everyone sees things the way I do. My experience is that these seeming min-

ute distinctions are consistently discernible and tend to pattern both spatially and temporally, so I am inclined to go with it for now. Because it is infinitely easier to combine things than to try to tease things apart after the fact, I prefer to separate types on the basis of consistently recognizable attributes. My experience has also been that, due to the unavoidable variation in the ways different people perceive shape and proportion, it can be difficult for multiple individuals to apply a typological template to the same artifact and get the same results.

Table 1. Mass and sectional density measures for Early Agricultural period projectile points in the Tucson Basin.

| Type/Variant | N | Mass (g) | | TCSA ^a (mm²) | Dart SecDen ^c | Estimated Penetration Depth (cm) ^d |
|-------------------------|----|----------|---------|-------------------------|--------------------------|---|
| | | Mean | Std Dev | | | |
| Western Basketmaker | | | | | | |
| White Dog | 9 | 2.3 | 0.4 | 41.8 | 2.0 | 2.0 |
| Crescent | 31 | 2.8 | 0.7 | 47.9 | 1.8 | 1.8 |
| Triangle | 16 | 2.7 | 1.0 | 44.2 | 1.9 | 1.9 |
| Arizona Transition Zone | | | | | | |
| Payson | 13 | 2.4 | 0.8 | 46.1 | 1.8 | 47 |
| Geronimo | 25 | 3.1 | 1.0 | 47.5 | 1.8 | 46 |
| Pozos | 9 | 5.5 | 2.4 | 57.8 | 1.5 | 38 |
| Cienega | | | | | | |
| Stemmed | 26 | 1.2 | 0.5 | 29.4 | 2.9 | 74 |
| Flared | 33 | 3.2 | 0.7 | 52.3 | 1.6 | 42 |
| Long | 79 | 2.7 | 1.2 | 47.5 | 1.8 | 46 |
| Short | 20 | 1.4 | 0.3 | 35.3 | 2.4 | 62 |
| San Pedro | | | | | | |
| Finado | 55 | 8.4 | 4.1 | 74.0 | 1.1 | 29 |
| Empire | | | | | | |
| La Playa | 29 | 8.2 | 3.4 | 78.8 | 1.1 | 28 |
| Magdalena | 29 | 7.7 | 1.4 | 72.7 | 1.2 | 30 |
| Capas | 17 | 6.4 | 2.2 | 64.5 | 1.3 | 34 |
| Sonoita | 16 | 5.9 | 0.8 | 58.2 | 1.5 | 36 |
| Frontera | 40 | 5.7 | 1.6 | 56.1 | 1.5 | 40 |
| San Pedro | | | | | | |
| Centro | 36 | 6 | 1.2 | 70.6 | 1.2 | 31 |
| Norte | 24 | 6.2 | 2.0 | 72.5 | 1.2 | 30 |

^aTip Cross Sectional Area: projectile point blade width x blade thickness.

^bPoint Sectional Density: mass/TCSA.

^cDart Sectional Density: complete dart mass/TCSA, calculated using a constant 85 g assumed total dart mass (after Pettigrew 2015:Table 1).

^dcalculated per Hughes (1998) as (mass*velocity)/TCSA, using the 85 g value for mass and Hughes' reported mean dart velocity of 23.6 m/s.

Ultimately, the types and variations presented here are the ones that have held up, so far, to decades of cumulative data collection, and the behavioral explanations for the observed patterning are offered as hypotheses that are supported by the data.

DATASETS AND RESULTS

Examples drawn from San Pedro and Cienega phase assemblages in southern Arizona illustrate how applying the newly defined subtypes (subcategories) in the analysis of well dated datasets reveal different kinds of spatial and temporal patterning. Some of these patterns can be explained functionally, while others are best explained with reference to social dynamics.

Case Study I: The San Pedro Phase at Las Capas, AZ AA:12:111 (ASM)

The Details

Las Capas, AZ AA:12:111 (ASM), is a large San Pedro phase habitation site located in the floodplain of the Santa Cruz River near its confluence with the Canada del Oro and the Rillito Rivers in Tucson, Arizona (Mabry 1998; Whittlesey et al. 2010). Dated features at the site produced both Empire ($n = 84$) and San Pedro points ($n = 95$), with the Empire points primarily occurring in earlier deposits ($n = 78$) and San Pedro primarily in the later ($n = 88$). A smaller number of points ($n = 18$) from the earlier contexts have attributes of both Empire and San Pedro points (Hesse 2010:201-208), leading to the initial hypothesis that Empire predated San Pedro, and that San Pedro was developmentally derived from Empire technology (Sliva 2015a:59).

A closer look at the data from both Las Capas and contemporaneous neighboring sites shows a more complex picture when the Empire and San Pedro points are separated by both subtype and their chronological position within the San Pedro phase, and when spatial distributions within the larger floodplain area are considered. In the middle Santa Cruz valley, Empire points occur only in the early San Pedro phase contexts at Las Capas, with a smaller number ($n = 11$) known from the as yet unexcavated and undated Roland site, AZ AA:12:86 (ASM) (Roland 1993). The early San Pedro phase occupations of the nearby Dairy ($n = 8$) and Valley Farms ($n = 2$) sites produced only San Pedro points, all the Norte variant (Sliva and Ryan 2015:86).

Further, the Empire points at Las Capas can be separated into two design sets: the stemless La Playa and Magdalena variants (see Figure 3) echoing points that are common at the site of La Playa, SON F:10:3 (ASM), in northern Sonora, roughly 200 km to the south (Sliva 2015a:Figure 2.25b-k), and a set of the stemmed Sonoita and Frontera designs (see Figure 3) that match points recovered during surveys in the Cienega Valley,

75 km to the southeast (Sliva 2015a:Figure 2.37c-f, 2.41f-h). Within Las Capas, the spatial distributions of the two sets of designs overlap somewhat but do not completely correspond to each other (Sliva and Ryan 2015:61, Figure 2.5). The Empire type points from the neighboring Roland site are predominantly stemmed (Sliva 2015a:Figure 2.41a-e, 2.45f-g).

A small number of points at Las Capas appear to be Empire blanks that were finished with San Pedro-style notches (Hesse 2010; Sliva 2015a: Figure 2.48). It should be noted that these notches copied the San Pedro shape, but not the flaking technique; the notches on actual San Pedro points were bifacially flaked, but the notches on the modified Empires were flaked from only one face of the point. However, contemporaneous San Pedro points from the other neighboring sites do not exhibit Empire-derived design attributes.

A flood event that occurred in roughly 1000 B.C. disrupted agricultural systems at Las Capas and triggered a multi-generation occupational hiatus (Vint 2015b). When the site was re-occupied in the late San Pedro phase, beginning circa 930 B.C., San Pedro points were manufactured there in great quantities and in a wide range of designs, including both defined variants and many more that do not correspond to a specific subtype. Empire points were uncommon, and may have been scavenged from earlier components.

The Interpretation

Both Empire and San Pedro points are associated with early San Pedro phase contexts in the middle Santa Cruz River floodplain, but were spatially segregated at the site level, with Empire points occurring at Las Capas and the surrounding sites producing only Norte San Pedro points. The two designs represent different hafting traditions that likely were developed in response to similar technological problems (Stevens and Sliva 2002:318-319), including leaving a substantial length of blade exposed so that broken points could be reworked while hafted (Shackley 1996), decreasing the frequency of shaft damage, and allowing easy removal of broken points and re-arming of the foreshaft (Bryan 1980; Holmer 1986; Keeley 1982; Mabry 1998; Musil 1988). Dart shafts and atlatls are not preserved in the floodplain environment, preventing comparisons between the complete weapons used under the two technological traditions. However, neck width, stem thickness, and stem length were virtually equivalent between Empire and San Pedro points, meaning that no modifications to existing dart foreshafts would have been necessary for a user to change from one point tradition to the other. No significant differences in large animals eaten at the different floodplain settlements are evident, and all of the hunters living in the floodplain presumably employed similar hunting tactics while exploiting the same nearby foothills and mountain terrain.

The functionality, or penetrative potential, of the points can be compared via measures of sectional density, calculated as total projectile mass divided by projectile point cross-sectional area (TCSA) (Sisk and Shea 2011). Hughes' (1998) equation for predicting penetrative depth incorporates TCSA along with mass, using a constant experimentally derived velocity, although the absence of preserved dart shafts requires using a constant estimated total dart mass as well. That is, given equal total projectile mass (mainshaft + foreshaft + point), velocities, and target types, a projectile tipped with a thin point with a small TCSA concentrates force in a smaller area than does a projectile tipped with a thick point. The higher sectional density value provided by the smaller TCSA therefore predicts greater penetrative depth for that projectile.

Because the Hughes formula employs two constant values that may not accurately reflect San Pedro phase dart technology, the estimated penetration values it returns for Empire and San Pedro points should be understood as measures of relative effectiveness rather than precise calculations of their performance (see Table 1). On average, sectional density values indicate that Empire points afforded a slight functional advantage over San Pedro, with the stemless La Playa and Magdalena variants providing equivalent or slightly less penetrative potential than San Pedro points, and the stemmed Sonoita and Frontera variants providing roughly 25 percent more (Table 1).

In addition to the sectional density measures, the tapered, narrow distal tips of many Empire points would have facilitated initial skin or hide penetration more than the excurvate edges of San Pedro point tips (Hughes 1998:353). Empire points likely were more resistant to breakage than San Pedro as well, given their shape that tapers to the haft, with substantial mass in the lower portion of the blade and the neck (Hughes 1998:373; Van Buren 1974). This is borne out by the predominance of complete Empire points in the Las Capas assemblage. Empire point blades were serrated roughly half of the time, whereas San Pedro points were unserrated; Loendorf's experimentation (Loendorf et al. 2015) suggests that this is a stylistic attribute related to social affiliation rather than function.

The Empire points at Las Capas are unique within the middle Santa Cruz geographic setting, resembling artifacts from northern Mexico and the Cienega Valley far more than they resemble the points at other early San Pedro phase sites in the vicinity. Differences in figurine style (Sliva 2015a:136-137) and architecture (Sliva 2015a:135; Stevens and Sliva 2002:318) between Las Capas and the nearby contemporaneous sites further support site-level differences in social identity in the area. Notably, Las Capas is accessible from both the La Playa area and the Cienega Valley by following watercourses from the south and east (Sliva 2015a:128, Figure 4.2).

The presence of San Pedro Norte points in multiple other contemporary sites surrounding Las Capas indicates that the design was indigenous to the middle Santa Cruz floodplain. It is likely that the Empire points at Las Capas were introduced by a migrant population rather than through other social processes such as trade or the post-marital relocation of men. This is because Empire points in the Tucson Basin were (1) limited to Las Capas and the Roland site and, further, only to the early San Pedro phase occupation there, (2) there was a corresponding dearth of San Pedro points at the sites, and (3) they exhibit strong stylistic similarities to collections from northern Mexico and the Cienega Valley. If Las Capas was occupied by a local population and the Empire design points were obtained by trade, or introduced by migrants joining the local community, we would expect a higher number of San Pedro points in the assemblage along with Empire points, a variety of central and northern Arizona points in addition to Empire

Cranial, skeletal, mitochondrial DNA, and Y-chromosome DNA studies indicate that male and female mobility differed in the region, with male exogamy and more frequent and longer-distance movement by small, male-dominated groups a possible scenario (Byrd 2012; McClelland 2005; Ogilvie 2005; Watson 2010; Watson and Stohl 2013). Multiple studies have noted skeletal similarities among Early Agricultural period populations in southern Arizona and northern Sonora (Carpenter et al. 2005:27; Lincoln-Babb 1997; Minturn and Lincoln-Babb 1995; Lincoln-Babb and Minturn 1998), hinting that northern Sonora was the source area of at least one group that brought Empire technology to the Tucson Basin.

The migrants were certainly aware of and experimented with incorporating elements of the indigenous San Pedro technology, as evidenced by the several points at Las Capas that were finished by adding San Pedro-style notches to Empire preforms. It is unclear whether this imitation reflects immigrants attempting to emulate a dominant local culture in order to increase their own status, to integrate into the local social economy, or simply to test the functionality provided by notched points. Notably, the continued dominance of unnotched Empire points throughout the early San Pedro phase occupation of Las Capas indicates that any performance advantages conferred by the notches were not significant enough to compel the Empire knappers to comprehensively overhaul their templates, particularly because the unmodified Empire points already outperformed San Pedro in terms of sectional density. Given this, prestige-based emulation may be the better explanation.

Regardless of the motivation behind the early San Pedro phase Las Capas knappers' small-scale adoption of foreign technology, it does not appear to have been shared by the indigenous residents of the Santa Cruz floodplain. The fact that the local San Pedro knappers

declined to incorporate Empire attributes into their own technological repertoire at even an experimental level, despite the modest penetrative advantage the Empire design conferred, suggests an imbalance in social capital between the indigenous and immigrant groups. The addition of notches to an Empire preform might be more obvious than San Pedro modifications in the direction of Empire, but if San Pedro knappers were inclined to experiment as well, we might reasonably expect to see Empire-style serrations—perhaps the most easily transferable Empire attribute—on otherwise recognizable San Pedro points from San Pedro phase contexts. This situation has yet to be encountered. Although the Las Capas point producers do not appear to have forged social ties with the indigenous groups living in the Santa Cruz floodplain, the somewhat different spatial distributions of the stemless and stemmed Empire variants at the site hint that they maintained relationships and/or affiliations with separate social groups in Sonora and the Cienega Valley.

After the break in occupation triggered by the flood, people resettled at Las Capas during the late San Pedro phase, but the Empire-using people did not return. The site was claimed by indigenous groups who continued to use San Pedro technology. In a change from the earlier interval, San Pedro points in the middle Santa Cruz were no longer limited to the Norte subtype, but now included a range of subtypes, including the Centro variant that may have originated in the San Pedro and Cienega valleys to the southeast (Sliva 2015a:29). The increased numbers and stylistic diversity of San Pedro type points may reflect an influx of people from other areas who, unlike the earlier Empire-using group, were able to integrate into the local social economy because they shared the general San Pedro technological tradition.

The Roland site across the river produced the only other significant concentration of Empire points yet encountered in the Tucson Basin, most of them the stemmed variants. Due to the lack of excavated contexts there, the site's relationship to Las Capas cannot be determined, but the number of points and their similarities to the Las Capas assemblage, which is otherwise unique in the region, suggests social ties between at least some of the social groups living at the two sites.

The San Pedro phase middle Santa Cruz floodplain hosted a closed social environment in which groups practicing different technological traditions did not co-reside or share technology at any appreciable level. During the earlier portion of the phase, Empire point technology was transported to Las Capas by male-dominated groups from northern Mexico, either directly north or via the Cienega Valley to the southeast. Despite bringing points that provided a modest functional advantage over the indigenous San Pedro points, the immigrants did not achieve sufficient levels of social capital to influence the locals to adopt their technology, or to integrate into the local social economy. The Empire-using popula-

tion incorporated aspects of San Pedro technology into their own points from time to time, but did not fully adopt it. Within two centuries, the Empire technological tradition disappeared from the Tucson Basin.

Case Study 2: The Cienega Phase in the Middle Santa Cruz River Valley

The Details

Across southern Arizona, the beginning of the Early Cienega phase (800–400 B.C.) is marked by a significant change in the existing San Pedro technological tradition and the abrupt appearance of a new suite of Cienega projectile point designs (Sliva 2015a:141–164). San Pedro points (Finado subtype) maintained the same general shapes and manufacturing techniques seen in the preceding phase, but now were exclusively corner-notched, and thus had narrower bases than blades. More importantly, their average size and mass increased considerably over San Pedro phase levels. In contrast, the newly introduced small, light Cienega points represented substantially different designs, raw materials, and flaking techniques than either the earlier San Pedro or Empire points. Two Cienega variants are associated with the Early Cienega phase (see Figure 3). One of these, Cienega Short, is exclusively associated with the Early Cienega phase, while the other, Cienega Long, persists through the Late Cienega phase as well.

The subsequent Late Cienega phase (400 B.C.–A.D. 50) saw the introduction of the larger, robustly serrated Cienega Flared variant (see Figure 3) across the region and the discontinuation of Cienega Short. At the same time, small numbers of northern points (Western Basketmaker II and Arizona Transition Zone designs) appeared at multiple sites in the Tucson Basin. At the large habitation site of Los Pozos, AZ AA:12:91 (ASM), numerous northern and some as-yet unidentified types co-occurred with the indigenous Cienega and San Pedro designs, and robust blade serration—a Cienega Flared design element—was added to types that typically were unserrated, including Cienega Long, San Pedro, and Western Basketmaker II (Sliva 2015b).

The Interpretation

The small, light Cienega points, which were fully pressure-flaked with deep corner notches, long, pointed barbs, and narrow necks, represent a significant departure from the design canon and manufacturing techniques of the previously established San Pedro technological tradition in southern Arizona. No obvious design antecedents are found in late San Pedro phase assemblages here. This, combined with the abrupt appearance of Cienega points in the Early Cienega phase, and the accompanying disappearance of the San Pedro Centro and Norte designs diagnostic of the previous phase, suggests that Cienega was an introduced tech-

nology that replaced San Pedro rather than being developed from it.

Points that appear to be intermediate between San Pedro and Cienega recovered from the site of La Playa suggest northern Mexico as a likely origin for the Cienega design (Sliva 2015a: Figure 5.3f-m). As in the early San Pedro phase, the presumed mechanism that transported Cienega technology to the Tucson Basin is the movement of males. Long-term trends in the metrics of debitage associated with core-reduction and tool-production trajectories in the Tucson Basin reflect a fairly constant domestic technological tradition of flake production and domestic tool manufacture overlain by a punctuated equilibrium pattern of projectile point design and manufacture (Sliva and Ryan 2015:93). This suggests a stable, long-term population gradually adapted their day-to-day domestic technology to increasing sedentism and agricultural reliance, while simultaneously adopting innovations in projectile technology from other areas. The latter process certainly occurred via both the transfer of ideas and, importantly, the co-residence of presumably male immigrants who understood both the knapping technique required to make the points and the armature and propulsion specifications required for optimal total weapon system performance.

Why did Cienega designs supplant the existing San Pedro designs so quickly and thoroughly? Cienega points provided a significant performance increase over earlier points. The low average mass and cross-sectional area of the new Cienega designs resulted in sectional densities 50 to 100 percent greater than San Pedro (Table 1). When the Tucson Basin San Pedro and Cienega phase point metrics are evaluated with the Hughes equation, the smaller Cienega phase points—both the Cienega series and the Arizona Transition Zone, Colorado Plateau, and Western Basketmaker types—provide a substantial increase in penetrative depth over San Pedro points, assuming a constant composite dart mass (see Table 1). In fact, if velocity were held constant, total dart mass would have needed to fall below 50 g before Cienega point-tipped projectile penetration drops below that of San Pedro points mounted on 85 g darts.

The metrical data suggest that the migrants who came to southern Arizona from northern Sonora brought a functionally superior point design and, crucially, the knowledge of the knapping techniques, raw material properties, and propulsion system it required. This allowed the Cienega technological tradition to be transmitted directly to indigenous populations, avoiding declines in performance due to multi-dimensional copying error resulting in overly thick or otherwise disproportionate points. Both of these factors likely translated into positive social capital for the migrants as their technology was accepted, and facilitated their integration into local communities. This in turn contributed to the rapid replacement of San Pedro by Cienega as the primary projectile technology across the region.

Despite the quick and essentially ubiquitous adoption of Cienega points by indigenous groups throughout Southern Arizona, the San Pedro template was not abandoned, but instead was modified and transitioned to a new role. The blade shape and many proportional dimensions of the Finado subtype echo earlier San Pedro designs, and unlike the fully pressure-flaked and mostly cryptocrystalline Cienega points, they continued to be manufactured with a combination of percussion and pressure flaking from more granular stone. With an average mass of 8.4 g, Cienega phase San Pedro Finado points are 1.3 times heavier than the earlier variants, and—more importantly—are 2.6 times heavier than even the larger two variants of Cienega points (Sliva 2015a: Table 2.1). The San Pedro redesign likely represents a shift to a new class of heavy projectiles, or to a non-projectile function such as hafted knives or thrusting spears. Their clear resemblance to earlier San Pedro variants and the retention of the earlier flaking techniques in their manufacture indicates that they almost certainly represent an in-place development within the existing indigenous technological tradition.

The Late Cienega phase also saw the introduction of non-indigenous point designs from the Arizona Transition Zone and Western Basketmaker areas to the north of the Tucson Basin (Sliva 2011: Figure 6.1c-e; Sliva 2015a:163, 180-181, Figure 2.72k-p; Sliva and Ryan 2015:92-93). Because these occurred in small numbers, they may reflect exchange instead of migration, particularly when they are not accompanied by introduced artifacts of other classes. Nonlocal point designs made from nonlocal materials have been used to infer trade elsewhere, for example the Mid-Atlantic United States (Stewart 1989:55, 62). The introduced Arizona Transition Zone and Western Basketmaker designs did not confer a sectional density advantage over the indigenous Cienega points (see Table 1), but they did co-occur with them.

In contrast to the preceding time period, the social economy of the Santa Cruz floodplain during the Cienega phase was open to introduced technological traditions from multiple outside areas. Los Pozos contained a variety of designs, but the assemblage is dominated by indigenous southern Arizona points. In addition to migrants from northern Mexico, the co-residence of a small number of migrants (presumably male) from the highlands to the north and northeast is suggested by several point designs typical of the Arizona Transition Zone, all of which are made of cherts—some of which appear to be Mogollon Rim variants. These cherts were not used to produce indigenous southern Arizona points, and two small (<20 mm) flakes are the only northern chert debitage recovered at the site. Indigenous individuals may not have had access to these raw materials or seen them as viable options for point manufacture, although the direct exchange of finished points cannot be ruled out. In the southern Tucson Basin, the assemblage from

Late Cienega phase features at Julian Wash contained only Western Basketmaker points (Sliva 2015a:153). The small number of points involved (three) might argue for exchange rather than human relocation, but no indigenous point designs were recovered from these contexts, and all three were made from various cherts, although not of distinctive enough varieties to hazard a guess about provenance.

At Los Pozos, design elements were transferred among people with different social affiliations, but none of the introduced technological traditions supplanted the now-indigenous Cienega technology. For example, robust blade serration (large, square-ended teeth with open spacing, as opposed to the fine, tightly spaced serration seen on the earlier Empire points) is a diagnostic design element that appeared across southern Arizona during the Late Cienega phase on Cienega Flared and Stemmed subtypes. The place of origin for this style of serration is as yet unknown. Serration is unlikely to have conferred a functional advantage over unserrated blades, but nonetheless was popular at Los Pozos, where it was used to augment a number of normally unserrated point types including both local and northern designs (Sliva 2015b:152). If this modification had no functional basis, its use on northern points may reflect hopeful emulation of the local social group, or a signal of migrants' formal integration into it.

The point types from the Arizona Transition Zone that appear to have been brought to Los Pozos by at least one male immigrant from the Mogollon Rim region reflect the same hafting technology as Cienega points and delivered similar—but not significantly greater—performance. Because only a few migrant individuals were likely to have been involved in this case, and because their projectile points did not provide any advantages to the indigenous population, it appears that migrants from the north did not accrue the capital that would have been required for the adoption of any elements of their technology. Even so, the continued co-occurrence of outside designs with the local technological tradition indicates that the local society was open to outside people without pressure to abandon their natal technologies, as well as a social environment in which the stylistic conventions associated with specific technological traditions were malleable and open to experimentation.

