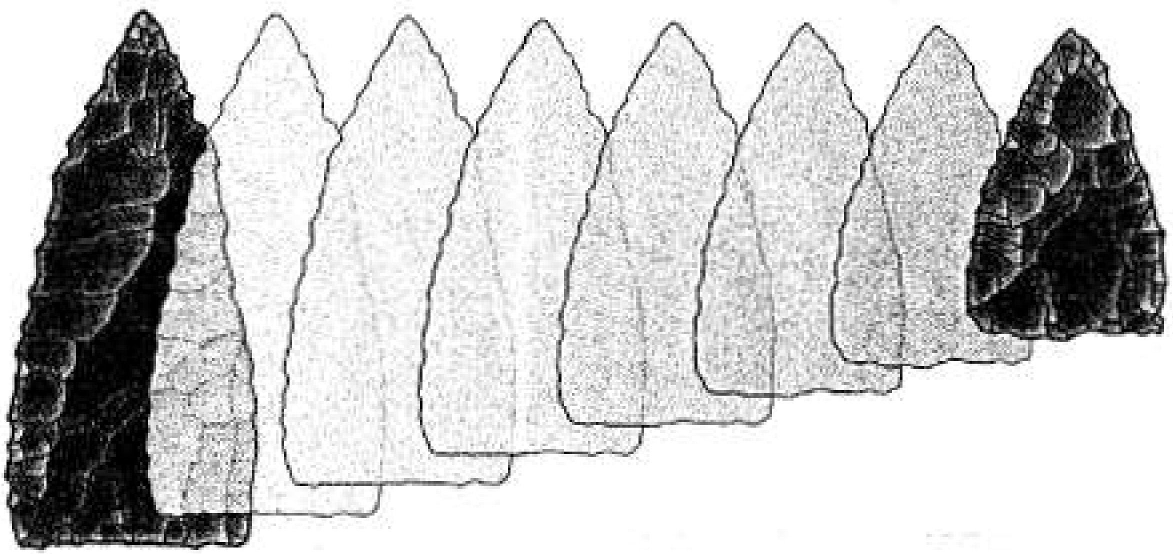
Archeological Data Recovery Excavations along Becerra Creek (41WB556), Webb County, Texas



by

Richard B. Mahoney, Raymond P. Mauldin, and Steve A. Tomka

with contributions by

C. Britt Bousman, J. Philip Dering, Mary E. Malainey, Kris L. Malisza, and Barbara A. Meissner

Environmental Affairs Division
Texas Department of Transportation
Archeological Studies Program, Report No. 44

Center for Archaeological Research
The University of Texas at San Antonio
Archaeological Survey Report, No. 321

2002

Chapter 9: Projectile Points and Beveled Tools
An Assessment of Typology and Function

Introduction

The investigation of lithic technology operates at a scale where integrity of the deposits at 41WB556 is not critical. The broadening of the scope of this lithic analysis was precipitated by a desire to address research issues that have both broader methodological and theoretical implications as well as regional and site-specific relevance. Beginning with the lithic artifact collection from 41WB556 and complementing it with the analysis of selected collections from other South Texas sites, the lithic technology module has two main objectives:

1) construction of a projectile point analysis protocol system applicable to point types commonly found in the region; and

2) functional identification of tool forms commonly found on South Texas sites.

The construction of a projectile point analysis protocol system applicable to point types common to South Texas has two main goals. One of the goals is to standardize the analysis of triangular and subtriangular projectile points so that the definition and characterization of types will be more readily accomplished using easily replicable and less subjective metric and non-metric attributes. The second goal is to provide systematic data that can help investigate the morphological and/or technological relationships between various point types to establish whether they represent valid chronological markers or simply similar forms distinguished based on size differences resulting from different degrees of point rejuvenation.

The second objective of the lithic analysis research design is to identify the function of some distally beveled tool forms common in South Texas lithic assemblages. These tool forms are variously known as Dimmit scrapers and unifacial and bifacial Nueces tools, and Olmos bifaces. Such knowledge regarding the function of these tools is critical for the accurate reconstruction of site use and function and therefore would provide broadly applicable results for regional archeological projects.