CONCLUSION

A more complex picture of social dynamics in southern Arizona has emerged from the detailed examination of both the stylistic and functional variation within the general projectile point types traditionally associated with the Early Agricultural period. The indigenous San Pedro phase populations within the middle Santa Cruz valley resisted adopting the Empire point technology used by immigrants who settled at Las Capas, possibly

because the stemless Empire variants offered no penetrative advantage over San Pedro, and the slight advantage offered by the stemmed variants may have been considered insufficient to compensate for the points' deviations from local San Pedro design canon. The Empire technological tradition disappeared from the Tucson Basin midway through the San Pedro phase.

In contrast, the Cienega phase saw populations across southern Arizona rapidly adopt a revolutionary projectile point technology introduced by successful male migrants from Mexico. It appears they modified their existing traditional point design (San Pedro) to perform a different function as hafted knives or tips on thrusting spears, while incorporating the Mexican migrants into their communities, and occasionally co-residing with additional immigrants from the Mogollon Rim and central Colorado Plateau who brought stylistically different but functionally equivalent point designs with them. During the Late Cienega phase at Los Pozos, a signature Cienega element—blade serration—was borrowed and used to augment other types of points. The composite picture is a society in which people were open to technology transfer from other traditions, modifying their own traditional designs and expanding their technological traditions to incorporate functionally superior introductions.

One set of data relevant to the San Pedro phase interpretations highlights intriguing issues for future research. The Roland site, the as-yet unexcavated site located directly across the Santa Cruz River from Las Capas, is tantalizing in that its surface assemblage contained nearly the complete typological sequence that has been documented for the Early Agricultural period in southern Arizona (Sliva 2015a: Figure 2.8h, 2.12a-c, 2.18a-f, 2.25a, 2.33a, 2.37a, 2.41a-e, 2.51e-i, 2.56i-j, 2.64a). This includes the largest number of Empire points from any single site yet known in southern Arizona other than Las Capas. Most of the Roland Empire points are the stemmed varieties that are associated with the Cienega Valley. At Las Capas, these same designs have a more constricted spatial distribution than the stemless variants that are common in northern Sonora, hinting at some social differentiation within the settlement. Their presence at Roland may reflect a social connection between contemporaneous sites, with the Roland site perhaps occupied in order to secure access to resources in the foothills of the Tucson Mountains on the west side of the river.

Alternately, after the ca. 1000 B.C. flood event disrupted the agricultural systems at Las Capas and forced the abandonment of the site, the portion of the group favoring the stemmed Empire designs may have moved across the river to the Roland site while the others moved elsewhere. Future excavations at the Roland site that document site stratigraphy, absolute chronology, and corroborating classes of material culture will be necessary to evaluate these possibilities. In the

same vein, future excavations in the Cienega Valley are needed to evaluate the observed dimorphism in the Las Capas Empire point assemblage that suggests, at a minimum, shared affiliations with Cienega Valley social groups. The paucity of stemmed Empire points at La Playa, the different spatial distributions of stemmed and stemless Empire points at Las Capas, and the dominance of stemmed varieties at the Roland site, when combined with the existence of the reasonably direct travel route, hints that some level of migration from the Cienega Valley to the Tucson Basin occurred in the early San Pedro phase, with people in both the Cienega Valley and northern Sonora subsumed under the general umbrella of the Empire technological tradition.

The main methodological limitation to the typological approach presented here is its reliance on different analysts perceiving details of attribute execution in the same way; the main inferential limitation is the ability to distinguish individual or coincidental variation from socially significant differences. Robust datasets from chronologically controlled contexts are key to avoiding errors in categorizing observed variation. Because it is difficult to separate things that are lumped together in the initial stages of the analytical process—the simple truth of the impossibility of unscrambling an egg—we split early and systematically, and later combine judiciously. At the same time, analysts must be cognizant of the tyranny of first impressions and the tendency to project early interpretations across ever larger and more complex cumulative datasets.

Projectile point functionality and stylistic analyses deal with separate technological and social systematics, and both are required to explain the observed changes in typological distributions in southern Arizona through the course of the Early Agricultural period.

Detailed recording of Early Agricultural period design attributes lets us discern variation at a fine level of resolution, revealing patterns that can elucidate changes in technological behaviors and social dynamics over time. These would be hidden otherwise when points are glossed at the upper level and chronology is treated at the period level.

REFERENCES CITED

- Bettinger, Robert L.
1982 Aboriginal Exchange and Territoriality in Owens Valley, California. In *Contexts for Prehistoric Exchange*, edited by J. E. Ericson and T. K. Earle, pp.103-128. Academic Press, New York.
- Bryan, Alan L.
1980 The Stemmed Point Tradition: An Early Technological Tradition in Western North America. In *Anthropological papers in Honor of Early H. Swanson Jr.*, edited by C. N. Warren and D. R. Tuohy, pp. .77-107. Special Publications of the Idaho State Museum of Natural History, Pocatello.
- Byrd, Rachael M.
2012 Biological Interactions of the First Forager-Farmers in the Sonoran Desert. Unpublished Master's thesis, School of Anthropology, University of Arizona, Tucson.
- Carpenter, John P., Guadalupe Sanchez, and Maria Elisa Villalpando C.
2005 The Late Archaic/Early Agricultural Period in Sonora, Mexico. In *The Late Archaic Across the Borderlands: From Foraging to Farming*, edited by B. J. Vierra, pp. 13-40. University of Texas Press, Austin.
- Gregory, David A.
2001 Variation and Trend During the Early Agricultural Period, in *Excavations in the Santa Cruz River Floodplain: The Early Agricultural Period Component at Los Pozos*, edited by D. A. Gregory, pp. 255-280. Anthropological Papers No. 21, Center for Desert Archaeology, Tucson.
- Griffen, William B.
1969 *Culture Change and Shifting Populations in Central Northern Mexico*. University of Arizona Press, Tucson.
- Hallenbeck, Cleve
1940 *Álvar Núñez Cabeza de Vaca: The Journey and Route of the First European to Cross the Continent of North America*, 1534-1536. Arthur H. Clark Company.
- Haury, Emil W.
1950 *The Stratigraphy and Archaeology of Ventana Cave*. University of Arizona Press, Tucson.
- Hesse, India S.
2010 Flaked Stone Artifacts. In *Recurrent Sedentism and the Making of Place: Archaeological Investigations at Las Capas, a Preceramic Period Farming Community in the Tucson Basin, Southern Arizona*, edited by S. M. Whittlesey, S. J. Hesse, and M. S. Foster, pp. 175-222. Cultural Resources Report No. 07-556. SWCA Environmental Consultants, Tucson.
- Hoffman, Charles Marshall
1997 Alliance Formation and Social Interaction During the Sedentary Period: A Stylistic Analysis of Hohokam Arrowpoints. Unpublished Ph.D. dissertation, Department of Anthropology, Arizona State University, Tempe.
- Holmer, Richard N.
1986 Projectile Points of the Intermountain West. In *Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings*, edited by Carol J. Condie and Don D. Fowler, pp. 90-115. Anthropological Papers No. 110. University of Utah Press, Salt Lake.
- Huckell, Bruce B.
1984 *The Archaic Occupation of the Rosemont Area, Northern Santa Rita Mountains, Southeast Arizona*. Archaeological Series No. 147. Arizona State Museum, Tucson.
1988 Late Archaic Archaeology of the Tucson Basin: A Status Report. In *Recent Research on Tucson Basin Prehistory: Proceedings of the Second Tucson Basin Conference*, edited by W. H. Doelle and P. R. Fish, pp. 57-80. Anthropological Papers No. 10. Institute for American Research, Tucson.
- 1996 The Archaic Prehistory of the North American Southwest. *Journal of World Prehistory* 10:305-373.
- Hughes, Susan S.
1998 Getting to the Point: Evolutionary Change in Prehistoric Weaponry. *Journal of Archaeological Method and Theory* 5:345-408.

- Keeley, Lawrence H.
1982 Hafting and Retooling: Effects on the Archaeological Record. *American Antiquity* 47:798-809.
- Lincoln-Babb, Lorrie
1997 Appendix I: Dental Analysis of the La Playa Burials. In *Rescate arqueológico La Playa (SON F:10:3)*, Municipio de Trincheras, Sonora, México, edited by J. P. Carpenter, G. Sánchez, and E. Villalpando. INAH, Mexico City.
- Lincoln-Babb, Lorrie, and Penny D. Minturn
1998 Análisis de los restos ósteos humanos. In *Salvamento arqueológico La Playa: Informe de la temporada 1997-1998 y análisis de los materiales arqueológicos*, edited by E. Villalpando, J. P. Carpenter, G. Sánchez, and M. Pastrana, pp. 123-129. INAH, Mexico City.
- Loendorf, Chris
2012 *The Hohokam-Akimel O'Odham Continuum: Sociocultural Dynamics and Projectile Point Design in the Phoenix Basin, Arizona*. Anthropological Research Papers Number 5, Gila River Indian Community Cultural Resource Management Program, Sacaton, Arizona.
- Loendorf, Chris, Theodore J. Oliver, Shari Tiedens, R. Scott Plumlee, M. Kyle Woodson, and Lynn Simon
2015 Flaked-stone Projectile Point Serration: A Controlled Experimental Study of Blade Margin Design. *Journal of Archaeological Science: Reports* 3:437-443.
- Mabry, Jonathan B.
1998 Introduction. In *Archaeological Investigations of Early Village Sites in the Middle Santa Cruz Valley: Analyses and Synthesis, Part I*, edited by J. B. Mabry, pp. 1-30. Anthropological Papers No. 19. Center for Desert Archaeology, Tucson.
- Mabry, Jonathan B.
2005 Changing Knowledge and Ideas About the First Farmers in Southeastern Arizona. In *The Late Archaic Across the Borderlands: From Foraging to Farming*, edited by B. J. Vierra, pp. 41-83. University of Texas Press, Austin.
- McClelland, John A.
2005 Bioarchaeological Analysis of Early Agricultural Period Human Skeletal Remains from Southern Arizona. In *Subsistence and Resource Use Strategies of Early Agricultural Communities in Southern Arizona*, edited by M. W. Diehl, pp. 153-168. Anthropological Papers No. 34. Center for Desert Archaeology, Tucson.
- Minturn, Penny, and Lorrie Lincoln-Babb
1995 Bioarchaeology of the Donaldson Site and Los Ojitos. In *Of Marshes and Maize*, edited by B. Huckell, pp. 106-116. Anthropological Papers of the University of Arizona No. 59. University of Arizona Press, Tucson.
- Musil, Robert R.
1988 Functional Efficiency and Hafting Change: A Hafting Tradition Model for Prehistoric North America. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface*, edited by J. A. Willig, C. M. Aikens, and J. L. Fagan, pp. 373-387. Anthropological Papers 21. Nevada State Museum, Carson City.
- Ogilvie, Marsha D.
2005 A Biological Reconstruction of Mobility Patterns in Late Archaic Populations. In *The Late Archaic Across the Borderlands: From Foraging to Farming*, edited by B. J. Vierra, pp. 84-112. University of Texas Press, Austin.
- Pettigrew, Devin B.
2015 *The Ballistics of Archaic North American Atlatls and Darts*. MA thesis, Department of Anthropology, University of Arkansas, Fayetteville. University Microfilms, Ann Arbor.
- Roland, E. H.
1993 Investigations at a Multicomponent Archaic Site in the Tucson Basin (AZ AA:12:86). Ms. on file, Desert Archaeology, Inc.
- Sayles, E.B. and Ernst Antevs
1941 *The Cochise Culture*. Medallion Papers No. 29. Gila Pueblo, Globe, Arizona.
- Shackley, M. Steven
1996 Elko or San Pedro? A Quantitative Analysis of Late Archaic Projectile Points from White Tanks, Yuma County, Arizona. *Kiva* 61(4):413-432.
- Sisk, Matthew L., and John J. Shea
2011 The African Origin of Complex Projectile Technology: An Analysis Using Tip Cross-Sectional Area and Perimeter. *International Journal of Evolutionary Biology*, vol. 2011, Article ID 968012, <http://dx.doi.org/10.4061/2011/968012>.
- Sliva, R. Jane
1999 Cienega Points and Late Archaic Period Chronology in the Southern Southwest. *Kiva* 64:339-367.
2011 Early Agricultural and Hohokam Sedentary Period Lithic Technology at Julian Wash Site, AZ BB:13:17 (ASM). In *Craft Specialization in the Southern Tucson Basin: Archaeological Excavations at the Julian Wash Site, AZ BB:13:17 (ASM): Part 1. Introduction, Excavation Results, and Artifact Investigations*, edited by H. D. Wallace, pp. 357-373. Anthropological Papers No. 40. Center for Desert Archaeology, Tucson.
2015a *Projectile Points of the Early Agricultural Southwest: Typology, Migration, and Social Dynamics from the Sonoran Desert to the Colorado Plateau*. Archaeology Southwest, Tucson.
2015b Further Explorations of Late Cienega Phase Lithic Technology at Los Pozos. In *Archaeological Investigations in Los Pozos, AZ AA:12:91(ASM), and Wetlands, AZ AA:12:90(ASM), for the Sweetwater Reclamation Facility Collector Pipeline and the Tucson Water Recharge Basins & Recovery Well Projects (Draft)*, edited by H. Wocherl. Technical Report No. 2012-03. Desert Archaeology, Inc., Tucson.
- Sliva, R. Jane, and Stacy L. Ryan
2015 San Pedro Phase Flaked Stone at Las Capas: Technology and Social Dynamics. In *Implements of Change: Tools, Subsistence, and the Built Environment of Las Capas, an Early Agricultural Irrigation Community in Southern Arizona*, edited by J. M. Vint, pp. 33-94. Anthropological Papers No. 51, Archaeology Southwest, Tucson.
- Stevens, Michelle N., and R. Jane Sliva
2002 Empire Points: An Addition to the San Pedro Phase Lithic Assemblage. *Kiva* 67(3):297-326.
- Stewart, R. Michael
1989 Trade and Exchange in Middle Atlantic Region Prehistory. *Archaeology of Eastern North America* 17:47-78.
- Van Buren, G.E.
1974 *Arrowheads and Projectile Points: A Classification Guide for Lithic Artifacts*. Garden Grove, CA: Arrowhead Publishing Company.

Vint, James M.

2015a Las Capas, AZ AA:12:111 (ASM), Introduced: Background, Chronology, and Research Orientation. In *Implementations of Change: Tools, Subsistence, and the Built Environment of Las Capas, an Early Agricultural Irrigation Community in Southern Arizona*, edited by J. M. Vint, pp. 1-32. Anthropological Papers No. 51. Archaeology Southwest, Tucson.

2015b Early Archaeological Anthropogenic Landscapes. In *The Anthropogenic Landscape of Las Capas, an Early Agricultural Irrigation Community in Southern Arizona*, edited by J. M. Vint, pp. 469-499. Anthropological Papers No. 50. Archaeology Southwest, Tucson.

Watson, James T.

2010 The Introduction of Agriculture and the Foundation of Biological Variation in the Southern Southwest. *Archaeological and Biological Variation in the New World*. Occasional Paper 36:135-171. Center for Archaeological Investigations, Carbondale.

Watson, James T., and Marijke Stoll

2013 Gendered Logistic Mobility Among the Earliest Farmers in the Sonoran Desert. *Latin American Antiquity* 24:433-450.

Whittlesey, Stephanie M., Annick Lascaux, India S. Hesse, Jerome Hesse, and Michael S. Foster

2010 Introduction. In *Recurrent Sedentism and the Making of Place: Archaeological Investigations at Las Capas, a Preceramic Period Farming Community in the Tucson Basin, Southern Arizona*, edited by S. M. Whittlesey, S. J. Hesse, and M. S. Foster, pp. 1-10. Cultural Resources Report No. 07-556. SWCA Environmental Consultants, Tucson.

PAINTED ARROWS AND WOODEN PROJECTILE POINTS: AN ANALYSIS OF SINAGUA ARROWS FROM THE DYCK CLIFF DWELLING IN THE VERDE VALLEY, ARIZONA

Todd W. Bostwick

ABSTRACT

This paper presents the results of an analysis of 74 arrow shafts and 43 wooden foreshafts collected between 1962 to 1972 from a Southern Sinagua cliff dwelling in the Verde Valley. Arrow shaft and foreshaft components, materials, manufacture, modification, and decorations are discussed. Decorations in a variety of colors and designs were painted on the shafts in the area of fletching where three split feathers were attached with sinew wrappings. Only two foreshafts are notched for holding stone points, and most of the foreshafts appear to have been designed, or modified after breaking, to serve as wooden points.

INTRODUCTION

The bow and arrow has been an important weapon for hunters and warriors of the American Southwest since A.D. 500 (Blitz 1988) or as early as A.D. 200 (LeBlanc 1999:101; Reed and Geib 2013). In 1895, Frank Hamilton Cushing published a lengthy treatise on arrows, and he argued that “there was no weapon and no single thing that for ages held sway so potent over the minds or the destinies of men, or wrought more varied influence over their institutions and customs than did the arrow” (Cushing 1895:308). After observing Zuni arrow making and inspecting museum collections, Cushing (1895) noted that the typical Puebloan arrow was a compound arrow made with a reed shaft, a fire-hardened foreshaft, which may or may not hold a stone projectile point, fletching composed of three split and trimmed feathers bound to the shaft by sinew, and a notched wooden plug inserted for the nock (Figure 1).

The following describes the results of an analysis of a collection of previously undocumented arrows from a Sinagua cliff dwelling in the Verde Valley. This collection of 74 arrow shafts and 43 foreshafts is remarkably similar to the description provided by Cushing (1895). The wood-

en bows recovered from the Dyck cliff dwelling also are briefly discussed.

The Dyck collection was excavated from 1962 to 1972 under the direction of Charles Rozaire of the Southwest Museum and, later, Los Angeles County Museum of Natural History, on the property of Paul Dyck in Rimrock, just north of Montezuma Castle. These excavations were conducted in 5 x 5 ft grid units in 6 inch levels and all materials were screened. The site consisted of three sections: (1) a limestone rockshelter which contained six cobble and adobe rooms, one of them two stories high (Figure 2); (2) a so-called “Kiva” which was a natural chamber with a narrow entrance above two of the rooms; and (3) the “Annex,” a smaller, adjacent rockshelter that contained two rooms. Ceramic types date the site to around AD 1100 to 1300, which places it in the Honanki Phase of the Southern Sinagua, contemporaneous with the early occupations of Tuzigoot and Montezuma Castle (Pilles 1981:13).

The following describes the characteristics of the Dyck arrows, including the arrow shafts, fletching techniques, nocks, and foreshafts. In addition, a brief mention is made of bows found at the site. Ethnographic information and data from numerous other Southwestern archaeological collections are compared with the Dyck arrows. Unfortunately, reported data on prehistoric and historic arrows are often only briefly summarized, limiting their usefulness for detailed comparisons.

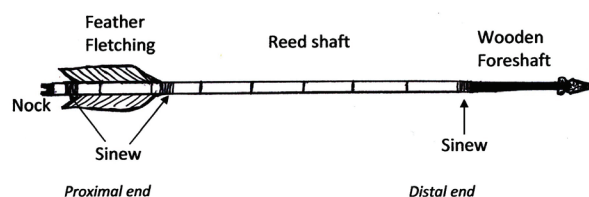


Figure 1. Components of the compound reed arrow.

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Table 2. Two complete, but damaged arrows from Dyck cliff dwelling.

| Spec. No. | Provenience | Shaft Length (cm) | Shaft Diameter (cm) | Overall Length (cm) | Weight (g) ^a | Comments |
|-----------|-------------|-------------------|---------------------|---------------------|-------------------------|--|
| 1025 | Cist 5I | 54.4 | 0.86 | 65.9 | 15 | Foreshaft split with sharp, narrow tip, painted red; wooden plugnock, painted black; 3 feather quills; decorated shaft (Table 4) |
| 4481 | Cist 5I | 54.3 | 0.89 | 74.5 | 17 | Foreshaft end semi-rounded pointed tip; wooden plugnock, painted black; 3 feather quills; decorated shaft (Table 4) |

a=weight includes foreshaft

the Verde River and its tributaries, as well as at springs.⁶ The phragmites reed grows up to 1.2 m in height and 1 cm or more in diameter (Benson and Darrow 1981:80). Its lanceolate-shaped leaves grow in a basal sheath around its jointed stem and can be easily removed.

As Cushing (1895:319) observed, reeds were preferred for arrow shafts, in part because they require little or no straightening, saving considerable labor (Mason et al. 1891:71). In addition, they are light, stiff, easy to obtain, and because they don't drop in flight as quickly as wooden arrow shafts, they can be very accurate (Hamm 1991:107). Reed arrow shafts have been recovered from cave and open air sites throughout Arizona, Utah, and New Mexico (Aikens 1970; Alexander and Reiter 1935; Bartlett 1934; Brown 1954; Cosgrove 1947; Dixon 1956; Ellis and Hammack 1968; Ferdon 1946; Fulton 1941; Gifford 1980; Grange 1952; Harrington 1933; Haury 1950; Holly 2010; Hough 1914; Judd 1954; Lambert and Ambler 1961; Magers 1986; Mera 1938; Morris 1919, 1928; Morss 1931; Nordenskiöld 1893; Pierson 1962; Pepper 1920; Steen 1962; Stewart 1937; Wasley 1962; Zingg 1940).

Reeds were used for arrow shafts by the Hopi (Stephen 1936; Voth 1912; Whiting 1939), Tewa (Robbins

Table 3. Possible unfinished or rejected arrow shafts from Cist 5I.

| Length (cm) | Diameter (cm) | Weight (g) | Comments |
|-------------|---------------|------------|---------------------------------------|
| 69.3 | 0.68 | 3 | smashed |
| 68.5 | 0.82 | 10 | fire-blackened in mid-section |
| 67.8 | 0.98 | 11 | one end cut |
| 67.7 | 0.72 | 6 | smashed, portions of leaves present |
| 65.6 | 0.95 | 8 | smashed |
| 64.6 | 0.86 | 8 | smashed |
| 60.5 | 0.73 | 7 | one end contains part of root, curved |
| 59.4 | 0.96 | 9 | one end cut, smashed, curved |
| 58.8 | 0.99 | 8 | one end notched? |
| 55.9 | 0.64 | 2 | portions of leaves present |
| 43.0 | 0.39 | 1 | smashed, portions of leaves present |

et al. 1916), Hualapai (Mekeel 1935), Havasupai (Spier 1928), Yavapai (Corbusier 1886), Cocopa (Kelly 1977), Isleta (Jones 1931), Apache (Bourke 1892; Opler 1965), Tarahumara (Bennett and Zingg 1935), Southern Paiute (Kelly 1964), Navajo (Matthews 1886), Tohono O'odham (Castetter and Underhill 1935), sometimes by the Maricopa (Spier 1933), and by various California groups (Kroeber 1922). Ellis and Hammack (1968:33) note that long reed arrows with wooden foreshafts were "formerly fashioned by the Acoma, Laguna, Zia, Santa Ana, Cochiti, and doubtless other pueblos, although arrows of wood, especially Apache Plume, also were used."



Figure 3. Four Self-bows from Dyck Cliff Dwelling, Cist 5I . Top to Bottom: VVAC 0762, VVAC 0763, VVAC 0761, VVAC 0764. Scale is 5 cm.



Figure 4. Two complete but damaged arrows in the Dyck collection. Both are missing their fletching, and portions of their shafts are split. Both have painted designs and are from Cist 5I, 18-24 inches depth (A= Spec. No. 1025; B=Spec. No. 4481). Scale is 5 cm.

Wooden arrow shafts were more commonly used during the late prehistoric and historic period in California (Kroeber 1922:271).

Reeds used for arrows were cut green, before they grew too tall, and dried to a hard yellow color, after which they were worked (Mekeel 1935:94; Opler 1965:390; Spier 1928:150). Mason (1894:658) reported that after the reed stems were dried, they were straightened in the hands before a fire, or they were rubbed against a small heated stone. Many of the joints or nodes of the Dyck reed arrow shafts have been slightly ground to smooth them, or trimmed with a sharp tool. The smooth side of the nodes is always oriented toward the tip of the arrow to ensure the arrow did not catch on the bow handle when the bowstring was released.

All but two of the 74 Dyck arrow shafts are fragmentary, apparently broken from use. The two complete arrows also are damaged (Figure 4). These two arrow main shafts have the following measurements: 54.4 cm length, 0.86 cm diameter, and 14 g weight (VVAC 1025); and 54.3 cm length, 0.89 cm diameter, and 19 g weight (VVAC 4481) (Table 2).

A set of 11 reed shafts recovered from a storage cist (5I) behind Room 4 may have been collected as possible arrow shafts, but were ultimately rejected or not finished. They measured 43.0 to 69.3 cm in length (mean length = 61.9 cm, $sd = 7.73$ cm; mean dia. = 0.79 cm, $sd = 0.19$ cm; mean weight = 6.6 g, $sd = 3.29$ g) (Table 3).

Comparing the Dyck cliff dwelling arrow lengths to other specimens reported in the archaeological and ethnographic literature is somewhat problematic. Often, it is not stated in a report if the arrow lengths given are for main shafts only or for shafts and foreshafts combined, or the arrow lengths are only given as averages. The two complete Dyck arrow shafts are similar in length (54.3 and 54.4 cm) to two reed arrow main shafts from the Canyon Creek Ruin in central Arizona, which measured 55 cm in length (Haury 1934:07), but shorter than the 12 reed arrows recovered from a quiver in Hidden House (62 to 65 cm in length), a Southern Sinagua cliff dwelling located in the northern part of the Verde Valley and dated to circa A.D. 1275 (Dixon 1956:47). However,

the possible unfinished arrow shafts from the Dyck cliff dwelling (Table 3) are similar in length (mean 61.9 cm) to those from Hidden House. Twenty-five arrow shafts and their foreshafts from a burial in the lower ruin of Tonto National Monument cliff dwelling were 63.5 to 66 cm in length; subtracting the foreshafts, which extended an average of 15.2 cm in length from the main shaft, suggests the main shafts were approximately 48.3 to 50.8 cm in length (Pierson 1962:59). Reed arrow shafts recovered from Chihuahua were 46 to 61 cm in length (Zingg 1940:60), and reed arrow shafts from the Upper Gila region were 51.4 to 71.8 cm in length (Cosgrove 1947:62). Eighty-one reed arrows found in Room 32 of Pueblo Bonito in Chaco Canyon averaged 59 cm in length (Pepper 1920:160).

Tarahumara reed arrow shafts were reported to be 51 cm long (Bennett and Zing 1935:115). The Havasupai determined the length of their arrow shafts by measuring them from the tip of their forefinger to the top of their biceps, about 60 to 61 cm (Spier 1928:151). Akimel O'odham (Pima) arrow makers measured their arrows from the tip of a forefinger to the nipple of their breast (Russell 1908:96). Eleven Akimel O'odham hunting arrows made simply of pointed arrow weed shafts without foreshafts were 78.5 cm in length, and a war arrow was 85 cm in length (Russell 1908:96 footnotes a, b).⁷

The reported examples of arrow shafts described above varied in length from 48 to 72 cm. The two finished Dyck arrow shafts, both a little more than 54 cm in length, fall within that range, but toward the shorter end of the range. However, if the unfinished Dyck arrow shafts are considered, which averaged almost 62 cm in length, then the Dyck arrow shafts are in the middle of the range. Based on the limited sample size it is difficult to evaluate how the Dyck arrow shaft lengths compare with the lengths in other regions or cultures.

The Dyck arrow shafts appear to have been selected for a certain diameter. Shaft diameters range from 0.35 to 0.94 cm ($n = 74$, mean = 0.72 cm, $sd = 0.10$), and only three arrow shafts have diameters less than 0.5 cm. Shaft diameters are rarely reported in the literature on Southwestern arrows. Reed arrow shafts from the Can-

Table 4. Painted decorations on Dyck arrow shafts (arranged proximal to distal end)^a.

| Spec. No. | Provenience | Shaft Decorations | Comments |
|-----------|----------------------------|---|-------------------------------|
| 0483 | unknown | Thin blue band, black diamond with black dot inside red diamond and red dot inside black diamond – both on yellow background, space, black band | Red nock, green sinew |
| 0486 | unknown | Dark brown longitudinal lines | |
| 0576 | Cist 5I | Red band | |
| 0578 | Cist 5I | Black band, red band | |
| 0580 | Cist 5I | Black band*, brown double row of 20 squares, brown band | Black nock |
| 0591 | Cist 5I | Thin green band, opposing “E” designs in red and black with long tails on yellow background, yellow band, black band, yellow band, red band | Black nock, green sinew (n=3) |
| 0608 | Cist 5I, 6-12” | Red band | |
| 0609 | Cist 5I, 6-12” | Red band with 8 red lines, black band* | |
| 0610 | Cist 5I, 6-12” | Red geometric on yellow background, black band, green band, black band, yellow band, red band | Yellow sinew |
| 0611 | Cist 5I, 6-12” | Black longitudinal zigzags, red band | |
| 0612 | Cist 5I, 6-12” | Red band | |
| 0613 | Cist 5I, 6-12” | Red band with 4 encircling red lines incised in middle, black dot | |
| 0616 | Cist 5I, 6-12” | 3 Black dots | |
| 0617 | Cist 5I, 6-12” | Black dot | |
| 0618 | Cist 5I, 6-12” | Black band | |
| 0728 | Cist 5I | Numerous brown dots in rows encircling shaft, narrow brown band, space, brown band | |
| 0731 | Cist 5I | Black band, brown band, 7 brown lines, space, red band | Black nock |
| 0732 | Cist 5I | Black band, 9 black lines, space, red band | Black nock, red sinew |
| 1024 | Cist 5I, 6-12” | Red band | |
| 1025 | Cist 5I, 18-24” | Black band*, black dots, red band | Black nock |
| 1026 | Cist 5I, cleanup | Black dot on nock, red band, black band, 8 black encircling lines | Red sinew |
| 1128 | Cist 5I, 0-6” | Red band, black dot | |
| 1422 | 3H, 6-12” | Black longitudinal lines | Black nock |
| 2183 | Cist 5I | Large and small black dots (near distal end) | |
| 2187 | Cist 5I | Black band (near distal end) | Red sinew |
| 2542 | Room 1, above floor debris | Red band, black band | |
| 2552 | 6F, 48-54” | Red band | |
| 4481 | Cist 5I, 18-24” | Black band*, space, black band* | Black nock |
| 4651 | Cist 5I, 6-12” | Red band, several black dots | |
| 4993 | A12, 0-6” | Black band with ground specular hematite | Black nock |
| 8639 | Cist 5I, 6-12” | Black dot | |
| 9132 | C17-D17, 18-24” | 10 black encircling lines, black band, red band | |

a= “space” is where there is no color between painted bands; *= includes ground specular hematite

yon Creek Ruin in central Arizona averaged 0.79 cm in diameter (Hauray 1934:107), and reed arrow shafts at Paquime ranged from 0.5 to 0.7 cm in diameter (DiPeso et al. 1974:117). Twenty-two reed arrow shafts from the Upper Gila region ranged from 0.64 to 0.95 cm in diameter (Cosgrove 1947:62).

PAINTED SHAFTS

Of the 45 Dyck arrow shafts with nocks, 29 (64.4%) have painted decorations, and a single indeterminate portion and 2 distal portions of arrow shafts are deco-

rated (Table 4). All of the nock portions of arrows that are decorated are painted in the area of the fletching, before the feathers were attached, which is called "cresting." Red, black, green, brown, yellow, and blue colors are present (Figures 5 to 8).⁸

Colored bands that encircle the arrow shaft are most common, but zigzag lines, dots, diamonds, and multiple lines (both longitudinal and encircling) also occur, sometimes in combinations. Different colored bands are often interspersed with non-painted bands on the same arrow. Red and black are the most common colors.

Thin parallel lines, zigzags, and rows of dots of the same color on the Dyck arrow shafts appear to have been incised. Alternatively, the shaft may have been loosely wrapped in sinew or fiber before being painted, with the sinew or fiber removed to create a set of encircling lines (Cosgrove 1947:64).

Four of the Dyck arrow shafts have ground specular hematite added to the black bands, which produces a dramatic sparkle effect in the light (Figure 8). Sparkling specular hematite has also been reported on Sinagua reed arrows from the Magician's burial east of Flagstaff (McGregor 1943; Kamp et al. 2016:6), on reed arrows in the Upper Gila region (Cosgrove 1947:64; Hough 1914:66), and on reed arrows from Arrow Grotto in Feather Cave, New Mexico (Ellis and Hammack 1968:29). Similar shiny black specularite paint is used as face decorations in Pueblo dances (Ellis and Hammack 1968:29; Parsons 1939).

The decorations on the Dyck arrows are similar to those painted on other reed arrows from archaeological sites located throughout the Southwest (e.g., Bartlett 1934; Brown 1954; Cosgrove 1947; Ellis and Hammack 1968; Fulton 1941; Grange 1952; Hough 1914; Harrington 1933; Hibben 1938; Judd 1954; Lambert and Ambler 1961; Magers 1986; Pepper 1920; Wasley 1962). Painted reed arrows found in the Northern Sinagua Magician's burial included red, green, white, orange, blue, and yellow colors (McGregor 1943; Kamp et al. 2016). At Hidden House, 8 of the 12 reed arrows were painted red or black in the area of fletching; those with stone points were painted black and those with wooden points were painted red (Dixon 1956:48). A possible reason for the association of a specific color with different tip types was to help the archer quickly select the proper arrow type from his quiver since nock ends are typically placed at the top of the quiver (Dixon 1956:48). Similar to the Dyck arrow decorations, the Hidden House painted designs included incised wavy lines, zigzag lines, and squares (Dixon 1956:48). Zigzag designs have been interpreted as representing lightning (Mason 1894:660; Parsons 1939:646). Judd (1954:252) commented that reed arrowshafts from Pueblo Bonito had been "scratched lengthwise with lightning lines." Zuni arrows were thought to be alive and endowed with the power of lightning, which was released when the arrow was shot (Cushing 1895:325).

Arrow Grotto in Feather Cave, New Mexico, contained 40 reed arrows with wooden points; the arrow shafts were painted with red and black bands, and Ellis and Hammack (1968:29) suggested that "some of the markings may have indicated identification of individuals or of religious societies."

Interpreting the Dyck arrow decorations is problematic, especially since no two decorations are identical, but there are several possibilities based on ethnographic accounts. Mason (1894:662) observed that some groups in California and Oregon had arrows with different coloring from tribe to tribe, and he commented that the "bands and stripes have been called clan marks, owner marks, tribal marks, and the like, but they are not decisive in such matters" (Mason 1894:662).

For Havasupai arrows, "... painting is purely decorative; these are not property marks, for a man could always recognize his own arrows" (Spier 1928:152). Ishi, the Yahi arrow maker from California, asserted that his red and green arrow colors had no particular meaning, but were meant for good luck and to help insure they flew straight (Pope 1918:113). In contrast, Driver and Masey (1957:349) provide a different view:

It is probably safe to say that the weapons of each tribe could be distinguished in most cases from those of every other tribe, especially if decorations were taken into account. Furthermore, individual hunters often placed ownership marks on arrow and dart shafts, or on harpoon heads, so that when a number of hunters discharged their missiles simultaneously at an animal, it was possible to tell whose weapon had been the most effective. The dividing of meat, hide, horns, and ivory of the slain animal was contingent upon the skill of the hunters, the most efficient man usually getting the most valuable parts.

The Dyck arrow colors may have had symbolic importance. Color symbolism plays an important role in Pueblo social organization, ritual, and cosmology, and particular colors are associated with directions (Plog 2003:671; Parsons 1939:99; Stephen 1936:1191). However, there is considerable variation in the symbolic meaning of colors among Pueblo groups (Smith 1952:170-172). Cushing (1895:325) stated that for the Zuni, individual colors on arrows were sacred and were meant to ensure a successful hunt or killing of the enemy – black represented death, red was blood, yellow was magic, green was life, and blue was life and victory.

The two complete but damaged arrows from the Dyck cliff dwelling, both found in the same level of Cist 51, have similarities that indicate they may have been made by the same person. Both have wooden plugs painted black for nocks, and both have wooden foreshafts with broken but sharp or semi-sharp tips. However, they do not have the same painted designs. Arrow VVAC 1025



Figure 5. (A) Painted reed arrow shaft with brown dots, brown band, and black-colored wooden nock from Cist 5I (VVAC 0580). (B) Painted reed arrow shaft with black band and lines and a red band; red colored sinew secures a black-colored wooden nock from Cist 5I (VVAC 0732). (C) Painted reed arrow shaft with black longitudinal lines from unknown provenience (VVAC 0486). (D) Painted reed arrow shaft with black zigzags, wide red band, and a wooden nock from Cist 5I, 6-12 inches depth (VVAC 0611).



Figure 6. (A) Painted reed arrow shaft with red band incised with encircling lines and a black band with ground specular hematite from Cist 5I, 6-12 inches depth (VVAC 0609). (B) Painted reed arrow shaft with brown band and lines and a black-colored wooden nock from Cist 5I (VVAC 0731). (C) Painted reed arrow shaft with red band and lines from Cist 5I, 6-12 inches depth (VVAC 0613). (D) Painted reed arrow shaft with red band, black encircling lines, and black band from Cist 5I; red colored sinew near nock (VVAC 1026).



Figure 7. (A) Painted reed arrow with blue band, black diamond with black circle inside a red diamond, yellow band, and a black band from unknown provenience; green-colored sinew is present (VVAC 0483). (B) Painted reed arrow shaft with red, black, green, and yellow bands from Cist 5I, 6-12 inches depth; the sinew wrapping is colored yellow (VVAC 0610). (C) Painted reed arrow shaft from Cist 5I with red and black geometric designs, and yellow, black and red bands; the nock is a wooden plug painted black; the three sinew wrappings are green colored (VVAC 591).



Figure 8. Painted reed arrow with black band of ground specular hematite from Cist 5I, 18-24 inches depth (VVAC 4481).



Figure 9. Reed paint container possibly used for painting arrows from ledge above Room 1 (VVAC 0534). Scale is 5 cm.

has a black band, a space with some black dots, and a red band, all under the fletching; arrow VVAC 4481 has a black band outside the fletching, and a space and a black band under the fletching (Figure 4). Both have ground specular hematite in the black painted areas.

REED PAINT CONTAINERS

At least three reed paint containers have been identified in the Dyck Collection that held pigments possibly used for decorating the arrows. Reed containers for painting arrows have been documented elsewhere. A Tarahumara reed container 7.6 cm in length was reported by Bennett and Zingg (1935:116) for coloring arrows, and a similar sized Southern Chihuahua reed container was recorded by Zingg (1940:59). Lumholtz (1902) also collected reed paint containers from groups living in northern Mexico. One of the Dyck reed containers is itself decorated in a black and red geometric design and contained a black mineral powder (Figure 9). The Dyck containers have been hollowed out, and one end has been partially cut to serve as a pouring spout which was closed with wadded cotton yarn.

ARROW NOCKS

A nock is the proximal end of the arrow meant to receive the bow string. All but two of the Dyck nocks ($n=47$) are U-shaped types with the nock having the same diameter or smaller than the arrow shaft. The other nocks are both V-shaped. The notch in the nock was most likely initially cut with a stone flake and then rasped out with a blunter edge flake tool with a rough texture (Cushing 1895:321).

More than one-third ($n=19$) of the nocks consist of separate notched wooden plugs that have been inserted in the arrow shaft, either extending out of the shaft, or fully inserted into a shaft that was also grooved. Five other nocks consist of short slightly smaller diameter reeds that were inserted into the main shaft and notched. The remaining 23 arrow shafts with nocks are simply notched. Two of these arrows have small diameter twigs jammed into them apparently to strengthen the nock. Reed arrows found in the Canyon Creek Ruin included both wooden plugs and separate pieces of cane as nocks (Haury 1934:108). Eight of the Dyck arrow nocks are painted black and one is painted red.

SINEW WRAPPING

All of the Dyck arrow shafts with nock ends had sinew wrapping still present, or evidence that it was once used, to secure the fletching. In addition, sinew wrapping was used to secure the end of shaft where the foreshaft was inserted ($n=22$), or to reinforce the nock area ($n=17$). According to Mason et al. (1891:60), "American Indian arrows, with very few exceptions, are

lashed with sinew." It was "the most important material in the kit of the arrowsmith, being pliable when damp, splitting into even threads, becoming horn-like on drying, and binding parts strongly together on shrinking" (Mason et al. 1891:60). Sinew consists of animal tendons, and those from the leg or back of large mammals were preferred (Mason 1894:651).

When applied wet, sinew contracts as it dries, forming a tight bond and lying flat (Laubin and Laubin 1980:116). The Havasupai chewed sinew and pulled it through their teeth until soft, then wrapped it several times around the nock end by twirling the shaft (Spier 1928:152). Apache arrow makers soaked sinew in saliva after they had pounded and shredded it, then wrapped the fletching with the sinew, tucking the loose end under the last turn (Mason 1894:651). None of the Dyck arrow shafts or foreshaft with tight sinew wrapping have loose ends visible, suggesting the sinew was wrapped in a similar manner. Some of the Dyck sinew was colored red ($n=6$), light green ($n=4$), or yellow ($n=1$) before it was applied⁹, a trait that has been noted for Native American arrows in general (Laubin and Laubin 1980:116).

FLETCHING

All of the Dyck arrow shafts wound with sinew wrapping near intact nock ends had split feather quills under the sinew, indicating three split feathers were used for fletching, with the feathers evenly spaced around the shaft. Based on the distance between pairs of sinew wrappings containing quills or portion of feathers, the feathers ranged from 2.0 to 8.5 cm in length ($n = 26$, mean = 4.4 cm, $sd = 1.46$ cm). More than 75 percent of the feathers were 3.5 to 6.3 cm in length. These feathers are considerably shorter than the dual feathers on 11 Akimel O'Odham small game hunting arrows that ranged between 12 and 22 cm in length, or a single Akimel O'Odham war arrow with three feathers that measured 10 cm in length (Russell 1908:96 footnotes a, b).

The fletching on the proximal end of an arrow serves as a rudder or drag, keeping the arrow from turning or twisting, and helping to maintain a straight flight (Hamilton 1972:15; Pope 1923:362-363). Three types of fletching have been recorded for arrows in North America: (1) none, (2) two feathers, and (3) three feathers (Mason 1894:654). Similar to the Dyck arrows, three split feathers spaced evenly apart are the most common fletching type for Southwestern groups (Mason et al. 1891:62; Laubin and Laubin 1980; Mason 1894; Zingg 1940). An exception are the Akimel O'Odham who sometimes used two feathers on small game hunting arrows, but they used three feathers on arrows designed for warfare (Mason 1894:Plate XLII; Russell 1908). The Havasupai used two feathers on arrows made for hunting small game, and three feathers for larger game hunting arrows (Mekeel 1935:94). The use of glue for securing feathers to



Figure 10. Reed arrow shaft with split Great Horned owl feather fletching from Cist 5I, 6-12 inches depth (VVAC 0622). Feathers are 13.3 cm in length.

the arrow shaft was not common in the Southwest, because wrapping with sinew, called “seizing,” was effective without glue (Mason 1894:663).

Wing or tail feathers from birds of prey were preferred for fletching, but the feathers of other birds were also used (Cushing 1895:322; Mason 1894:651). One of the Dyck arrow shafts has the remains of a Great Horned owl (*Bubo virginianus*) feather (Figure 10). Owl feathers were preferred by the Omaha because it was believed that an arrow with owl feathers finds its mark silently and accurately just like an owl does when it hunts (Laubin and Laubin 1980:121). However, Hamm (1991:111) suggested that owl feathers were rarely used. The Zuni believe that owls drive away other birds and keep away the rain (Parsons 1939:136). According

to Russell (1908:263), the Akimel O’Odham consider the owl dangerous and its presence at night can be a bad omen. No other Dyck arrow feathers could be identified to species.

FORESHAFTS

There are 43 wooden foreshafts in a variety of sizes in the Dyck Collection, 18 of which are still inserted into a reed shaft. Most of these are broken at one or both ends. The portion of the foreshaft that was inserted into the main shaft is always tapered, some with long tangs (Figure 11). Complete or nearly complete tangs are 3.7 to 13.5 cm in length ($n = 19$, mean = 6.3 cm, $sd = 2.35$ cm). Most foreshafts were carved, scraped, and/

Table 5. Southwestern ethnographic groups that used wooden arrow points for small game hunting (from Ellis 1997: Table 3; Bohrer 1962).

| Group | Intended Target | References |
|-------------------|------------------------|---|
| Cocopa | Large and small game | Drucker (1941:119); Gifford (1933:273) |
| Chiricahua Apache | Large game and warfare | Opler (1965:387-390) |
| Hualapai | Small game | Mekeel (1935:92-93); Gifford 1936:285 |
| Havasupai | Small game | Spier (1928:150-151) |
| Jicarilla Apache | Small game | Gifford (1940:30-31) |
| Keresan Pueblo | Small game | Gifford (1940:30-31) |
| Mescalero Apache | Small game | Gifford (1940:30-31) |
| Mohave | Small game | Drucker (1941:119); Kroeber (1935:751) |
| Navajo | Small game | Kluckholm et al. (1971:33-43) |
| Pima (O’Odham) | Small game | Drucker (1941:119); Russell (1908:96,111) |
| Seri | Small game | McGee (1898:197-198) |
| Southern Paiute | Large and small game | Kelly (1964:72-76) |
| Western Apache | Small game | Bourke (1890:56-57) |
| Yavapai | Small game | Gifford (1932:233-234) |



Figure 11. Various wooden foreshafts showing differences in lengths but general similarities in diameters. Scale is 10 cm.

or sanded to form a uniformly round cross-section, but some were crudely made with little attention given to their overall shape. More than one-third ($n=16$) are polished.

At least 11 of the foreshafts have a squared-off shoulder that facilitated the foreshaft fitting evenly against the flat portion of the end of the reed shaft (Figure 12a). These foreshafts tend to be more carefully made, and the foreshaft diameter is the same as the reed shaft. Other foreshafts simply taper along the length of the tang, and these foreshafts do not fit as smoothly as those that have square shoulders (Figure 12b). Both shouldered and tapered tangs are reported for foreshafts from the Upper Gila region (Hough 1914: Figure 141; Cosgrove 1947:62).