Figure 37 presents a graphical illustration of selected projectile point metric analysis attributes. Table 11 presents a comprehensive list of the analysis attributes, including metric and nominal observational attributes. Metric attributes were measured to the nearest .1 mm with Mitutoyo digital calipers using the guidelines outlined in Figure 37.

One key to the functional identification of South Texas tool forms is a systematic program of macroscopic and microscopic use-wear studies. To accomplish this aspect of the lithic analysis, all Dimmit/Nueces and Olmos tools included in this study were examined for macroscopic use-wear evidence (step fracturing, polish, edge rounding). Next, selected specimens that exhibited traces of macroscopic use-wear were subjected to low-power microscopic analysis (20-80X) to identify the manner of tool use (i.e., scraping, cutting, planing, gouging). A small sub-sample of specimens was also examined using the UTSA high-power Scanning Electron Microscope (SEM). While the low-power analysis was very useful in identifying wear traces and tool use, the SEM could not be accessed regularly and the few specimens analyzed did not exhibit clear wear patterns at the higher range of magnification.

As an additional aspect of this analysis, a number of metric and nominal attributes were recorded on each tool. These attributes are listed in Table 12. As in the case of the projectile point attributes, the measurements are designed to characterize the different tool forms while the nominal attributes are designed to capture other sources of morphological variability between groups such as tool blank production and selection criteria (i.e., heat treatment, platform location, cortex presence), manufacture strategies (i.e., unifacial and bifacial forms and degree of ventral face retouch), and rejuvenation characteristics. To aid the reader with some of the more technical terms used in this chapter, a glossary is presented in Appendix G.

A number of distally beveled tool forms that occur in southern Texas and northern Mexico have been identified through years of archeological investigations.

SITE NUMBER: ____________________

PROJECTILE POINT TYPE: ____________

LENGTH:

A Maximum Length: ________ *mm*

B Distance of Max. Thickness from Base: ______ *mm*

WIDTH:

C Maximum Width: _______ *mm*

D Maximum Base Width: ________ *mm*

E 2-mm Distal Width: ________ *mm*

THICKNESS:

F Maximum Thickness: _________ *mm*

G 5-mm Base Thickness: ________ *mm*

BASE DEPTH:

H - _____ *mm* for concave and notched

H + ______ *mm* for convex

H 0 mm for straight

FLUTED POINTS:

I Max. Length of Thinning Flake Scar

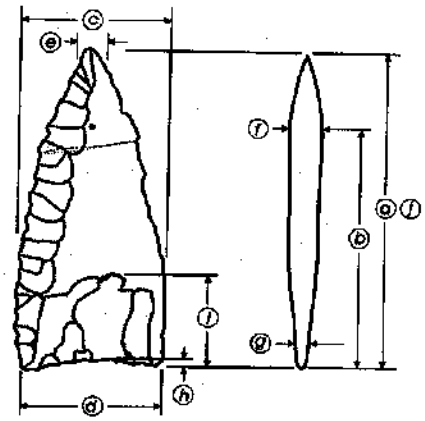
Face 1= _______ *mm*

Face 2= _______ *mm*

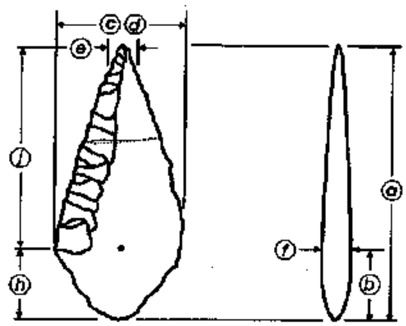
J Length of resharpening

Face 1= _______ *mm*

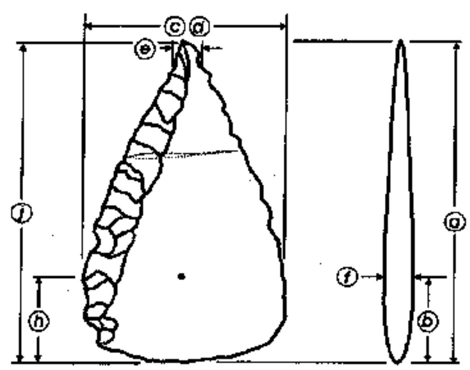
Face 2= _______ *mm*



Tortugas



Desmuke



Abasolo

Figure 37. *List of metric projectile point attributes and their measurements.*

Table 11. Analysis attributes measured and recorded on projectile points analyzed for this study

Section A. Comprehensive list of projectile point analysis attributes measured on round base and triangular points.