The Dyck foreshafts range from 0.4 to 0.9 cm in

maximum diameter ($n = 19$, mean = 6.92 cm, sd = 0.95 cm), with 85.7 percent of them 0.60 to 0.85 cm in diameter. The foreshaft diameters are similar to the Dyck arrow shaft diameters, and other reported foreshaft data are similar. Grange (1952:388) reported that the 40 foreshafts recovered from Tularosa and Cordova Caves ranged from 0.5 to 0.8 cm in diameter, and averaged 0.6 cm. Complete foreshafts ($n=28$) from Antelope House in Canyon de Chelly ranged from 0.6 to 1 cm in diameter, averaging 0.8 cm (Magers 1986:287). Ten foreshafts from Hidden House in the Verde Valley were all 0.8 cm in diameter (Dixon 1956:52). The 52 foreshafts recovered from Winchester Cave in southeastern Arizona ranged from 0.4 to 0.8 cm (Fulton 1941:16). Thomas (1978) measured 132 arrow foreshafts curated in the American Museum of Natural History and found that



Figure 12. Two wooden foreshafts. A has a square shoulder tang and is 22 cm in length and 0.66 cm in diameter; it is from "Kiva" test pit 101A, 6-12 inches depth (VVAC 8925). B has a tapered tang and is 24.8 cm in length and 0.65 cm in diameter; it is from Cist 5I, 6-12 inches depth (VVAC 2190).



Figure 13. Square shouldered foreshaft with adhesive on its tang from Unit 5I, 0-6 inches depth, in front of Cist 5I (VVAC 9128). Foreshaft is 23 cm in length and 0.73 cm in diameter with a tang that is 6.1 cm in length.



Figure 14. Wooden foreshaft with square shouldered tang inserted into broken portion of a reed arrow shaft with red-colored sinew securing their juncture, from Cist 5I; end of foreshaft tang on right has adhesive residue (VVAC 1138).

they averaged 0.71 cm in diameter, compared to 10 dart foreshafts that averaged 1 cm in diameter. These data suggest that there was optimal diameter for arrows used with Native American bows.

Foreshafts from the Dyck cliff dwelling that could be weighed independently of arrow shafts range from 2 to 8 grams ($n = 23$, mean = 5 g, $sd = 1.69$ g). These weights should be taken cautiously, however, since almost all of the foreshafts are not complete, but have broken tangs and/or tips. A long, complete foreshaft (VVAC 1145) that was apparently not intended to receive a stone point weighs 6 grams (Figure 11, specimen on far left). Two foreshafts with intact tangs, but broken and re-sharpened tips, weigh 5 grams (VVAC 8925) and 6 grams (VVAC 2190) (Figure 12), and another similar foreshaft (VVAC 1131) with a broken and resharpened tip weighs 5 grams.

Adhesive is present on seven of the Dyck foreshafts tangs where it was used to secure the foreshaft inside the reed shaft (Figure 13 and 14). On five of the specimens, the adhesive is a red color. The Yumans used the sap of pinyon trees (*Pinus monophylla*), mesquite trees (*Prosopis juliflora*), and creosote bush (*Larix mexicana*) for adhesives on their arrows (Mason 1894:662).

None of the Dyck foreshafts have stone projectile points attached, although more than two dozen obsidian and chert projectile points were recovered from the site. Only two of the foreshafts have damaged notches in their distal ends, indicating they once had a stone point attached (Figure 15a). Other than their notched tips, neither of these two foreshafts are dissimilar to other Dyck foreshafts. According to Ellis (1997:47), stone-tipped projectile points “in general produce more lethal wounds than most organic-tipped projectiles,” and therefore were preferred for larger and more dan-

gerous animals, including humans. It can be assumed, therefore, that these two notched foreshafts were tipped with stone projectile points and the arrows were used as weapons for hunting large game or for warfare (Loendorf et al. 2015a).

Most of the Dyck foreshafts have sharp, rounded, or blunt distal ends, which suggests they were used as wooden projectile points (Figure 15b and c). The tips of all of these foreshafts were the same diameter or slightly smaller in diameter as their bodies; none had bulbous tips or were used as part of a cross-piece commonly used for small game or birds (Ellis 1997:49). Some of the Dyck foreshafts with round tips were clearly designed to be used as wooden points, but many of the foreshafts appear to have been broken during use and their broken tips, usually split, were resharpened; these foreshafts could have originally carried stone points but were converted to wooden points after breaking. Five of the foreshafts with rounded ends are charred, possibly from being fire-hardened or from burning done to reshape a broken end. Three of the foreshafts are painted red, including one that has red paint on its split tip (Figure 15c). The Akimel O’Odham painted some of their arrows (and bows) with rabbit blood or smashed cochineal insects (*Dactylopius coccus*) that live on prickly pear cactus (*Opuntia* sp.; Russell 1908:96).

One of the Dyck foreshafts is barbed (Figure 15d). Its tang appears to have been broken off and was reshaped. Three barbed foreshafts were recovered from caves in the Upper Gila region (Cosgrove 1947: Figure 20), and a barbed foreshaft was found in the Reserve Area, New Mexico (Brown 1954:187). The Zuni used barbed arrows for hunting wood rats, and the barbs helped to dislodge them from rock holes (Gifford 1940:83). Barbed points were also used for fishing (Ma-

son 1894).

The ethnographic literature of the Southwest, Great Basin, and parts of California consistently describes the use of pointed foreshafts without stone points for hunting small game and birds (Ellis 1997: Tables 1 through 5). Wooden points were also occasionally used to hunt large game and in warfare (Table 5).

Driver and Massey (1957) note that wooden points would not stick in trees when misfired or break as easily as stone points and didn't need to be re-sharpened as frequently. Consequently, wooden arrow points have a longer use-life, require less investment, and are more reliable, but they also do not penetrate as deeply as stone points (Loendorf et al. 2015b:Table 3).

On the other hand, stone points are heavier and will sink in water when used for hunting waterfowl, small aquatic mammals, or fish (Ellis 1997:50). Pope (1923:369) stated that sharpened wooden arrow points

are effective for piercing the abdomen or chest of small mammals such as fox, rabbit, and squirrel. In addition, Ellis (1997:94) argues that small game can be more easily stunned and captured with wooden arrow points than larger game. Thus, the hunter would not damage their skin so it can be sewn into bags or used for other purposes. Both stone-tipped points and sharp wooden points "too easily penetrate small game completely such that the game could run away," but blunt wooden points limit penetration (Ellis 1997:51).

Archaeological sites in which reed arrows have been found often contain pointed foreshafts that apparently were used as wooden points. It has long been known that some foreshafts of arrows were commonly not tipped with stone points, but were "merely sharpened" (Mason et al. 1891:62). Nordenskiöld (1893:101) recognized that some of the foreshafts at Mesa Grande were not designed to hold stone points, but were sharp-



Figure 15. Foreshaft tip shapes. (A) Broken notched end for a stone projectile point from unknown provenience (VVAC 1155), painted red. **(B)** Rounded tip serving as a wooden point from Cist 5I (VVAC 2190). **(C)** Split foreshaft used as wooden point with foreshaft painted red including on portion of split area, from Cist 5I; sinew is missing from shaft where foreshaft is inserted (VVAC 1025). **(D)** Wooden foreshaft with barbed tip from "Kiva" E15 (VVAC 1197).

ened and used “when a smaller animal was the quarry.” Hough (1914:66) found a number of foreshafts that were not notched for stone points in the Upper Gila region, and he commented that, “[i]n all respects, they are effective arrows, and they may have been used without the points for hunting.” Kidder and Guernsey (1919:122) reported that the majority of wooden foreshafts they recovered from sites in northeastern Arizona were not notched for stone points.

The use of wooden foreshafts without stone points predates the use of the bow and arrow in the Great Basin and Southwest. Dart foreshafts, thrown with atlatls, from Gypsum Cave in Southern Nevada included those which were intended to be used without stone points (Harrington 1933:102, 104). Caves in the Great Salt Lake area of Utah contained foreshafts that “merely taper to a rather blunt point and do not have a stone tip” (Steward 1937:12), and Jennings (1957:183) reported on a wooden dart point in Danger Cave, Utah. In a comparison of Great Basin and Southwestern prehistoric darts and arrows, Aikens (1970:160) commented that “the use of foreshafts without stone points is a widespread trait” for both atlatl darts and bow arrows.

Reed arrows recovered from Aztec West Pueblo in New Mexico had wooden foreshafts that tapered to an abrupt point and apparently were “used without a stone point” (Morris 1919:59). Pointed foreshafts without stone points were found at Pueblo Bonito and Pepper (1920:161) argued they “were not intended to hold a stone point.” Judd (1954:252) stated that “Wooden arrowheads were widely used throughout the ancient Pueblo territory and no doubt were present at Pueblo Bonito in larger numbers than our data indicate.” Among a hidden cache of 94 bows and 4,000 arrows found in the Mogollon Mountains in New Mexico, only 4 foreshafts were notched for stone points and all others were interpreted as wooden points (Hibben 1938:38). Describing the foreshafts found in the Canyon Creek Ruin of central Arizona, Haury (1934:107) stated that “...some, if not most, of the foreshafts were never fitted with chipped stone points, the sharpened end serving as a point.” Many of the arrow foreshafts from Tularosa and Cordova Caves in New Mexico had broken and then were resharpened to be used without stone points (Grange 1952:341, 388). A foreshaft in a reed arrow from Jemez Cave in New Mexico was apparently used without a stone point (Alexander and Reiter 1935:47).

The majority of foreshafts found in the upper and lower ruins of Tonto National Monument were designed to be used without stone points (Pierson 1962; Steen 1962). They were interpreted as weapons used for hunting small game (Bohrer 1962). Among the many offerings associated with the Sinagua Magician’s Burial in northern Arizona was an arrow foreshaft with its end bluntly pointed (McGregor 1943:288; Kamp et al. 2016). Judd (1930:10) reported on a foreshaft from Betatakin in northern Arizona that was tapered on one end and

pointed on the other.

Excavations at Antelope House in Canyon De Chelly National Monument recovered 15 bows and 200 reed arrows, and all but one of the 100+ foreshafts were not designed to hold stone arrow points, but instead tapered to a blunt or flattened point (Magers 1986). Nearly one-third of these wooden points were splintered from use. Don Morris (1986:161) argued the wooden points “would appear to be an efficient penetrator” and may have been used for hunting large game as well as small game.

Wooden arrow points were also used against humans in some cases. In California, arrows without stone-tips were sometimes used in warfare “because the object was not to kill an opponent but to show one’s bravery or, alternatively, to demoralize one’s enemy” (Ellis 1997:47). Wooden projectile points could also be lethal for humans (Bourke 1891). A skeleton in the Winnemucca Lake area of central Nevada had a wooden projectile point embedded in its hip, which may have been the cause of that individual’s death (Hattori 1982:120). Chiricahua Apache sometimes used wooden projectile points in war (Opler 1965). At Oraibi on the Hopi Mesas, reed arrows with wooden points were left in a shrine as offerings to the war gods (Parsons 1939; Voth 1912).

There are no obvious indications that the Dyck wooden projectile points had been smeared with poisons. Ethnographic accounts record the application of various poisonous concoctions to stone arrow points, including rattlesnake venom (Ellis 1997:55; Jones 2007). The Cocopa poisoned their sharpened wooden arrow points with a bush that grew in salt flats, which was reported to kill a person in 1-2 hours if the arrow had penetrated well (Kelly 1977:52). The Walapai sometimes added a poison made from scorpions or ants ground with a stinging bush boiled in deer blood (Mekeel 1935:94). Apache arrow tips were occasionally poisoned with the blood of an animal and “prickly plants,” with the mixture allowed to spoil before being applied to the arrow tip (Opler 1965:319). However, the effectiveness of adding poison probably had its limitations:

...these were certainly not fast-acting poisons that immediately took effect and their usefulness in hunting by reducing the tracking time of wounded prey was quite limited. Thus, it is perhaps not surprising that they were used on stone points because they still had to rely heavily on the damage the point did to the animal or human in order to be really effective (Ellis 1997:56).

DYCK ARROW DISCOVERY CONTEXTS

The majority of the arrows (68.9%) and foreshafts (69.7%) recovered from the Dyck cliff dwelling were found in a large bedrock niche (Cist 5I) with plas-

tered walls and floor and served as a storage feature behind Room 4 (see Figure 2). This storage room had been sealed with a cobble and mortar wall while the cliff dwelling was still in use, and it was full of debris more than 50 cm in height that included a number of ritual objects. A radiocarbon date of AD 1210 (Cal AD 1155 to 1255 at 2 sigma) was obtained from a prickly pear (*Opuntia* sp.) seed from a well-preserved fruit found inside the sealed cist. Interestingly, all of the wooden bows with provenience information (7 of 8) also were recovered from the upper 30.4cm (12 inches) of deposits within Cist 5I. The two complete but damaged arrows (VVAC 1025 and 4481) were also recovered from this storage feature, both from deposits between 30.4-61cm (18-24 inches) below the surface.

The vast majority of the painted arrow shafts with known proveniences (83.3%) were found in this storage room adjacent to Room 4. In addition, one was recovered from Room 1, one from in front of Room 3, one from Room 4, and two from the "Kiva" chamber (Figure 2 and Table 3). Cushing (1895:311) argued that arrows were imbued with magic, and Parsons (1939:546, 633, 646, 841) documented numerous examples of the use of arrows in Pueblo ceremonies, including arrow swallowing by the Zuni War Society. Mason et al (1891:73) noted that arrows that had been fired were considered special and often became talismans that were kept by their owners. Perhaps the damaged Dyck arrows were considered dangerous and were placed in permanent storage in the back of the cliff dwelling where they would not be handled by anyone, essentially "ritually retired" with other ceremonial objects (Walker 1995, 1999).

The 74 arrow shafts recovered from the Dyck cliff dwelling likely represent an unknown portion of the arrows that were owned by the site's inhabitants, whom we assume took their still useable arrows with them when they abandoned the cliff dwelling. Archaeological and ethnographic data indicates that the number of arrows per quiver varies. For the Southern Paiute, each man's quivers contained 5 to 10 arrows (Kelly 1964: 161). In contrast, Apache quivers could hold up to 30 or more arrows (Opler 1965:388) and Havasupai quivers held between 20 and 30 arrows (Spier 1928:15). The quiver with a Hohokam burial in Ventana Cave contained nine reed arrows (Haury 1950:418), and a burial accompaniment in the Lower Ruin of Tonto National Monument cliff dwelling contained 25 complete and partial reed arrows tied in a bundle (Pierson 1962:58). Two quivers from a burial in Hidden Cave in the Verde Valley contained 12 finished arrows in one quiver and 10 unfinished arrows in the other; one self-bow and an unfinished bow were also present (Dixon 1956:47). As previously stated, four complete self-bows were found in the Dyck cliff dwelling. If each bow was owned by one individual, the 74 arrows divided by 4 equals 18.5 arrows

per quiver.

SUMMARY AND CONCLUSION

This analysis of the Dyck Rockshelter arrows reveals that the compound arrow using a reed shaft was an important component of the Sinagua hunting equipment and that sharpened or rounded foreshafts attached to reed shafts were used without stone tips. A few broken wooden foreshafts originally used with stone projectile points appear to have been reused as wooden points. The characteristics of the Dyck arrows show similarities with many other arrows found at sites throughout the Southwest and with various ethnographic groups, indicating there was a wide-spread perception that persisted over many centuries of how to make an efficient missile shot with a bow. A relatively narrow range of diameters was selected for use as arrow shafts, probably related to weapon aerodynamics and many other factors including stiffness or spine. More than one-third (43.2%) of the Dyck reed arrow shafts are painted, but no two designs were alike, so it is unclear if they were decorated for personal or group identification. The poor condition of most of the foreshafts also makes it hard to evaluate if the decorations were designed to assist a hunter or warrior with the quick selection of arrows with different kinds of tips from a quiver. What is clear, however, is that some of the Sinagua arrow makers at the Dyck cliff dwelling took great care in the decoration of their arrows, and the majority of those damaged arrows, along with at least 7 of the 8 bows and the bow stave found at the site, were intentionally sealed inside a storage unit in the back of the cliff dwelling, perhaps as an offering or to ritually retire them.

Notes

1. A small bow 44 cm in length with an agave fiber cord tied to both ends was found at the Lower Ruin of Tonto National Monument that Bohrer (1962:88, Plate 3) identified as a ceremonial item. She noted that similar bows are given by masked clowns to Zuni boys during the autumn corn dances (Cushing 1920:605). A miniature bow 40 cm in length with a yucca cord was also found at Canyon Creek cliff dwelling (Haury 1934:106, Figure 22).

2. A self-bow is a bow made from a single material and is different than a recurved bow, with the latter having its tips bent forward, away from the shooter, when it is unstrung. All the larger Dyck bows have oval or semi-oval cross sections and are thickest where their handles are located. LeBlanc (1997) has argued that self-bows are not as effective as recurved bows, but that recurved bows were not introduced into the Southwest until the late AD 1200s (LeBlanc 1999:103), which may explain why the Dyck bows are all self-bows. LeBlanc (1999:99) suggests that self-bows in the Southwest "were not particularly long and were probably quite weak." He also states that self-bows are "close to being perfectly

straight before being strung" (Le Blanc 1999:99), but all four of the Dyck self-bows have their tips curved inward toward the shooter (see Figure 3). One of the Dyck bows (VVAC 0763) is very sturdy and is highly polished, indicating it is well used; this bow appears to be fully functional and may have been ritually retired after its owner died.

3. Justin Parks is analyzing the Dyck bows as part of his MA thesis at Northern Arizona University. He identified the bow stave in the process of being manufactured. It is 95.1 cm in length.

4. A burial at Hidden House in the Verde Valley contained a self-bow 129.5 cm in length with two notches at each end (Dixon 1956:46). This bow had sinew string still attached. Also present among the burial offerings was an unfinished bow stave 147 cm in length.

5. Kelley Hays-Gilpin has identified this bow as a ceremonial bow.

6. A straight, processed wooden stick from Cist 51 also may have been selected for an arrow shaft. It is 0.69 to 0.78 cm in diameter and 71.1 cm in length.

7. The longer O'Odham arrows may be related to the fact that O'Odham bows are greater in length than the Dyck bows. Russell (1908: 95 footnotes a, b) measured two O'Odham bows at 1.35 m and 1.365 m in length., compared to the largest Dyck bow at 1.04 m in length.

8. It is unknown how much the current colors represent the original colors when painted by the arrow makers. The red color painted on the Dyck arrow shafts according to the Munsell color chart currently varies from 7.5YR 3/6 to 5GY 6/2. The brown color is 2.5YR 2/4, the yellow color is 10YR 5/8, and the blue color is 10BG 6/4.

9. The red colored sinew is 7.5YR 3/6 and the light green colored sinew is 2.5GY 6/2.

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REFERENCES CITED

- Aikens, C. Melvin
1970 *Hogup Cave*. University of Utah Anthropological Papers 93, Salt Lake City.
- Alexander, H.G., and P. Reiter
1935 *Report on the Excavation of Jemez Cave, New Mexico*. Monographs of the School of American Research, Santa Fe.
- Bartlett, Katharine
1934 *The Material Culture of Pueblo II in the San Francisco Mountains, Arizona*. Museum of Northern Arizona Bulletin 7, Flagstaff.
- Bennett, Wendell C., and Robert M. Zingg
1935 *The Tarahumara, An Indian Tribe of Northern Mexico*. University of Chicago Press, Chicago.
- Benson, Lyman, and Robert A. Darrow
1981 *Trees and Shrubs of the Southwestern Deserts*. University of Arizona Press, Tucson.
- Blitz, John H.
1988 Adoption of the Bow in Prehistoric North America. *North American Archaeologist* 9:123-145.
- Bohrer, Vorsila L.
1962 Ethnobotanical Materials from Tonto National Monument. In *Archaeological Studies at Tonto National Monument, Arizona*, edited by Louis R. Caywood, pp. 75-114. Southwestern Monuments Association Technical Series 2, Gila Pueblo, Globe.
- Bourke, John G.
1890 Vesper Hours of the Stone Age. *American Anthropologist*, Old Series 3:55-63.
- 1891 Arrows and Arrow-Makers: Remarks. In *The American Naturalist*. The Anthropological Society of Washington. Volume IV:71-74. Judd and Detweiler, Washington DC.
- 1892 *Medicine Men of the Apache*. Ninth Annual Report of the Bureau of American Ethnology, Washington, D.C.
- Brown, James A.
1954 Wooden Artifacts. In *Caves of the Reserve Area*, by Paul S. Martin, J.B. Rinaldo, E. A. Bluhm, H.C. Culter, and Roger Grange, Jr., pp. 181-211. Fieldiana: Anthropology 42, Chicago.
- Castetter, Edward F., and Ruth Underhill
1935 *The Ethnobiology of the Papago Indians*. University of New Mexico Bulletin 275, Biological Series 4(3), Albuquerque.
- Cosgrove, Cornelius B.
1947 *Caves of the Upper Gila and Hueco Areas*. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University 24 (2), Cambridge.
- Corbusier, William F.
1886 The Apache Yuma and Apache-Mohave. *American Antiquarian* 8(6):325-329.
- Cushing, Frank Hamilton
1895 The Arrow. *American Anthropologist* 8(4):307-349.
- 1920 *Zuni Breadstuffs*. Museum of the American Indian, Indian Notes and Monographs No. 8.
- DiPeso, Charles C. John B. Rinaldo, and Gloria J. Fenner
1974 *Casa Grandes: A Fallen Trading Center of the Gran Chichimeca, Vol. 8: Bones, Perishables, Commerce, Subsistence, and Burials*. Amerind Museum, Dragoon, and Northland Press, Flagstaff.
- Dixon, Keith A.
1956 *Hidden House: A Cliff Dwelling in Sycamore Canyon, Central Arizona*. Museum of Northern Arizona Bulletin 29, Flagstaff.
- Driver, Harold W., and William C. Massey
1957 *Comparative Studies of North American Indians*. American Philosophical Society, Philadelphia.
- Drucker, Phillip
1941 Culture Element Distribution XVII: Yuman-Piman. *University of California Anthropological Records*

- 6(3):91-230, Berkeley.
- Ellis, Christopher J.
1997 Factors Influencing the Use of Stone Projectile Tips: An Ethnographic Perspective. In *Projectile Technology*, edited by Heidi Knecht, pp. 37-74. Plenum Press, New York.
- Ellis, Florence Hawley, and Larry Hammack
1968 The Inner Sanctum of Feather Cave, A Mogollon Sun and Earth Shrine Linking Mexico and the Southwest. *American Antiquity* 33(1): 25-44.
- Ferdon, Edwin N., Jr.
1946 *An Excavation of Hermit's Cave, New Mexico*. Monographs of the School of American Research 10, Santa Fe.
- Fulton, William S.
1941 *A Ceremonial Cave in the Winchester Mountains, Arizona*. Amerind Foundation No. 2, Dagoon.
- Gifford, E. W.
1932 The Southeastern Yavapai. *University of California Publications in American Archaeology and Ethnology* 29(3):177-252, Berkeley.
1933 The Cocopa. *University of California Publication in American Archaeology and Ethnology* 31(5):257-334, Berkeley.
1936 The Northeastern and Western Yavapai. *University of California Publications in American Archaeology and Ethnology* 34(4), Berkeley.
1940 Culture Element Distribution XII: Apache-Pueblo. *University of California Anthropological Records* 4(1):1-207, Berkeley.
- Gifford, James C.
1980 Archaeological Explorations in Caves of the Point of Pines Region, Arizona. *Anthropological Papers of the University of Arizona* 36. University of Arizona Press, Tucson.
- Grange, Roger, Jr.
1952 Wooden Artifacts. In *Mogollon Cultural Continuity and Change: The Stratigraphic Analysis of Tularosa and Cordova Caves*, by Paul S. Martin, J. B. Rinaldo, and E. A. Bluhm, pp. 331-451. Fieldiana: Anthropology 40, Chicago.
- Hamilton, T.M.
1972 *Native American Bows*. George Shumway Publishers, New York.
- Hamm, Jim
1991 *Bows and Arrows of the Native Americans: A Complete Step-by-Step Guide to Wooden Bows, Sinew-Backed Bows, Composite Bows, Strings, Arrows, and Quivers*. Lyons and Burford, New York.
- Harrington, Mark R.
1933 *Gypsum Cave, Nevada*. Southwest Museum Papers 8, Los Angeles.
- Hattori, Eugene
1982 *The Archaeology of Falcon Hill, Winnemucca Lake, Washoe County, Nevada*. Nevada State Museum Anthropological Papers 18, Carson City.
- Haury, Emil W.
1934 *The Canyon Creek Ruin and the Cliff Dwellings of the Sierra Ancha*. Medallion Papers No. 14, Gila Pueblo, Globe.
1945a *Painted Cave, Northeastern Arizona*. Papers of the Amerind Foundation 3, Dagoon.
1945b *The Excavation of Los Muertos and Neighboring Ruins in the Salt River Valley, Southern Arizona*. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University 24(1), Cambridge.
- 1950 *The Stratigraphy and Archaeology of Ventana Cave, Arizona*. University of Arizona Press, Tucson.
- Hibben, Frank C.
1938 A Cache of Wooden Bows from the Mogollon Mountains. *American Antiquity* 4(1):36-38.
- Holly, Lance E.
2010 *Beyond the Point: Arrow Shaft Technology of the Prehistoric Southwest*. Unpublished MA thesis, University of Colorado at Boulder.
- Hough, Walter
1914 *Culture of the Ancient Pueblos of the Upper Gila*. United States National Museum Bulletin 87, Washington, D.C.
- Jackson, Earl
1933 A Survey of the Verde Drainage. Unpublished MA thesis, Department of Anthropology, University of Arizona, Tucson.
- Jennings, Jesse D.
1957 *Danger Cave*. University of Utah Anthropological Papers 27, Salt Lake City.
- Jones, David E.
2007 *Poison Arrows: North American Indian Hunting and Warfare*. University of Texas Press, Austin.
- Jones, Volney H.
1931 The Ethnobotany of the Isleta Indians. Unpublished MA thesis, Department of Anthropology, University of New Mexico, Albuquerque.
- Judd, Neil M.
1930 *The Excavation and Repair of Betatakin*. United States National Museum Proceedings 77, Article 5, Washington, D.C.
1954 *The Material Culture of Pueblo Bonito*. Smithsonian Miscellaneous Collections 124, Washington, D.C.
- Kamp, Kathryn A., John C. Whittaker, and William D. Bryce
2016 The Magician of Ridge Ruin: Insights into Ceremony and Status from Arrow Points and Bows. *Lithic Technology*, DOI: 10.1080/01977261.2016.1252620.
- Kelly, Isabel
1964 *Southern Paiute Ethnography*. University of Utah Anthropological Papers 69, Glen Canyon Series 21, Salt Lake City.
- Kelly, William H.
1977 *Cocopa Ethnography*. University of Arizona Anthropological Papers 29, Tucson.
- Kidder, Alfred V., and Samuel J. Guernsey
1919 *Archaeological Explorations in Northeastern Arizona*. Bureau of American Ethnology Bulletin 65. Washington, D.C.
- Kluckholm, Clyde, W. Hill, and W. Kluckholm
1971 *Navaho Material Culture*. Belknap Press, Cambridge.
- Kroeber, Alfred L.
1922 Elements of Culture in Native California. *University of California Publications in American Archaeology and Ethnography* 13(8): 239-328. Berkeley.
- Kroeber, Alfred L. (editor)
1935 *Walapai Ethnography*. American Anthropological Association Memoir 42, Menasha, Wisc.
- LeBlanc, Steve A.
1997 Modeling Warfare in the Southwestern Prehistory. *North American Archaeologist* 18(3):235-276.
1999 *Prehistoric Warfare in the American Southwest*. Univer-

- sity of Utah Press, Salt Lake City.
- Lambert, Majorie, and Richard R. Ambler
1961 *A Survey and Excavation of Caves in Hidalgo County, New Mexico*. Monographs of the School of American Research 25, Santa Fe.
- Laubin, Reginald, and Gladys Laubin
1980 *American Indian Archery*. University of Oklahoma Press, Norman.
- Loendorf, Chris, Lynn Simon, Daniel Dybowski, M. Kyle Woodson, R. Scott Plumlee, Shari Tiedens, and Michael Withrow
2015a Warfare and Big Game Hunting: Flaked-stone Projectile Points along the Middle Gila River in Arizona. *Antiquity* 89 (346): 940–953.
- Loendorf, Chris, Theodore J. Oliver, Shari Tiedens, R. Scott Plumlee, M. Kyle Woodson, and Lynn Simon
2015b Flaked-stone Projectile Point Serration: A Controlled Experimental Study of Blade Margin Design. *Journal of Archaeological Science: Reports* 3: 437–443.
- Lumholtz, Carl
1902 *Unknown Mexico*. Charles Scribner's Sons, New York.
- Magers, Pamela C.
1986 Miscellaneous Wooden and Vegetal Artifacts. In *Archaeological Investigations at Antelope House*, by Don P. Morris, pp. 277–305. National Park Service, Washington, D.C.
- Mason, Otis T.
1894 North American Bows, Arrows, and Quivers. *Smithsonian Institution Annual Report for 1893*, pp. 631–679, Washington, D.C.
- Mason, Otis T., W. H. Holmes, Thomas Wilson, Walter Hough, Weston Flint, W. J. Hoffman, and John G. Bourke
1891 Arrows and Arrow-Makers. *American Anthropologist* 4(1): 45–74.
- Matthews, Washington
1886 Navajo Names for Plants. *American Naturalist* 20(9).
- McGregor, John C.
1943 Burial of an Early American Magician. *American Philosophical Society Proceedings* 86(2):270–298, Philadelphia.
- McGee, W. J.
1898 *The Seri Indians*. Annual Report of the Bureau of American Ethnology for 1895–96, Vol. 17 (1), Washington, D.C.
- Mekeel, H. Scudder
1935 Weapons. In *Walapai Ethnography*, edited by A.L. Kroeber, pp. 92–96. Memoirs of the American Anthropological Association 42, Menasha, Wisc.
- Mera, Harry P.
1938 *Reconnaissance and Excavation in Southeastern New Mexico*. Memoirs of the American Anthropological Association No. 51, Menasha, Wisc.
- Morris, Don P.
1986 The Nonavian Faunal Remains. In *Archaeological Investigations at Antelope House*, by Don P. Morris, pp. 159–164. National Park Service, Washington, D.C.
- Morris, Earl H.
1919 *The Aztec Ruin*. American Museum of Natural History Anthropological Papers 26, Part 1, New York.
1928 An Aboriginal Salt Mine at Camp Verde, Arizona. *American Museum of Natural History Anthropological Papers* 30, Part 3:75–97, New York.
- Morss, Noel
1931 *The Ancient Culture of the Fremont River in Utah*. Papers of the Peabody Museum of American Archaeology and Ethnology 12(3), Harvard University, Cambridge.
- Nordenskiöld, Gustav E. A.
1893 *The Cliff Dwellers of the Mesa Verde, Southwestern Colorado: Their Pottery and Implements*. Translated by D. Lloyd Morgan. P. A. Norstedt and Söner, Stockholm.
- Opler, Morris E.
1965 *An Apache Life-Way: The Economic, Social and Religious Institutions of the Chiricahua Indians*. University of Chicago Press, Chicago. Originally published in 1941.
- Parsons, Elsie Clews
1939 *Pueblo Indian Religion*. University of Chicago Press, Chicago.
- Pepper, George H.
1920 *Pueblo Bonito*. American Museum of Natural History Anthropological Papers 27, New York.
- Pierson, Lloyd M.
1962 Excavations at the Lower Ruin, Tonto National Monument. In *Archaeological Studies at Tonto National Monument, Arizona*, edited by Louis R. Caywood, pp. 33–68. Southwestern Monuments Association Technical Series 2, Gila Pueblo, Globe.
- Pilles, Peter J., Jr.
1981 The Southern Sinagua. *Plateau* 53(1):6–17. Museum of Northern Arizona, Flagstaff.
- Plog, Stephen
2003 Exploring the Ubiquitous through the Unusual: Color Symbolism in Pueblo Black-on-White Pottery. *American Antiquity* 68(4):665–695.
- Pope, Saxton P.
1918 *Yahi Archery*. University of California Publications in Archaeology and Ethnology 13(3). Berkeley.
1923 *A Study of Bows and Arrows*. University of California Publications in Archaeology and Ethnology 13(9). Berkeley.
- Reed, Paul F., and Phil R. Geib
2013 Sedentism, Social Change, Warfare, and the Bow in the Ancient Pueblo Southwest. *Evolutionary Anthropology: Issues, News, and Reviews* 22(3): 103–110.
- Robbins, Wilfred W., John P. Harrington, and Barbara Freire-Marreco
1916 *The Ethnobotany of the Tewa Indians*. Bureau of American Ethnology Bulletin 55, Washington, D.C.
- Russell, Frank
1908 The Pima Indians. *Annual Report of the Bureau of American Ethnology for 1904–1905*, 27(2–289), Washington, D.C.
- Smith, Watson
1952 Kiva Mural Decorations at Awatovi and Kawaika-a. *Papers of the Peabody Museum of American Archaeology and Ethnology* 37. Harvard University, Cambridge.
- Spier, Leslie
1928 Havasupai Ethnography. *Anthropological Papers of the American Museum of Natural History* 29(3):83–408. New York.
1933 *Yuman Tribes of the Gila River*. University of Chi-

cago Press, Chicago.

Steen, Charlie R.

1962 Excavations at the Upper Ruin, Tonto National Monument. In *Archaeological Studies at Tonto National Monument, Arizona*, edited by Louis R. Caywood, pp. 1-32. Southwestern Monuments Association Technical Series 2, Gila Pueblo, Globe.

Stephen, Alexander M.

1936 *Hopi Journal of Alexander M. Stephen*, edited by Ellie C. Parsons. Columbia University Press, New York.

Steward, Julian H.

1937 *Ancient Caves of the Great Salt Lake Region*. Bureau of American Ethnology Bulletin 116, Washington, D.C.

Thomas, David Hurst

1978 Arrowheads and Atlatl Darts: How the Stones Got the Shaft. *American Antiquity* 43:461-472.

Voth, H.R.

1912 *Brief Miscellaneous Hopi Papers*. Field Museum of Natural History Publication 157, Anthropology Series 11(2), Chicago.

Walker, William H.

1995 Ceremonial Trash? In *Expanding Archaeology*, edited by J. M. Skibo, William H. Walker, and A. E. Nielson, pp. 67-79. University of Utah Press, Salt Lake City.

1999 Ritual Life Histories and the Afterlives of People and Things. *Journal of the Southwest* 41(3).

Wasley, William W.

1962 A Ceremonial Cave on Bonita Creek, Arizona. *American Antiquity* 27 (3):380-394.

Whiting, Alfred F.

1939 *Ethnobotany of the Hopi*. Museum of Northern Arizona, Flagstaff.

Zingg, R. M.

1940 *Report on Archaeology of Southern Chihuahua*. University of Denver Contributions 3, Center of Latin American Studies 1, Denver.

PROTOHISTORIC PROJECTILE POINTS AND OTHER DIAGNOSTICS: A PAN-REGIONAL SOUTHERN SOUTHWESTERN PERSPECTIVE

Deni J. Seymour

ABSTRACT

Advances made over the last couple of decades in understanding the period commonly designated as protohistoric in the southernmost Southwest include insights relating to projectile points. Arizona's small arrow points attributable to the many local culture groups (Sobaipuri and other O'odham, Chiricahua and Mescalero Apache, and the Jano, Jocomé, Manso, and Suma) are found throughout a much broader area, which raises issues regarding cultural affiliation and diagnosticity, ways of measuring and classifying, and routine ways of constructing cultural and material culture boundaries. Many processes contribute to the complex distribution of points that form and inordinately affect the archaeological record of this period, not least of which is the expansive and overlapping territories of these groups. This article presents a programmatic statement intended to offer new directions and research possibilities.

Substantial advances have been made over the last couple of decades in understanding the so-called Protohistoric period in the southernmost Southwest.¹ New insights are available for the Sobaipuri O'odham, ancestral Chiricahua Apache, and the Jocomé and Jano—all groups (among others) who are known from historic documents to have occupied southern Arizona (Seymour 2004, 2009, 2011a, 2012a, 2013, 2014, 2016, 2017a). An abundance of new data allows new directions for research not even conceived a few decades ago. Projectile points are among the topics studied and, importantly, the small arrow points recognized in southern Arizona for many of these culture groups are found throughout a much broader area, raising issues regarding cultural affiliation and diagnosticity, ways of measuring and classifying, and customary ways of perceiving cultural and material culture boundaries. Deeper understandings have also arisen by recognizing the processes that result in the distribution of points found in the archaeological record. It has become abundantly clear that the conceptual frameworks needed—and now successful-

ly being used—to study the Protohistoric in this region differ substantially from the way prehistoric farming groups are studied (Seymour 2002, 2008, 2010, 2012a, 2017b, 2017c). Our basic assumptions continue to be reexamined as more applicable theory is developed, as long-held notions are challenged, and as new data are obtained. Fresh methodologies address the especially unobtrusive character of these period assemblages, that often include projectile points, and that more often than not are comingled with other components.

Advancement of knowledge regarding Arizona's Protohistoric period has until recently been inhibited by any number of flawed logical constructs and their underlying faulty assumptions that result to a large degree from a lack of basic and sufficient data. For example, for some time assignment of the small triangular indented base points specifically to Protohistoric groups was questioned because they were also found in prehistoric contexts (Ravesloot and Whittlesey 1987). This presented an impasse that stalled progress for a number of years, because newly identified finds could not be interpreted. The gaping occupational chasm perceived between the Late Prehistoric and Protohistoric periods meant that these points thought to be diagnostic of later-occurring groups could no longer be temporally restricted to them (such as the Sobaipuri O'odham, then widely thought to have arrived in the A.D. 1600s). This obstacle was only removed as chronometric dates became available which demonstrated that many of the groups that made these points, including the farming and ceramic-producing Sobaipuri O'odham, were contemporaneous with the Hohokam and other prehistoric farming and ceramic-producing groups. These dates and other data have shown that the Sobaipuri O'odham were present and thriving in the A.D. 1200s and 1300s, thereby explaining the early occurrence of these points (see Harlan and Seymour 2017; Seymour 2011a, 2011b, 2013, 2014, 2016, 2017a).

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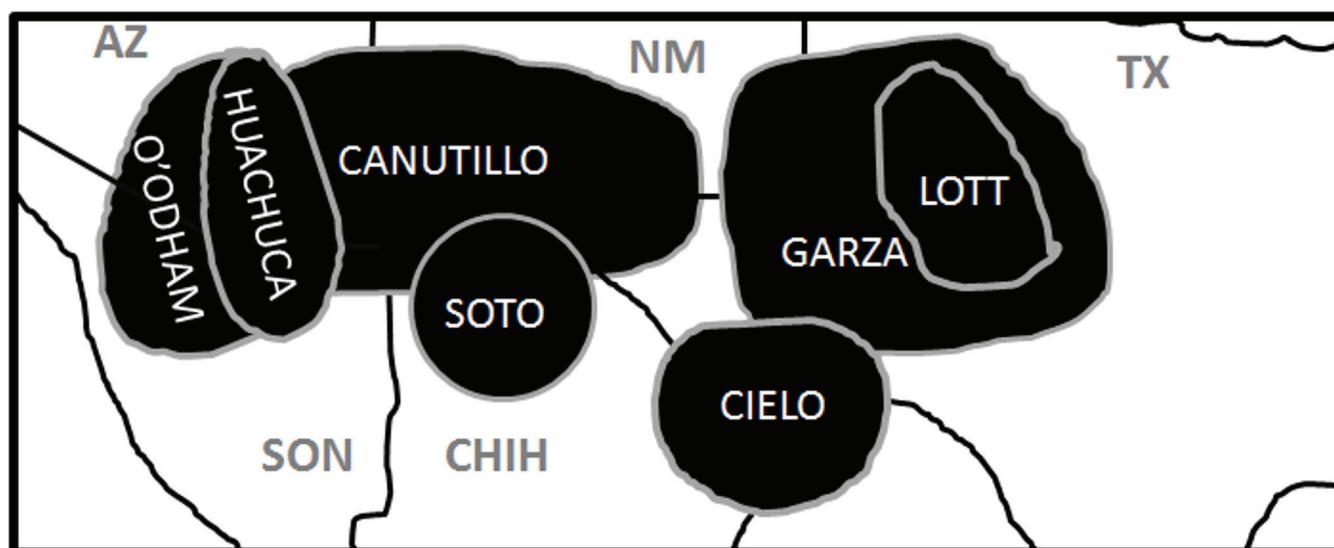


Figure 1. Culture Areas and Point Types. Small unnotched arrowheads recognized in southern Arizona are found throughout a much broader area and have been confused with those made by the Sobaipuri O'Odham.

The widespread distributions of similar looking points have presented another hurdle. In particular, the small arrow points that have long been considered representative of specific groups in southern Arizona, and expressly considered the single-most diagnostic Sobaipuri O'Odham lithic artifact (Masse 1981:39), are actually found throughout a much broader area (Figure 1). If specific point shapes are temporally and culturally diagnostic they should not occur over such a broad area because a premise for differentiating culture groups is their discrete spatial boundaries. At one level this similarity in-and-of itself is not news, for we all know that similar point types occur over broad areas (Jelks 1993; Justice 1987, 2002a, 2002b; Seymour 2002:358). In some of these instances *similar* is the operative word because many of these widely dispersed points are not actually all the same. Yet, if, as has been the practice, we assume that all these small triangular-indented base points are the same, then we must also address the issue that these similar looking points are found many hundreds of miles from the center of specific historically documented territories. For example, at this level of classification, the Huachuca point attributed to the Sobaipuri O'Odham occurs in the Mexican state of Chihuahua in the heartlands of Suma and Jano territories, just as similar-looking bifacial knives and lanceheads occur as far east as Coahuila and in association with a different point type where the Concho, Chiso, Jumano, and others were historically documented.

Broad comparisons indicate that groups thought by the Spaniards to be distinct and whose material culture record and geographic heartlands were different, made points of the same general form as the Sobaipuri O'Odham. Thus, these points from Arizona appear in some cases to be *similar* to those of the other groups, but are not the same, because they were made locally by

the Sobaipuri O'Odham. On the other hand, others are actually the same as those occurring in Coahuila and Chihuahua because (a) people who called those distant places home came to Arizona and (b) points made by those people found their way west via other means. Variations in seemingly minor morphological attributes are helpful in distinguishing subsets of points made in specific geographic areas—areas that in many instances correspond to ethnohistorically described peoples who practiced significantly different lifeways and spoke different languages. It's these distinctions we want to capture if we care to address issues of ethnicity, temporal and geographic variation, and similar problems. In not recognizing these minor distinctions as significant, many point types—such as Canutillo, Soto, and Garza—have been confused with Huachuca points (typical of the Sobaipuri's Cayetano complex and other O'Odham/Pima; for example, Justice 2002a:262-264, Figure 31.21-29; Seymour 2011a, 2014). Yet, not every small, thin, narrow, triangular indented base point found in southern Arizona is Sobaipuri. This now-obsolete point type name (Sobaipuri) illustrates how in typological analysis it is procedurally inappropriate to allocate an ethnic name to any aspect of material culture because assigning ethnicity is a different inferential step than identification of a distinct artifact type (Seymour 2002, 2011a:76-77). In this case, points formerly known as Sobaipuri are inferred to represent a number of distinct mobile groups, while only a subset (Huachuca) were made by the Sobaipuri.² Other points of similar form were made by other O'Odham ethnic groups. These distinctions among the O'Odham require further study, while at the same time it is important to recognize that archaeological and ethnohistoric evidence of non-O'Odham groups from the east (e.g., Canutillo complex; see Seymour 2009, 2016) have been recorded at least as far west as Ventana Cave on the Tohono O'Odham Nation.³

This current article represents a programmatic statement designed to set forth some of the issues and approaches that are important in addressing the topic of Protohistoric projectile point variability and in providing comparative data and references for further research. The compilation of historical and ethnographic data on how projectile points are actually made, used, and deposited on archaeological sites is used to suggest future research possibilities. The identification and evaluation of projectile point types and lithic complexes provides a much needed broader context in which to suggest future research directions.

GEOGRAPHIC BREADTH AND STYLISTIC DIVERSITY

In light of the above mentioned issues, it is useful to illustrate the geographic breadth and typological diversity of small triangular indented base points from this period, along with associated tools that I consider equally culturally and temporally diagnostic.⁴ I suggest that while there are broad similarities in point shape throughout the Southwest and beyond, distinctions are being proffered that have implications for the identity of the makers and are relevant with respect to the ways in which we analyze them. Some of the distinct traditions recognized throughout the Southwestern US, Southern Plains, West Texas, and northwest Mexico demonstrate that many of the attributes of points, associated stone tools, and technological trajectories thought to be unique to the Sobaipuri represent a much larger phenomenon, and, by seeing it as such, we can begin to parse the distinctions (Figures 2 through 8).

These illustrations reveal the often subtle nature and fine distinctions that differentiate these point types, which in turn require a refined set of attribute analyses. Rather than deciding in advance which attributes are relevant (as is customary in point analysis), I hope to demonstrate the value of allowing the point assemblages themselves to divulge which attributes are pertinent in conveying differences that may be indicative of identity or cultural affiliation.⁵ By focusing attention on several of these non-customary traits of point morphology it is possible to systematically distinguish points from widely dispersed geographic locations and to quantify these distinctions.

Three general classes of projectile points occur in the Late Prehistoric-Early Historic periods in the Greater Southwest.⁶ These three classes relate specifically to hafting techniques that result in distinctive bases, which in turn tend to be used for point classification. These include: (a) *side notched* (Desert Side-notched and related forms, attributable to Apachean groups in the southern Southwest during the Terminal Prehistoric and Historic periods [Cerro Rojo in southern New Mexico and southern Arizona]), (b) *barbed shoulders with a contracted stem* (Perdiz) in southern Texas and northern Mexico

(see Mallouf 1987 for descriptions and variations), and (c) *small triangular indented or flat base*, as occur throughout the southern Southwest (Justice 2002a; Loendorf 2014; Seymour 2002).

The following discussion will focus only on the latter class. There is a continuum of small triangular-indented or flat base points throughout a vast area. As Harlan (2017:121) notes the “underlying variation in the data set as a whole is continuous. It does not, however, indicate that partitions do not exist in the data set, just that other methods may be needed to search for them.” Importantly, in many instances points co-occur with distinctive scraper, perforator, and biface types. The tool forms, like the points, represent much more complex associations than simple trait lists might imply. It is therefore useful to consider the potential diagnostic value of these other artifact types, including the bifaces and other tools and the debris left behind from their manufacture and maintenance, along with their stylistic attributes and specific technological characteristics (see Figures 2 through 8).