Part I. Metric Attributes

Maximum Length: measured on complete and incomplete specimens

Distance of maximum thickness from center of base

Length of longest base thinning flake Face 1

Length of longest base thinning flake Face 2

Length of longest resharpening and/or beveling on either edge of Face 1:
measured from tip to base, measured on complete and fragmentary specimens

Length of longest resharpening and/or beveling on either edge of Face 2:
measured from tip to base, measured on complete and fragmentary specimens

Maximum Width measured on complete specimens and fragments when available

Maximum Base Width: measured on complete specimens and proximal fragments

Width 2 mm from tip: measured on complete specimens and distal fragments

Maximum Thickness: measured on complete specimens and fragments when available

Maximum Thickness 5 mm from base:
measured at center of base on complete and proximal fragments

Base Depth:
– ___ mm for concave [or notched] based points
+ ___ mm for convex based points
0 mm for straight based points

Part II. Non-metric Observational Attributes

Raw Material Type:	f-g chert	c-g chert	chalcedony	rhyolite	agate/jasper	quartzite	Other
Heat Treatment:	present	absent	indeterminate				
Completeness:	complete	proximal	medial	distal	longitudinal		
Number of base thinning scars Face 1							
Number of base thinning scars Face 2							
Blade Beveling:	alternate left		alternate right		irregular	absent	
Break Morphology/Cause:	perverse	snap	impact scar	burin scar	post-depositional	indeterminate	

Table 11. continued...

Section B. Comprehensive list of metric and nominal attributes employed in the study of distally beveled tool forms.

Part I. Metric Attributes

Maximum Length:	measured on complete specimens and fragments
Maximum Width:	measured on complete specimens and fragments when available
Maximum Thickness:	measured on complete specimens and fragments when available
Thickness @ 5 mm above base:	measured on complete and proximal fragments
Working edge angle:	measured with goniometer
Ventral face protrusion:	measured as protrusion from vertical

Part II. Non-metric Observational Attributes

Raw material type:	f-g chert	c-g chert	chalcedony	rhyolite	agate/jasper	quartzite	Other
Flake blank platform location:	proximal	lateral	distal	indeterminate			
Flake blank cortex:	present	absent	indeterminate				
Manufacture strategy:	unifacial	bifacial	indeterminate				
Ventral face retouch:	slight	moderate	extensive				
Working edge shape:	concave	straight	convex				
Heat Treatment:	Present	absent	indeterminate				
Completeness:	complete	proximal	medial	distal	longitudinal		
Ventral face polish:	minimal	moderate	extensive				
Ventral face step fractures:	minimal	moderate	extensive				
Ventral face shape:	concave	convex	straight	recurved			

This section focuses on the Archaic projectile points and distally beveled tools. Whether we view projectile point types and tool forms as cultural identifiers or not, because they represent the material culture that allowed the populations to interact with their natural environment, these technological components must have provided some advantages to their users that allowed these tools to function and evolve with only minor changes over a 3,200 year span of the Archaic era. This chapter has two main goals: 1) to describe and consider the morphological variability in projectile points in terms of manufacture and rejuvenation technology and consider the diagnostic criteria differentiating these types and the validity of the types themselves; and 2) to describe the common technological and functional characteristics of selected distally beveled tool forms.

In a recent review of the archeology of South Texas, Hester (1995:438), following Hall et al.'s (1986) lead, remarks that the Middle Archaic represents "specific regional cultural patterns ca. 2500 B.C., emphasizing unstemmed dart points and smaller bifacial and unifacial beveled tools." This pattern continued into the Late Archaic lasting approximately 3,200 years. A brief survey of limited resources from northern Mexico (Nuevo León and Tamaulipas) indicates that this pattern may have even more antiquity there (McClurkan 1966; MacNeish 1958; Nance 1992; Gustavo Ramirez, INAH-Tamaulipas, personal communication 2001). To provide some background to the detailed lithic analysis, the next section consists of a historical overview and morphological descriptions of the common South Texas projectile points and tool forms.