Mixed Point Assemblages

In order to address the issue of identity and to associate points with historically referenced and archaeologically defined groups, we first must examine some of the processes that contribute to the interpretive complexity of archaeological point assemblages. Many of these processes are already known, but their relevance tends to be diminished and set aside because there is often no means other than the projectile points to expediently date a site or assign cultural affiliation. Yet, effective analytical strategies and typological schemes for explaining and understanding Protohistoric projectile points require that a number of these considerations are moved to the foreground. Among these is the recognition that most point assemblages are mixed as a result of a variety of processes, and include specimens from more than a single group.

While mixed point assemblages are not unique to the Protohistoric they present an especially difficult problem and weigh more heavily on interpretation than earlier when there are more substantial assemblages. The problem is underlain by acceptance of the fundamental principle just discussed that artifacts and other traits that cluster in geographic space and time can be used to distinguish groups (culture, ethnic, etc.). Boundaries may be permeable and changing, but, nonetheless, these material culture distinctions are fundamental to disciplinary practice. Yet, many of the people present during this era were mobile and as a result their behavior conformed to different rules than the culture groups customarily studied. The clearly demarcated culture area boundaries typical of sedentary farmers are simply not in evidence for the Protohistoric period, probably owing to small social groups, limited-scale learning networks, and a lack of cohesive overarching social or

political structure. Mobile groups used the landscape differently than settled farmers and therefore left a different type of material and spatial record. Although they were sedentary farmers, the Sobaipuri O'odham left a much lighter archaeological footprint than their Puebloan counterparts and, consequently, new conceptions are required to study and understand the Sobaipuri O'odham.

These factors raise the question as to whether such distinctions as are sought in the Protohistoric at the scale of ethnic or historically referenced groups can ever be

distinguished. The answer is probably not for many historically differentiated small mobile groups with similar adaptations in similar natural settings who occupied the same niche, especially if our modes of analysis remain static. Additionally, successful weaponry (such as new bow types, arrow characteristics, and projectile point technology) was probably rapidly adopted as neighbors gained advantages in life-or-death circumstances, creating widespread seemingly contemporaneous changes. Importantly, the type of distinctions that documentary and ethnographic sources provide are often at finer scales than

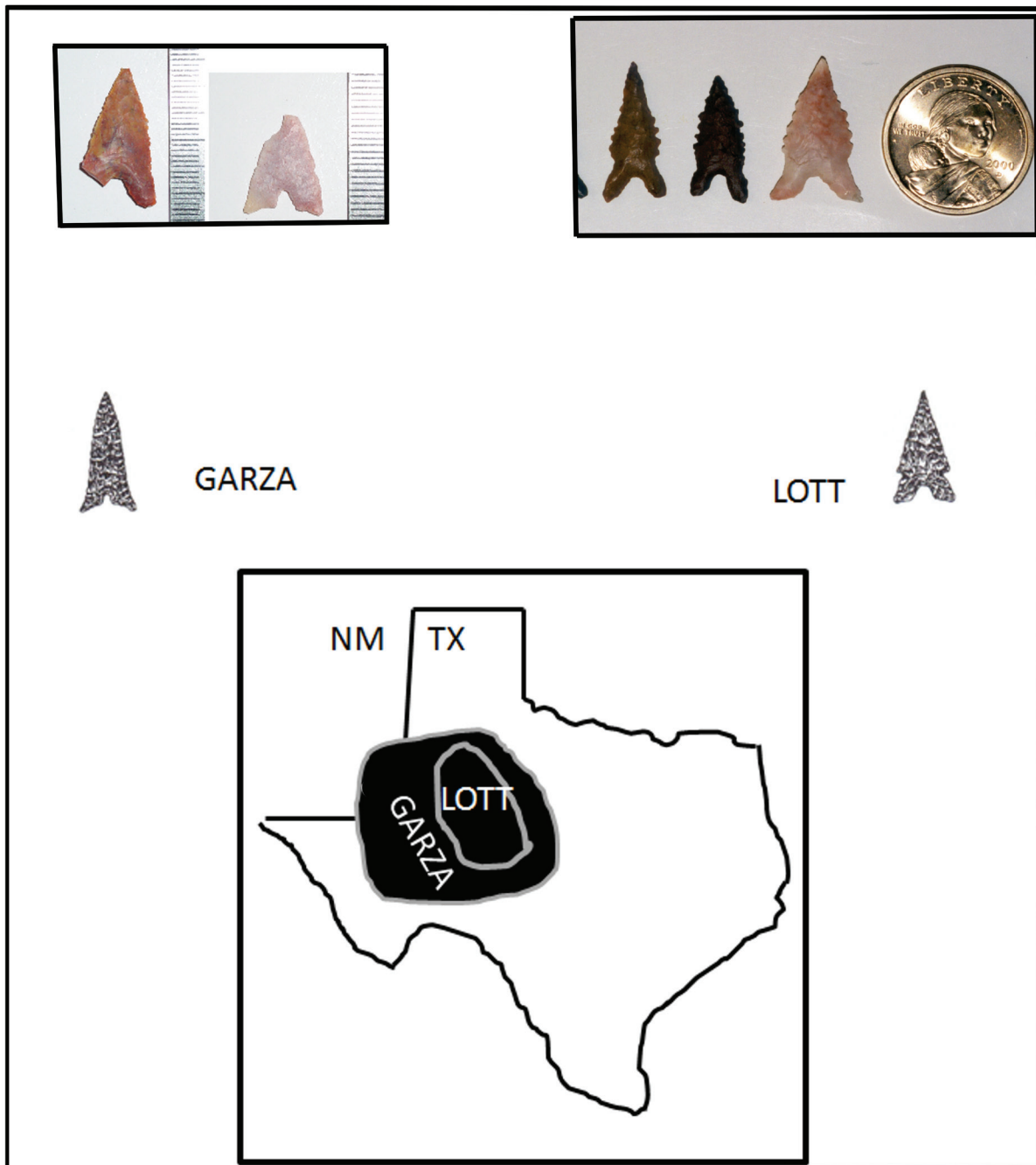


Figure 2. Garza and Lott. Images after Boyd 2001 and Runkles 1964. Garza is represented by bone, pecked and ground stone, formal drills, flake knives, unifacial side and end scrapers, choppers, and STIB points; A.D. 1000 to 1500. Its distribution overlaps that of Lott, which is much more poorly defined.

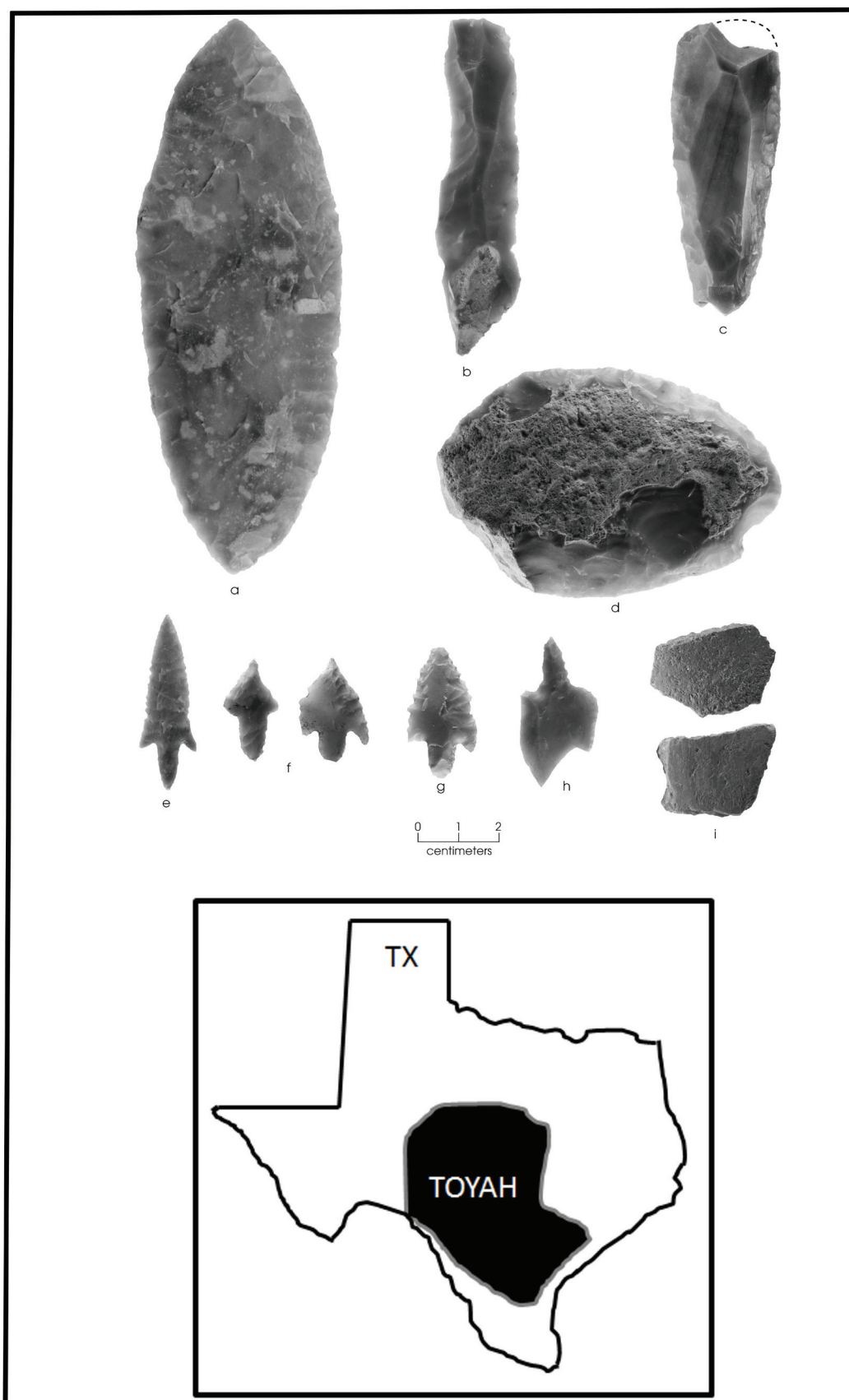


Figure 3. Toyah Assemblage. Beveled knives, blade, end scraper, side scrapers, Perdiz points, flake perforators, bone-tempered coiled plainware pottery; A.D. 1200/1300-1700. Images courtesy of Douglas Boyd and Nancy Kenmotsu (2012:Figure 1.8).

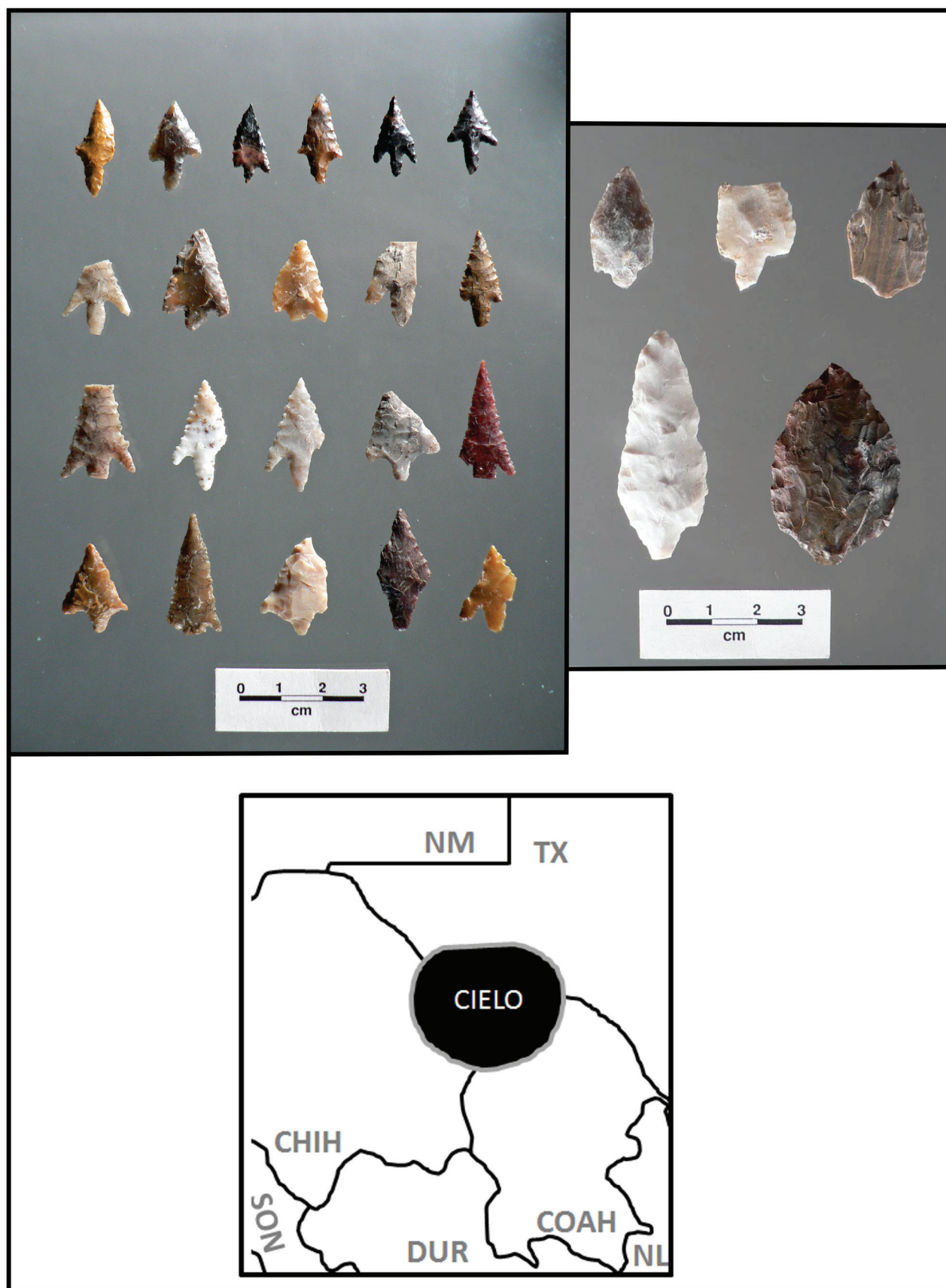


Figure 4. Cielo Complex. Perdiz points, flake drills, hide scrapers, beveled knives, expedient tools fashioned on both flakes and blades, oval pestles, manos, net sinkers, bone rasps, fragments of deer-ulna awls, small bone and stone beads, tiny turquoise beads, and Olivella beads; A.D. 1450-1700. No pottery. Images courtesy of Robert Mallouf.

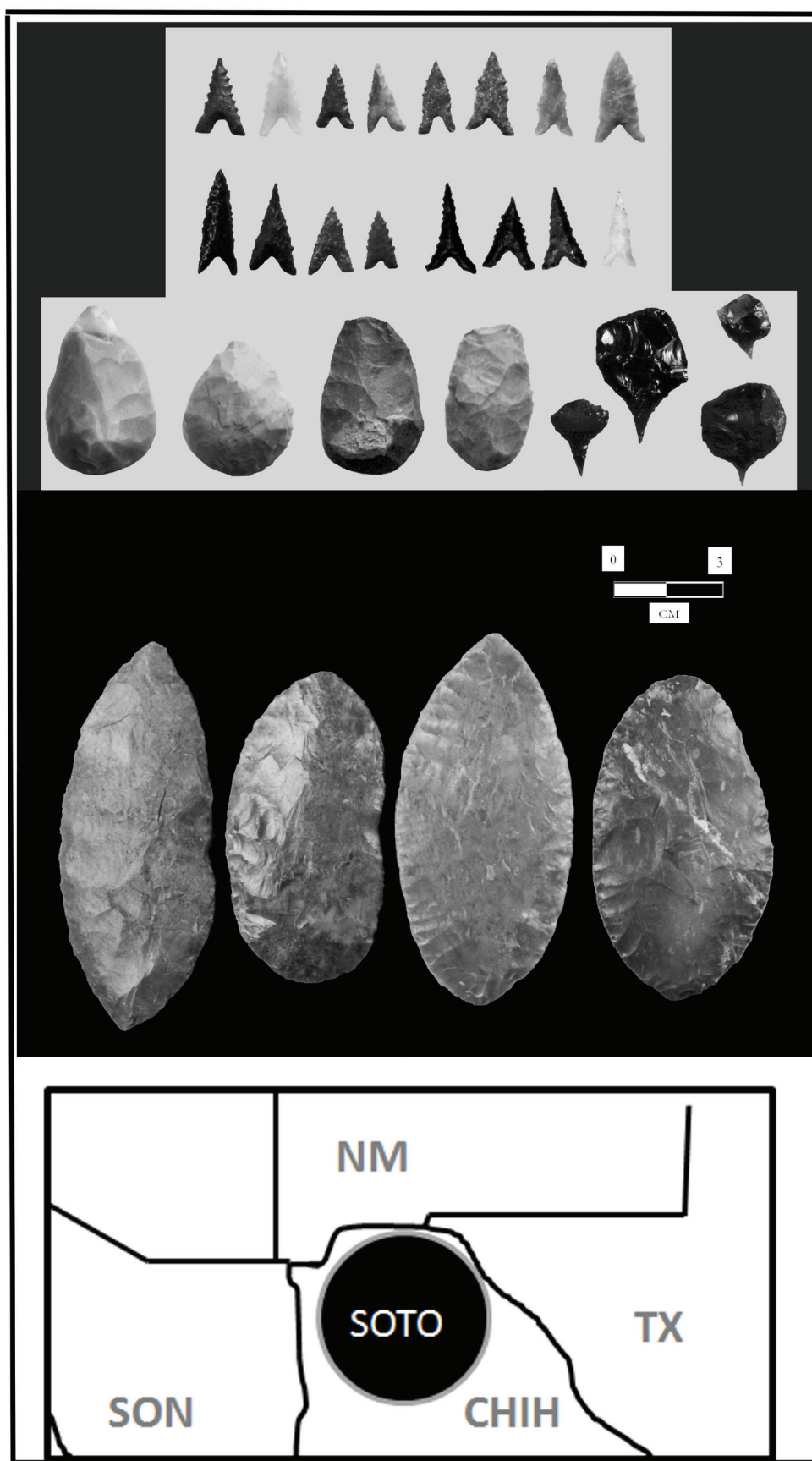


Figure 5. Soto. With its “Eiffel Tower” shape the Soto point is quite distinctive. Other aspects of the assemblage are also diagnostic including beveled knives, blades, end scrapers, side scraper, Soto points, flake perforator; A.D. 1400-1750?

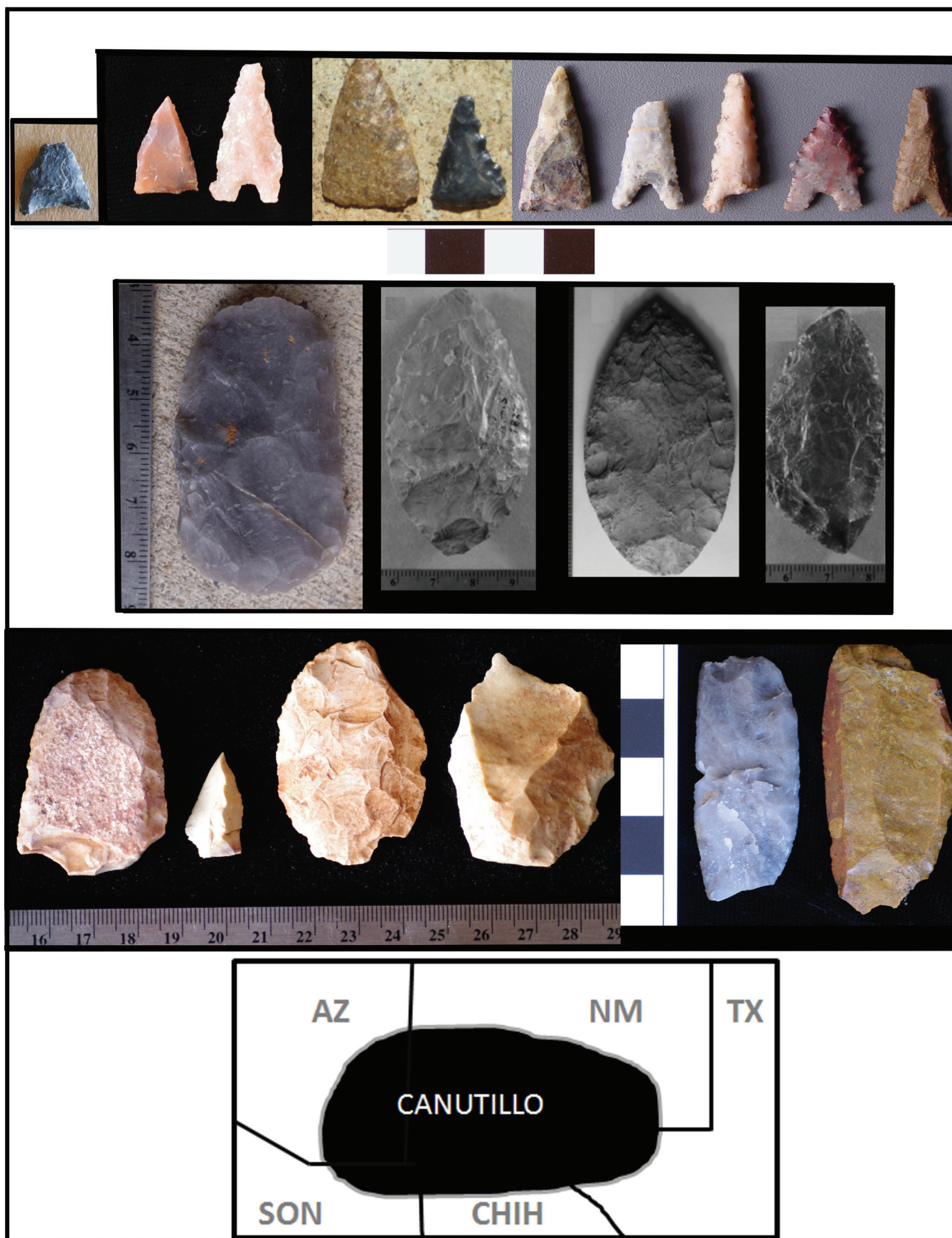


Figure 6. Canutillo Complex. Beveled knives, blades, end scrapers, side scrapers, expedient groundstone; STIB points, flake perforators; A.D. 1400-1750.

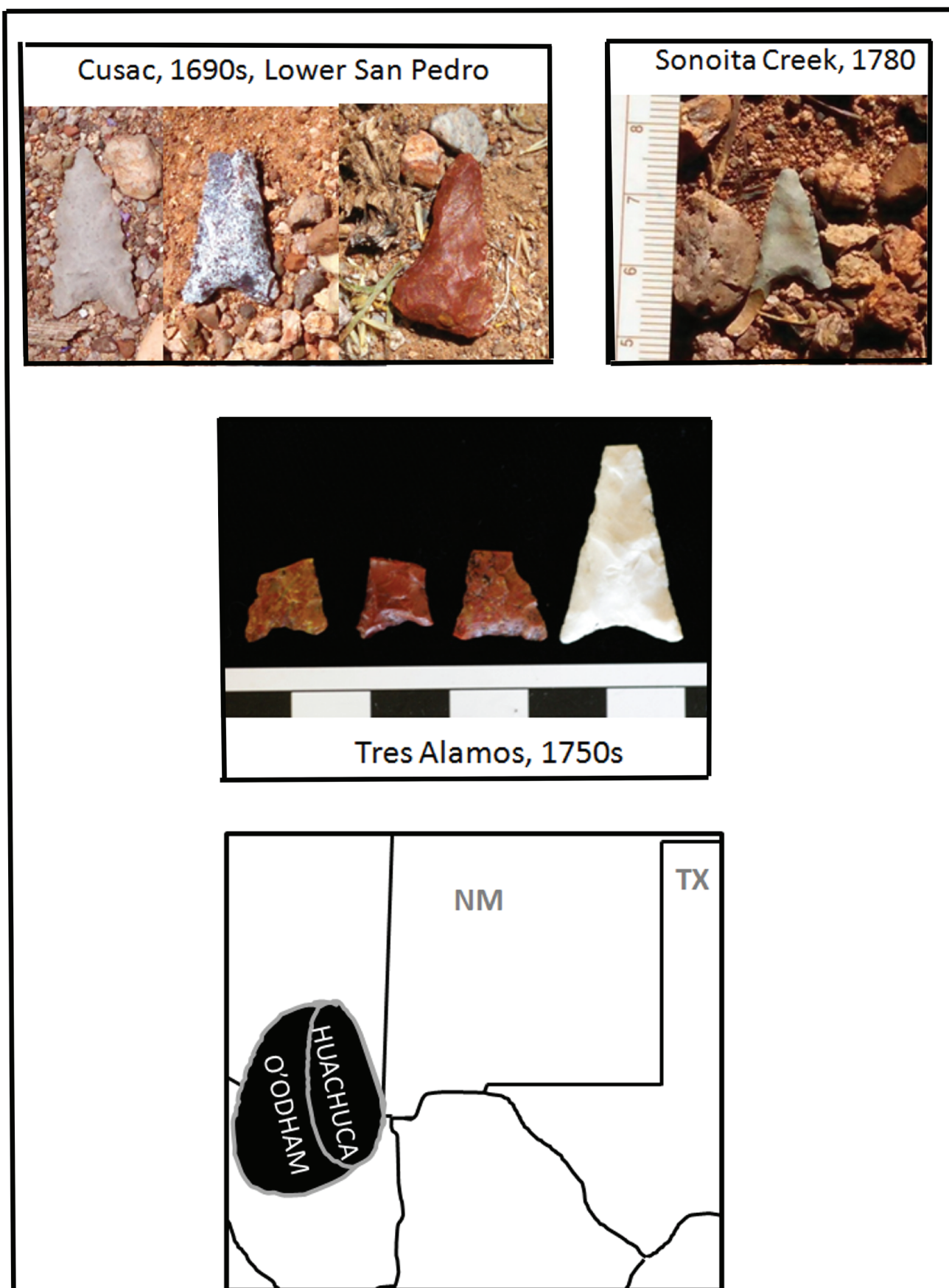


Figure 7. Sobaipuri/Cayetano Complex. Huachuca points, expedient tools, flake end and side scrapers, groundstone, including trough metates and mortar and pestles, shell artifacts, bone tools, Whetstone Plain pottery; A.D. 1200s-1800s

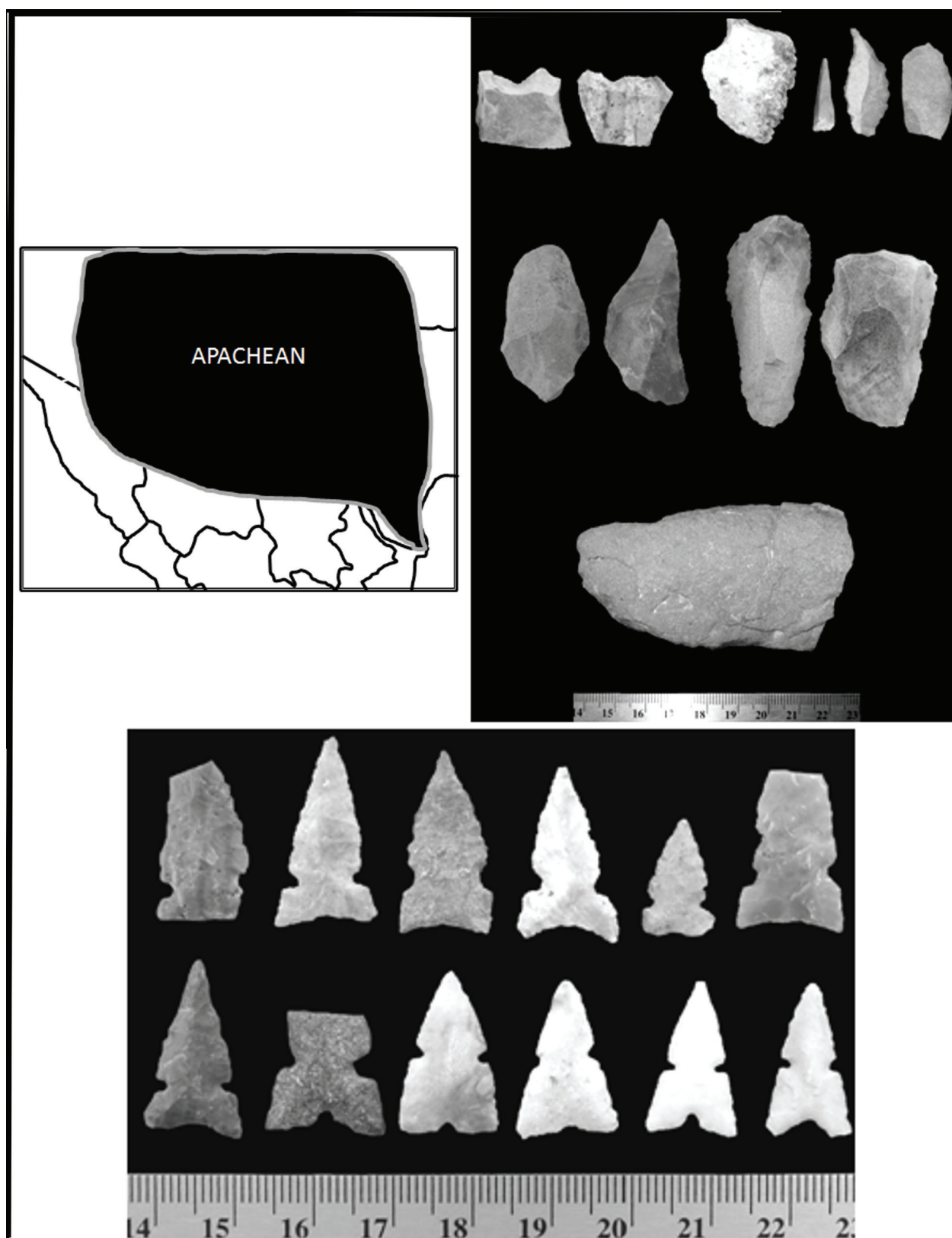


Figure 8. Ancestral Apache/Cerro Rojo Complex. The small thin side-notched points are not known to have been made by any other groups during this era in the southern Southwest and therefore can be considered diagnostic of ancestral Apachean groups. These side-notched points co-occur with other tool forms (end and side scrapers, expedient graters and perforators, flake knives, bifacial knives, plainware pottery, spokeshaves, expedient groundstone, and brownware pottery) and a range of distinctive feature types that date between A.D. 1300-1800s and that have been described elsewhere in detail.

can seemingly be distinguished archaeologically, because Spaniards were considering face paint, haircuts, language, and socially recognized but physically unmarked territorial boundaries, while archaeology requires tangible distinctions in attributes of pots, points, and other physical traits. This suggests that some of the smaller ethnohistorically differentiated groups may be combined into larger archaeological units, but how large and in what configurations remain questions (see Seymour 2016).

Points that look similar are found many hundreds of miles from the center of historically documented territories making broad types difficult to sort. Some of this represents actual mixing of assemblages and overlap of projectile point occurrences, while some points are inappropriately classed together and are only superficially similar. Among the many factors contributing to assemblage mixing is the fact that the boundaries of mobile group territories overlapped and use of certain zones was not exclusive (Seymour 2012b). Moreover these boundaries changed over time as groups moved to new areas in pursuit of resources or during raiding or as they were pushed out by political pressure from neighbors. The movement of one group might start a chain reaction of movement and conflict at boundaries. In fact, these conflict zones are where the greatest intermixing of points is expected, depositing points at battlefields.⁷

Mobile groups also allied themselves with neighboring groups, sometimes living together and intermarrying, raiding or going to war together, or participating in ceremonies or large-scale social events. This fact is well established in the historical literature; for example, the 1695 campaign report by Captain Juan Fernandez de la Fuente noted that “We have seen how the Janos, Jocomes, Mansos, Sumas, Chinarras, and Apaches have united. We have seen their great numbers and how they always travel together” (Naylor and Polzer 1986:585). Groups whose territorial heartlands were many hundreds of miles to the southeast, such as the Suma, were routinely reported as camping in the Chiricahua Mountains of southeastern Arizona and elsewhere (see for example Naylor and Polzer 1986:590, 591). These accounts explain the many archaeological sites with seemingly contradictory evidence of cultural affiliation in point assemblages. Interaction of groups within the same space obscures the difficult-to-discern material culture patterns to an even greater degree.

Historical sources also document that scouts from other areas tended to accompany Spaniards on campaigns or embarked on their own far into enemy territory. Another example from the 1695 Fuente campaign includes Conchos, Opatas, Sobaipuris, and Pimas in the muster rolls, equipped with bows and arrows (Naylor and Polzer 1986:604-605). Use of bows and arrows by military scouts continues into at least the late eighteenth century and seemingly the early nineteenth (see for example, Bourke 1891:26, *passim*; Cozzens 2001:64). These campaigns would have spread points throughout

expansive areas and brought knappers of varying traditions in contact with one another, likely explaining some of the known distributions.

The wagering of arrows and the enjoyment of arrow games were common ways in which arrows and their stone points might have been transferred between groups, contributing to the mixing of point assemblages. For small mobile groups, both gambling and games were important for inter-group interaction, which in turn was essential for solidifying social bonds, finding mates, transferring information, assembling a sufficient number of specialists and ceremonial leaders, forming alliances, and organizing war, raiding, and hunting parties (Seymour 2017d). Several written sources mention arrows being transferred by these means, including in the 1600s by Father Andrés Perez de Ribas (Reff et al. 1999:363) who noted of the natives in Sonora and Sinaloa: “In their games it is the custom of these Indians to wager their bows, arrows, and other small items that they value, in the same way that Europeans gamble money.” Later John Bourke (in Mason 1894:669) commented that “The same [Apache] warrior may have in his quiver representatives of several types [of points], sometimes serrated, and sometimes non-serrated, but all deadly.” These examples demonstrate how gambling and games contributed to point assemblages mixing (also see Harlan 2017:129; Seymour 2002:266; Wiesner 1983:261).

Intergroup interaction was not always amiable, and for most mobile groups in the southern Southwest this interaction included raiding and battles. The historically documented 1698 battle at a Sobaipuri O’Odham village on the San Pedro River resulted in the interspersion of arrow points and lanceheads from seven groups at Santa Cruz de Gaybanipitea (Seymour 2014, 2015a). Some of these were lost and broken in battle, others were likely retrieved as trophies and therefore were incorporated into other site contexts through ceremonialism and ritual. Still others were embedded in victims and thereby incorporated into dispersed contexts, including in burials at and near the site and in the attackers’ homelands, as well as along the trail home. Until recently, most of these battle sites have not been recognized as representing mixed point assemblages with the resulting consequence that the points of numerous mobile groups have been conflated with those of the Sobaipuri O’Odham.

DISCERNING ETHNICITY WITH POINTS

The issues discussed above and others contribute to a complex and often confusing archaeological record and so these issues must be brought to the foreground when assessing projectile points in this late period. With these in mind we can touch on the issue of ethnicity or associating projectile points with archaeological culture groups. Here the goal is to clarify that within each of

the ethnohistoric homelands or culture areas discussed above, there are certain point types that are similar to those in southern Arizona, but that are sufficiently distinct in their idealized or archetypal forms to distinguish when the appropriate analytical criteria are used. As I have said, the overlap and mixing of assemblages seemingly assume a more important role during this late period than earlier owing to the mobility of people, lack of firm territorial boundaries, establishment of new alliances, and also the disruption and movement of groups to new areas. The small assemblage sizes also play a role in privileging those diagnostics that are present (Seymour 2010, 2015b, 2017b). Nonetheless, our inability to detect differences also relate to the crudeness of our classificatory schemes and use of inappropriate or too nonspecific analytical criteria. The implication is that points that initially look similar to the analyst's eye were actually quite dissimilar to their makers and users. The question then becomes to what degree we lump or split point attributes in our analyses and whether key and traditional landmarks are sufficient. As Harlan (2017:119) notes, we should "maintain neutrality, not assuming that any single part of an arrowhead is more important than any other in the search for meaningful categories." The datasets themselves can be especially effective in outlining parameters used to partition attributes, as his study reinforces.

Style, Diagnosticity, and Archetypes

The apparent broad-scale similarities are just that, similarities, but they are not identical. With refined analytical perspectives and approaches we can distinguish subtle technological and stylistic differences that, on the basis of preliminary comparisons, correspond generally to distinct geographic areas where these historically referenced groups were centered (see Seymour 2002:266-267). It's not that these points do not occur elsewhere; they in fact occur in a much broader area owing to the processes just described (which is a reason for much of the confusion), but the core of their distributions can be identified and the traits in these core areas can be used to distinguish distinct types. Whether these represent ethnicity or something else is an issue for further discussion, but it is possible to examine point attributes in relation to their specific densities within generalized geographic locations. Identifying and characterizing a set of subtle differences in attributes that differ from the norm in point analysis and that have relevance to style, function, and ethnicity is the key to recognizing these distinctions.

By noting and measuring a different set of attributes some of the distinctions become obvious. A good example is that if using just point outline shape for small triangular indented base (STIBs) points, that includes lateral margins and basal indentation, Garza points (from West Texas) look the same as Huachuca

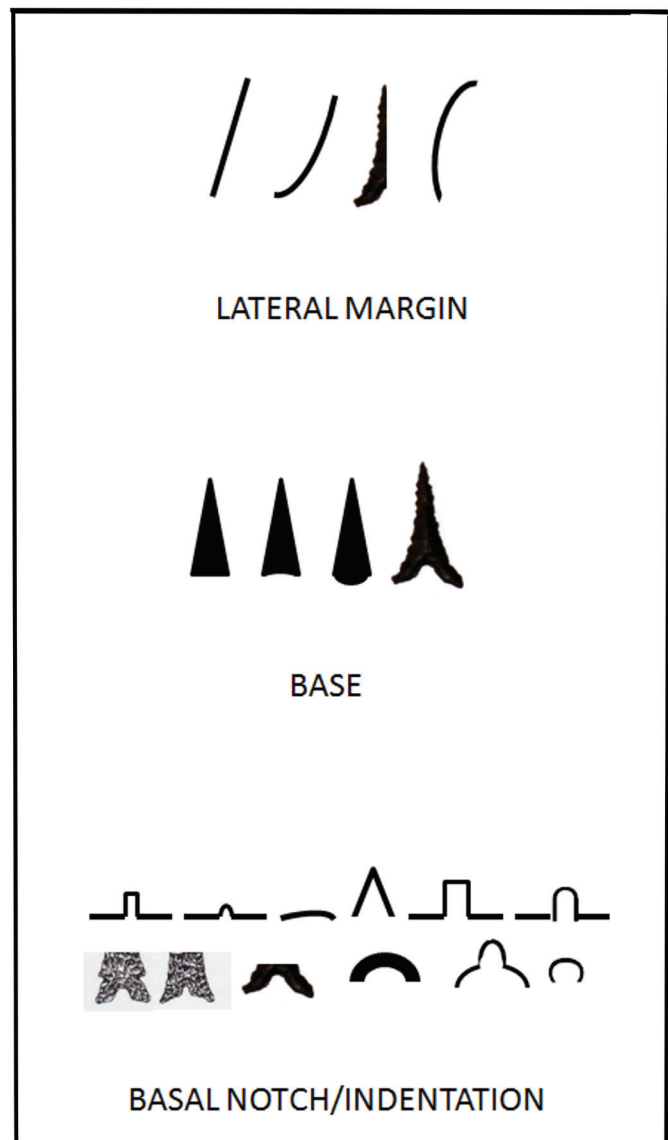


Figure 9. Attributes that seem relevant for distinguishing different point types.

points (from southeastern Arizona). They look so similar in fact that I asked John Speth to send his Garza points from the Garnsey Spring site so that I could compare them to the Sobaipuri's Huachuca points. While these points looked the same in illustrations they are actually quite different in overall size, thickness, basal treatment, notch form, and flaking attributes. As Fritz (1989) and Masse (1981) have previously indicated (see discussion in Seymour 2011a:80-85), there is an even more striking similarity between Huachuca and Soto points. As it turns out, one reason for this conclusion is that some of the points they referenced in southeastern Arizona are, in fact, Soto points, brought to the location by the Suma or Jano. For example, many of the points and tools from Second Canyon and Alder Wash Ruin (Franklin 1980:164; Masse 1980) should be identified as belonging to the Canutillo complex and Soto, representing a Jocome, Jano, or Suma occupa-

tion rather than (or in addition to) a Sobaipuri one (see Seymour 2017a). When it is accepted that many of the traits and points formerly attributed to the Sobaipuri actually represent mobile group components and artifacts, identifications are less ambiguous and point attributes actually pattern much more definitively. By considering a more refined and broader set of attributes, Huachuca points can be distinguished from Soto, and both of these can be distinguished from the points of other groups that shared the same territories (Seymour 2016).

Importantly, not all points are distinctive and many cannot be classified stylistically in more than a general way. An archetypical subset may be inferred to represent the idealized type that knappers set out to achieve, with more or less success. That Protohistoric peoples were keying in on specific subtle distinctions when they made these points is indicated by the ones that can be archaeologically distinguished. As Harlan (2017:117) points out:

As with many mechanical devices, arrowheads can fulfill their physical function while assuming a range of actual shapes. The basic requirements for penetrating a target or causing a large wound may tightly constrain the front end of the point's shape, but shaping the haft end is less constrained by physical requirements and more open to personal preference or learning traditions.

After in-depth statistical analyses, Harlan further concludes that the typological categories that focus largely on attributes related to hafting more clearly convey style (Harlan 2017:127). This is consistent with the analytical focus on basal characteristics emphasizing that in many cases the bases and character of notching are often the most distinctive elements of the point, although lateral margins are also distinctive, such as in Eiffel-Tower-shaped Soto points, for example (see below). Many factors likely worked against many more specimens being useful for discerning cultural or ethnic identity, including small social groups, informal learning networks, and often expedient production efforts. The fact that in this region during the Late Prehistoric through Historic periods only a small number of the points in any one assemblage are diagnostic of ethnicity may be an indication of the increased relevance of these factors. Fewer than a third of the points were diagnostic from the Sobaipuri O'Odham site of Santa Cruz de Gaybanipitea where a historically known battle occurred in 1698 that involved seven distinct groups, including the Jocomé, Apache, Jano, Manso, Suma, and western O'Odham (Seymour 2014, 2015a).

Additionally, many points were reworked and as a result lost their form. This occurred quite commonly despite that fact that some sources suggest that re-

working broken arrow points was less likely to have occurred than for atlatl dart and spear points (Loendorf 2012; also see Flenniken and Raymond 1986; Hoffman 1985; Loendorf et al., this issue). It seems that expediency and compromise in the face of critical need were driving factors. Substantial examples of point reworking include: (a) the Cerro Rojo site where just under a third of the side-notched and simple triangular points were substantially reworked to nubs (Seymour 2004), (b) the 1698 battlefield at Santa Cruz de Gaybanipitea where a third of all recovered points were reworked (Seymour 2014, 2015a), and (c) the Cienega Creek burials where at least a tenth of the basally notched points were reworked to the degree that the original analyst classified these versions with shorter blades as a different point type (e.g., Vint 2005:Figure 8; see Seymour 2007).

In other instances points were made expediently, such as during the 1698 battle just referenced, resulting in rough triangular forms that do not exhibit the subtle stylistic traits that allow them to be distinguished. Also, some groups seemed to have made some points for certain uses that had clear attributes specific to their area and other points used in other contexts that do not exhibit these traits, but are more basic, generalized, or crude. This suggests that points used in different contexts were made with different care or concepts, and some points were modified for other uses.

Distinguishing Attributes and Generic Descriptions

Several attributes can be discerned as important when comparing STIBs across group heartlands (as may be defined either by historical reference to groups or by archaeological distributions that convey the densest concentrations of points with unique attributes). By accepting that the points illustrated in Figures 2 and 5 through 7 originate in different areas and therefore were made by different groups of people, it is possible to characterize the nature of the analytical problem. The point images reveal the often fine distinctions that differentiate (mostly preexisting) types and, as shown in Figure 9, these include the character of the lateral margin, base shape, basal notch or indentation, and basal corner characteristics. Yet, these defining criteria tend not to be included in type descriptions in more than a general way and so existing typologies are at present too generic to be of much use. While initial type designations may be clear, through time a greater range of points are included in a type and in many instances collapsing many different types into a single one. For example, it is difficult to find a type description of Soto because many Texan classifications collapse this type into Garza, while Soto points found in Arizona have been considered Sobaipuri (e.g., Huachuca). Garza is described as "a triangular point, often with serrated lateral edges, that has a centrally notched base" (Turner and Hester 1999:215). From such a generic description it is easy to see why oth-

er points would seem to be the same. Soto is described as “generally triangular ...with the lateral edges straight and always centrally notched. The blade is often serrated and the side of the base will sometimes flare outward” (Phelps 1968:18, compare to Phelps 1987). Several points that elsewhere are classed as distinct types have for some time been collapsed into the Huachuca type of the Sobaipuri. In aggregate, these points have been described as “small triangular chips of siliceous stone exhibiting a deep basal notch, and nearly always the edges of the blade are serrate” (Masse 1981:39-40). Points that are clearly O’Odham, including from some historic sites on the Gila River are “almost exclusively small triangular forms that lack notching or serration” (Loendorf 2012, 2014; also see Haury 1975:Plate 22; Russell 1975:Figure 30, 111; Wells 2006:26). It is easy to see that these descriptions are insufficient to differentiate points that were made by distinct groups that originate in discrete geographic areas. All of these points are small and triangular with indented bases and often with serrated margins. One reason for the lack of greater descriptive specificity is that analysts are not distinguishing between archetypal points (that have been executed more or less effectively to conform to a standard) and other generalized triangular types that are also present, nor are they contrasting local points with those known to be from other areas. The classificatory value of these descriptions is also diluted because a number of distinctive point types already defined in other areas have, as noted above, been fused to accommodate a single all-encompassing type description. For instance, the attributes that allow Soto to be distinguished from otherwise triangular indented base points with serrations, such as Garza and Huachuca, are the concave lateral margins and out flaring basal corners and the pronounced U-shaped basal notch that form the Eiffel Tower shape. Points classed as Soto more or less conform to this description, whereas Garza and Huachuca do not. Recognizing that (a) points may be more or less effective in attaining this ideal and (b) points of many different types may occur on a single site, and certainly within a particular region, is the first step in solving this sorting problem.

Confusion stemming from a lack of descriptive specificity is further compounded by the widespread distribution of points of generally similar form. Points of one type (Soto) that generally look similar to another type (Huachuca) not only occur within the Soto area of Chihuahua, but also occur in southern Arizona where Huachuca points are centered. As people moved across the landscape, so did their points, exceeding the geographic boundaries of particular homelands. Because geographic distributions overlap, the type descriptions have become too inclusive and therefore distinctions between archetypal point types have been blurred. The problem persists owing to a general failure to look beyond familiar culture area boundaries (for exceptions see Fritz 1989 and Masse 1981; see discussion in Seymour 2011a).

Attributes and Non-Customary Traits

Owing to the above stated factors, it is useful to incorporate a refined set of attributes for consideration in future analyses. The point assemblages themselves that are pegged to specific geographic heartlands divulge which attributes are pertinent in conveying differences that may be indicative of identity or cultural affiliation. Several non-customary (seemingly nitpicky) traits of point morphology are useful in efforts to systematically distinguish points that are from widely dispersed geographic locations. Harlan’s (2017) shape analysis effectively captured some of these distinctions and while he did not incorporate preconceived categories, in the end he noted a correspondence between his results and some of the established archetypal point types. Taken further, Harlan’s analytical strategy would be effective in distinguishing a larger sample of point types.

It is possible to argue that the point itself is less important in the weapon system (see Harlan 2017). Nonetheless, the archaeological distribution of points indicates that there are widespread traditions and within these traditions there are subtle differences that carry some meaning. Further analyses are needed to decode the message, but as of now, the difference between Soto (probably Suma or Jano) and Huachuca (Sobaipuri and perhaps other O’Odham) relate to whether the margins are concave or straight (even slightly convex) and the basal corners are barbed or rounded, respectively, as described above. The presence and character of basal indentations on otherwise simple triangular forms seem pertinent and the character of this indentation provides relevant information. For example, Starr points from Coahuila (and McGloin from South Texas) have an often deep V-shaped basal notch (Turner and Hester 1999:231), Garza have a concave base with a tiny notch, Mesilla have a tiny notch in an otherwise flat or minimally concave base, and Huachuca points have moderately deep U- or C-shaped basal notch with the ends of the basal corner either rounded or flat.

A number of simple triangular points lack basal notching and are often found in association with basal-notched or side-notched forms. Many of these are widely accepted as preforms, though they are more formally prepared than flake blanks, so this is likely a misnomer. In fact, a number of actual types that lack basal notching have been defined, including Guerrero-like points that may originate in mission communities in the late seventeenth century and are found in multi-ethnic settings in southern Arizona (see Seymour 2014, 2015a). Flaking characteristics seem to provide valuable clues. For example, both initial flake removal techniques (such as blade flakes that leave and often exhibit long linear parallel flake scars) and subsequent sharpening and retouch are reflected in the character of beveled lateral margins seen on a subset of small triangular points without basal notches found in the Jano and Jocome homelands that otherwise generally fit with

Cottonwood Triangular and Cameron (e.g., Bliss points, Seymour 2002:272, 279, Figure 7.24). These are distinguishable from the small thin Chihuahua point variety that is shaped like an isosceles triangle without a basal notch, and with edges that pinch inward at the tip and have poorly developed serrations (Seymour 2002:271, 297, Figure 7.21).

Serrated lateral margins may relate to whether poison was used, though poison tends to have been applied to the upper portion of the shaft, rather than the point, so serration might relate to a desire to inflict more damage, greater bleeding, or greater pain (see the discussions in Harlan 2017:136 and Seymour 2002, 2014; Loendorf et al., this issue). Serrations may be more or less pronounced, are produced in slightly different ways, and extend to differing degrees along the lateral margins suggesting these aspects of this attribute may also have some relevance for classification.

Some distinctions in points likely relate to whether they were intended for human or animal targets (Loendorf et al. 2015). Simple triangular points in the O'Odham area may have been used for small game hunting (Seymour 2002:358-359, 2011:95, 2014:173, 174; but see Loendorf 2012), as were the sharpened fire-hardened tips of wooden arrows, as indicated by historic and ethnographic sources and analysis of archaeological samples (Loendorf 2012; Russell 1975; Seymour 2002:358-359, 2011:95, 2014:173, 174; Treutlein 1949:202-203; see also Bostwick, this volume). As Harlan's (2017:123) study indicates, the differences between the narrower basally indented forms and those that are more squat and triangular without pronounced indentations may relate to the difference between those focused on penetration rather than wound width. Harlan's (2017:121, 125) analogy to a golf bag seems fitting given the tradeoffs between performance characteristics and that any of the typological categories one devises on the basis of style, including shape, may contain either of the functional categories.

The historically described distinction between these broad triangular points and the narrower ones relates to what Harlan (2017:117) references as broadheads (causing more extensive bleeding) or bodkins (allowing armor penetration, and also penetration of thick hides). While barbing sacrifices penetrating power, barbing keeps the point in the wound so that removing the arrow shaft or moving the victim exacerbates the hemorrhage (Browne 1940; see Harlan 2017:117). This basic distinction is consistent with rabbit blood recovered from residue analysis on one of the broad triangular points from southern Arizona (Seymour 2014:177). Further residue analyses and experimental studies (see Loendorf and others, this issue), may address some of these questions, as long as we recognize that performance parameters may be offset and contradicted by cultural factors and preferences. Experimental studies that empirically discern how attributes affect perfor-

mance are most useful when they are decoupled from assumptions that past performers engaged in purely rational behavior. Stylistic variation accepts that actual practice may deviate from an empirically justifiable course for a number of reasons, including individual ability. While peak performance provides a baseline for understanding, perceptions of what is rational and best practice may vary with input of personal experience, superstition, ritual precepts, and evaluations as to justification for amount of energy invested. These are some of the reasons for the stylistic variability visible in the execution of the generalized forms described here.

CONCLUSIONS

Projectile points have been one of the most commonly used indices of ethnicity or archaeological cultural affiliation. But assumptions regarding the attributes employed to define cultural groups must be questioned, unless you accept that the points shown in Figures 2 and 5 through 7 are all Sobaipuri points, even though most of these points occur far outside Sobaipuri territory. Clearly, these cannot all be Sobaipuri because they occur as the primary point styles and in greater numbers as far away as south Texas, Coahuila, Chihuahua, Sonora, as well as in southern Arizona beyond Sobaipuri territory. Consequently, we must consider one of two options: (a) subtle differences visible in these points are relevant and useful for distinguishing point styles (and therefore groups) within specific geographic areas, or (b) points are useless in discerning ethnicity because styles, including point shapes are randomly distributed across a large geographic area and therefore archaeological practice must revise its expectations of the informational value of projectile points.

It is my view that projectile points can be effective in distinguishing culture groups, but that not all points in any assemblage are diagnostic and therefore effective in this goal. This fact probably relates to small informal knowledge transfer among mobile groups, improvisation as needs arose, and many of the factors mentioned above that contribute to assemblage mixing. Other factors are important as well, not least among these is that numerous mobile groups were present in the Late Prehistoric and Early Historic periods, only some of which were historically referenced or recognized by Europeans and therefore distinguished. Moreover, some of the groups distinguished by Europeans or by the people themselves may not be distinguishable archaeologically.

Despite all of the hurdles discussed herein, I am convinced that by considering a wider range and different array of subtle point attributes it is possible to isolate certain styles, and therefore types that seem to represent ethnicity/identity/culture in a general way. One step toward addressing this problem is to look at specific geographic areas where historically recognized

groups were focused and to identify the most distinctive points present in each area that occur in the greatest numbers and in the most contexts, as has done to some degree already (Loendorf 2014; Seymour 2002, 2014, 2016). First, however, we must understand the notion that named points occur far outside their designated territories. This is something some archaeologists have been hesitant to recognize; for example, one established Texan archaeologist commented to this author in no uncertain terms that the southern Arizona points could not be Guerrero because this type does not occur in Arizona. Then if we accept that most assemblages are mixed we can incorporate methodologies that accommodate this inconvenience by looking at the overlap in point attributes across a number of sites and culling those that differ (Seymour 2012a). Another effective approach is to examine known locations where historical encounters occurred with specific groups, as was the case at Santa Cruz de Gaybanipitea, as well as various mission and presidio sites. The most effective analyses focus on letting the character of the points assemblages themselves determine which attributes are meaningful, avoiding the pitfalls of predetermined classifications. I invite future analysts to pursue these suggestions further using an expanded list of attributes on existing collections.

Notes

1. See Seymour 2011a and 2016a for discussions of the term protohistoric and definition of the period.
2. These points were not originally called "Sobaipuri"; it's just that when scholars meant that points made by the Sobaipuri were triangular they used the phrase "Sobaipuri points are triangular" and others began calling them Sobaipuri points as a formal name.
3. In an effort to achieve more finely grained assessments of ethnicity based on points it is important to consider the potential variations of Huachuca points throughout the O'odham area, and not just for the Sobaipuri-O'odham. This current discussion of the O'odham's Huachuca projectile points does focus disproportionately on the 'eastern' Akimel O'odham (e.g., the Sobaipuri along the Santa Cruz and San Pedro rivers and their tributaries) because this is where my work has focused. In doing so it does not address the more western Akimel and Tohono O'odham, or the more poorly known Hia-ced and Kohatk O'odham. There may be tangible ethnic differences in terms of shape (straight versus U or C-shaped bases) and serration. Loendorf (2014:Figure 2) illustrates three historic point types from Gila River Indian Community lands. He notes there is a continuum of attributes among these point types, but by suggesting that Huachuca points are a recognizable sub-type of his 'U-shaped base triangular points, and by distinguishing the three generalized types, he is potentially laying the groundwork for exploring the possibility that O'odham projectile points may be sensitive to internal ethnic divisions. This is one reason why

from here forward these should be referenced by a non-ethnic point name, rather than O'odham. Given Kino's reference to Sobaipuri O'odham along a portion of the Gila River (e.g., Seymour in prep) and many of the other factors indicated above, some point mixing is expected, but nonetheless, this is an important area to focus future analyses. As Bruce Masse (personal communication to the author, 2016) says: "I would not be surprised that the Protohistoric period point variation among the O'odham is eventually demonstrated to be the result of systematic differences in point-making traditions among ethnic and dialect groups within the O'odham—Sobaipuri, Tohono, Akimel, Hia-ced, Kohatk, Pima Bajo—rather than of a functional or idiosyncratic nature."

4. Space limitations prohibit me from discussing these in detail, but illustrations should convey my point. Debitage from the manufacture of these tools is also many times highly diagnostic.

5. "Point assemblage" here means a group or collection of points found at the same context or site, or that may be grouped together because they are found in the same region.

6. In this case, the Greater Southwest is intended as shorthand to include Texas, Coahuila, Chihuahua, Sonora, New Mexico, and Arizona.

7. One important part of the battlefield signature is the number of points deposited (see Seymour 2014, 2015a).

REFERENCES CITED

- Bourke, John G.
1891[1950] *On the Border with Crook*. Charles Scribner's Sons, New York.
- Boyd, Douglas K.
2001 Querechos and Teyas: Protohistoric Hunters and Gatherers in the Texas Panhandle-Plains, A.D. 1540-1700. *Bulletin to the Texas Archeological Society*, Vol. 72:5-22.
- Boyd, Douglas K. and Nancy Adele Kenmotsu
2012 *The Toyah Phase of Central Texas: Late Prehistoric Economic and Social Processes*. Texas A&M University Anthropology Series, College Station.
- Browne, James
1940 Projectile Points. *American Antiquity* 5:209-213.
- Cozzens, Peter
2001 Eyewitnesses to the Indian Wars, 1865-1890: Volume 1. Stackpole Books, Mechanicsburg, PA
- Flenniken, J. J., and A. W. Raymond
1986 Morphological Projectile Point Typology: Replication Experimentation and Technological Analysis. *American Antiquity* 51:603-614.
- Franklin, Hayward H.
1980 Excavations at Second Canyon Ruin, San Pedro Valley, Arizona. Arizona State Museum Contributions to Highway Salvage Archaeology in Arizona, No. 60. Tucson.
- Fritz, Gordon L.
1989 The Ecological Significance of Early Piman Immigration to Southern Arizona. *The Artifact* 27(1):51-109.

- Harlan, Mark
2017 Protohistoric Arrowhead Variability in the Greater Southwest. Chapter 9 in *Fierce and Indomitable: The Protohistoric Non-Pueblo World in the American Southwest*, edited by Deni Seymour, pp. 115-137. University of Utah Press, Salt Lake City.
- Harlan, Mark E. and Deni J. Seymour
2017 Sobaipuri O'odham and Mobile Group Relevance to Late Prehistoric Social Networks in the San Pedro Valley. Chapter 13 in *Fierce and Indomitable: The Protohistoric Non-Pueblo World in the American Southwest*, edited by Deni Seymour, pp. 170-187. University of Utah Press, Salt Lake City.
- Haury, Emil W.
1975 [1950] *The Stratigraphy and Archaeology of Ventana Cave*. University of Arizona Press, Tucson.
- Hoffman, Charles M.
1985 Projectile Point Maintenance and Typology: Assessment with Factor Analysis and Canonical Correlation. In *For Concordance in Archaeological Analysis*, edited by C. Carr, pp. 566-612. Waveland Press, Prospect Heights, Illinois.
- Jelks, Edward B.
1993 Observations on the Distributions of Certain Arrow-Point Types in Texas and Adjoining Regions. *Lithic Technology* 18(1-2):9-15.
- Justice, Noel D.
1987 *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States*. Indiana University Press, Bloomington.
2002a *Stone Age Spear and Arrow Points of the Southwestern United States*. Indiana University Press, Bloomington.
2002b *Stone Age Spear and Arrow Points of California and the Great Basin*. Indiana University Press, Bloomington.
- Loendorf, Chris
2012 The Hohokam—Akimel O'odham Continuum: Socio-cultural Dynamics and Projectile Point Design in the Phoenix Basin, Arizona. *Gila River Indian Community Anthropology Research Papers Number 5*, University of Arizona Press, Tucson, Arizona.
2014 Historic Period Akimel O'odham Projectile Points and Settlement Patterns. *The Kiva* 79(1):83-103.
- Loendorf, Chris, Lynn Simon, Daniel Dybowski, M. Kyle Woodson, R. Scott Plumlee, Shari Tiedens, and Michael Withrow
2015 Warfare and Big Game Hunting: Flaked-Stone Projectile Point Designs along the Middle Gila River in Arizona. *Antiquity* 89 344(2015):1-14.
- Mallouf, Robert J.
1987 Las Haciendas: A Cairn-Burial Assemblage from Northeastern Chihuahua, Mexico. *Office of the State Archeologist Report* 35. Texas Historical Commission, Austin.
- Mason, Otis T.
1894 North American Bows, Arrows, and Quivers. U.S. Government Printing Office, Washington, D.C.
- Masse, W. Bruce
1980 *The Peppersauce Wash Project*. Highway Salvage manuscript, edited by Gayle Hartmann. Arizona State Museum Archives, Tucson.
1981 A Reappraisal of the Protohistoric Sobaipuri Indians of Southeastern Arizona. In *The Protohistoric Period in the North American Southwest, AD 1450-1700*, pp. 28-56. Arizona State University Anthropological Research Papers No. 24. Tempe.
- Naylor, Thomas H., and Charles W. Polzer, S. J.
1986 *The Presidio and Militia on the Northern Frontier of New Spain, 1570-1700*. University of Arizona Press, Tucson.
- Phelps, Alan L.
1968 An Incised Stone Pendant and a Soto Projectile Point from Northwestern Chihuahua. *The Artifact* 6(3):16-22.
1987 Soto: A Distinctive Projectile Point Type. *The Artifact* 25(4):7-22.
- Ravesloot, John C., and Stephanie M. Whittlesey
1987 Inferring the Protohistoric Period in Southern Arizona. In *The Archaeology of the San Xavier Bridge Site (AZ BB:13:14), Tucson Basin, Southern Arizona*, edited by J. C. Ravesloot, pp. 81-98, Archaeological Series No. 171, Arizona State Museum, University of Arizona, Tucson.
- Reff, Daniel T., Maureen Ahern, and Richard K. Danford (translators)
1999 *Pérez de Ribas, History of the Triumphs of Our Holy Faith Amongst the Most Barbarous and Fierce Peoples of the New World*. University of Arizona Press, Tucson.
- Runkles, Frank A.
1964 The Garza Site: A Neo-American Campsite Near Post, Texas. *Texas Archaeological Society Bulletin* 35:101-126.
- Russell, Frank
1975 [1908] *The Pima Indians*. University of Arizona Press, Tucson.
- Seymour, Deni J.
2002 Conquest and Concealment: After the El Paso Phase on Fort Bliss. Conservation Division, Directorate of Environment, Fort Bliss. Lone Mountain Report 525/528. This document can be obtained by contacting martha.yduarte@us.army.mil.
2004 A Ranchería in the Gran Apachería: Evidence of Intercultural Interaction at the Cerro Rojo Site. *Plains Anthropologist* 49(190):153-192.
2007 Sexually Based War Crimes or Structured Conflict Strategies: An Archaeological Example from the American Southwest. In *Texas and Points West: Papers in Honor of John A. Hedrick and Carol P. Hedrick*, edited by Regge N. Wiseman, Thomas C. O'Laughlin, and Cordelia T. Snow, pp. 117-134. Papers of the Archaeological Society of New Mexico No. 33. Archaeological Society of New Mexico, Albuquerque.
2008 Surfing Behind The Wave: A Counterpoint Discussion Relating To "A Ranchería In the Gran Apachería." *Plains Anthropologist* 53(206):241-262.
2009 The Canutillo Complex: Evidence of Protohistoric Mobile Occupants in the Southern Southwest. *Kiva* 74(4):421-446.
2010 Contextual Incongruities, Statistical Outliers, and Anomalies: Targeting Inconspicuous Occupational Events. *American Antiquity* 75(1):158-176.
2011a *Where the Earth and Sky Are Sewn Together: Sobaipuri-O'odham Contexts of Contact and Colonialism*. University of Utah Press, Salt Lake City.
2011b Dating the Sobaipuri: A Case Study in Chronology Building and Archaeological Interpretation. *Old Pueblo Archaeology Bulletin* 67:1-13.

- 2012a Isolating a Pre-Differentiation Athapaskan Assemblage in the Southern Southwest: The Cerro Rojo Complex. Chapter 5. In *From the Land of Ever Winter to the American Southwest: Athapaskan Migrations, Mobility, and Ethnogenesis*, edited by Deni Seymour. University of Utah Press, Salt Lake City.
- 2012b Big Trips" and Historic Apache Movement and Interaction: Models for Early Athapaskan Migrations. Chapter in *From Land of Ever Winter to the American Southwest: Athapaskan Migrations and Ethnogenesis*, edited by Deni J. Seymour, pp. 377-409. University of Utah Press, Salt Lake City.
- 2013 Platform-Cache Encampments: Implications for Mobility Strategies and the Earliest Ancestral Apaches. *Journal of Field Archaeology* 38(2):161-172.
- 2014 *A Fateful Day in 1698: The Remarkable Sobaipuri-O'odham Victory Over the Apaches and Their Allies*. University of Utah Press, Salt Lake City.
- 2015a Behavioral Assessment of a Pompeii-Like Event and Its Battlefield Signature. Chapter 2 in *Explorations in Behavioral Archaeology*, edited by William H. Walker and James M. Skibo, pp.8-21. University of Utah Press, Salt Lake City.
- 2015b Mobile Group Visitation at the Eastern Frontier Pueblos: An Archaeological Example From Tabirá. *Plains Anthropologist* 60(233):4-39.
- 2016 Defining the Jcome and Their "Gifts of Little Value". *Kiva* 82(2):137-172.
- 2017a Three Sisters Site: An Ancestral Chokonen Apache Encampment in the Dragoon Mountains. Chapter 17, in *Fierce and Indomitable: The Protohistoric Non-Pueblo World in the American Southwest*, edited by Deni Seymour, pp. 222-239. University of Utah Press, Salt Lake City.
- 2017b Conceptualizing Mobility in the Pueblo Area: Evidence in Images. Chapter 14. In *Fierce and Indomitable: The Protohistoric Non-Pueblo World in the American Southwest*, edited by Deni Seymour, pp. 39-63. University of Utah Press, Salt Lake City.
- 2017c "Fierce, Barbarous, and Untamed": Ending Archaeological Silence on Southwestern Mobile Peoples Chapter 1. In *Fierce and Indomitable: The Protohistoric Non-Pueblo World in the American Southwest*, edited by Deni Seymour, pp. 1-15. University of Utah Press, Salt Lake City.
- 2017d Social Aspects of an Apachean Stave-Dice Gaming Feature at Three Sisters Chapter 10 in *Prehistoric Games of Indigenous Societies of North America*, edited by Barbara Voorhies. University of Utah Press, Salt Lake City.
- In prep Documentary Clarification of the Gila River Sobaipuri-Pima in Kino's Time. Chapter in *A Green Band in a Parched and Burning Land: Sobaipuri-O'odham Landscapes*. Book manuscript under review.
- Turner, Ellen Sue, and Thomas R. Hester
1999 [1985] *A Field Guide to Stone Artifacts of Texas Indians*. Gulf Publishing, Lanham, Maryland.
- Vint, James M.
2005 An Instance of Violence along Cienega Creek: The Cienega Creek Burials (AZ EE:2:480 [ASM]) and a Study of Protohistoric Projectile Technology in Southeastern Arizona. Technical Report No. 2005-101, Center for Desert Archaeology, Tucson.
- Wells, E. Christian
2006 From Hohokam to O'odham: The Protohistoric Occupation of the Middle Gila River Valley, Central Arizona. *Gila River Community Anthropological Research Papers, No. 3*, Gila River Indian Community, Cultural Resource Management Program, Sacaton.
- Wiesner, Polly
1983 Style and Social Information in Kalahari San Projectile Points. *American Antiquity* 48:253-276.



Additional painted Sinagua reed arrows, Dyck Cliff Dwelling, see Bostwick Figure 7.



Specular hematite on a reed arrow shaft, Dyck Cliff Dwelling, see Bostwick Figure 8.



Painted reed pigment container, Dyck Cliff Dwelling, see Bostwick Figure 9.

IN THIS ISSUE:

- 83 PROJECTILE POINT DESIGN: FLAKED-STONE PROJECTILE TIP SELECTION, FUNCTION, AND STYLE
Chris Loendorf, R. Scott Plumlee, and Shari Tiedens
- 99 EVALUATING EARLY AGRICULTURAL PERIOD SOCIAL DYNAMICS IN SOUTHERN ARIZONA
THROUGH PROJECTILE POINT TYPOLOGY
R. Jane Sliva
- 113 PAINTED ARROWS AND WOODEN PROJECTILE POINTS: AN ANALYSIS OF SINAGUA ARROWS
FROM THE DYCK CLIFF DWELLING IN THE VERDE VALLEY, ARIZONA
Todd W. Bostwick
- 132 PROTOHISTORIC PROJECTILE POINTS AND OTHER DIAGNOSTICS: A PAN-REGIONAL SOUTHERN
SOUTHWESTERN PERSPECTIVE
Deni J. Seymour

Cover: (Left) Empire point type, Early San Pedro Phase (Sliva, Figure 1); (Center) Wooden point, Honanki Phase, Southern Sinagua Tradition (Bostwick, Figure 15); (Right) Protohistoric point, Sobaipuri/Cayetano Complex (Seymour, Figure 7).