Table 12. Comprehensive list of metric and non-metric attributes employed in the study of distally beveled tool forms

Part I. Metric Attributes							
Maximum Length	measured on complete specimens						
Maximum Width	measured on complete specimens and fragments when available						
Maximum Thickness	measured on complete specimens and fragments when available						
Maximum Thickness at break							
Working edge angle	measured with goniometer						
Ventral face protrusion	measured as protrusion from vertical						
Part II. Non-metric Observational Attributes							
Raw material type	f-g chert	c-g chert	chalcedony	rhyolite	agate/jasper	quartzite	Other
Flake blank platform location	proximal	lateral	distal	indeterminate			
Flake blank cortex	present	absent	indeterminate				
Manufacture strategy	unifacial	bifacial	indeterminate				
Ventral face retouch	slight	moderate	extensive				
Working edge shape	concave	straight	convex				
Heat Treatment	Present	Absent	Indeterminate				
Completeness	Complete	Proximal	Medial	Distal	Longitudinal		
Ventral face polish	minimal	moderate	extensive				
Ventral face step fractures	minimal	moderate	extensive				
Other use-wear attributes comparing traits on experimental and archaeological specimens							

A Historical Overview and Summary of Common Projectile Point and Tool Forms from South Texas and Northern Mexico

Selected South Texas Projectile Point Types

Although some less common and less widely distributed point types (i.e., Carrizo, perhaps Kinney) also exist in South Texas and northern Mexico, the most common Middle and Late Archaic projectile point types consist of Abasolo, Catán, Desmuke, Matamoros, Refugio, and Tortugas (Figure 38). The following section provides a brief historic review of the definition of these types in alphabetic order.

Abasolo

Abasolo Round-base or Abasolo was named by MacNeish (1958) based on a large number of surface (n=845) and a smaller sample of excavated (n=155) specimens from the Sierra de Tamaulipas. MacNeish described the type as having a roughly teardrop shape with a convex base that gradually merges into convex sides. Suhm et al. (1954:400) describe the outline as ranging from weakly convex to well-rounded, almost semicircular. Thinning of the base using large flakes was uncommon on these specimens. MacNeish (1958:64) remarked that often the tips of the points had been steeply beveled on opposite edges and sides. Hester et al. (1969) describe the type as having a trianguloid outline, convex base and straight to slightly convex blade edges. One of the key characteristics of the type is that its maximum width occurs very near the base of the point. Another of its diagnostic characteristics is that by definition, only teardrop shaped specimens that are greater than 40 mm in maximum length have been defined as Abasolo (Suhm et al. 1954:400).

McClurkan (1966:25–27) differentiates three varieties in the sample from Cueva de la Zona de Derrumbes. The Variety I specimens are narrow in relation to their length, are leaf-shaped in outline and have convex sides and well-rounded bases. This group is also relatively thin in cross-section (thickness ranges from 6–10 mm; see Table 13). The Variety II specimens also are leaf-shaped but are relatively wide in relation to their length and are thick in cross-section (see Table 13). Finally, the Variety III Abasolo points constitute a median group and exhibit no distinguishing features.

Distribution: The type is widespread in Tamaulipas and it seems to be most common in the Rio Grande Valley below Laredo. Campbell (1964; cited in Hester 1969) and Newton (1963; cited in Hester 1969) have both reported the type from Kleberg County. Campbell also found Abasolo specimens at the Kent-Crane site in Aransas County (Campbell 1952) and in the Webb Island site collection from Nueces County (Campbell 1956). Prewitt's (1995:88) distributional analysis indicates that small numbers of specimens occur in the Lower Pecos and in Central Texas. The core area of distribution appears to be South Texas, including the coastal counties. This general triangular round-based form is also rather common throughout North and South America. However, because such forms can also serve as a blanks for the manufacture of many notched point types, low frequency occurrences of triangular round-based forms may not represent the true use of the specimens as finished projectile points. According to MacNeish (1958) the form is similar to the large variety of Desmuke points in southern Texas.

Temporal Range: MacNeish's (1958) work in Tamaulipas has been roundly criticized for oversimplifying stratigraphy and cultural sequences and ignoring the complex and sometimes mixed nature of deposits (Epstein 1980; Taylor 1960). Nonetheless, since it is the work that laid the chronological foundation for subsequent research in both northeastern Mexico and parts of South Texas, the temporal position of the points named by MacNeish (1958) will be presented in the following discussion. According to MacNeish (1958), in Tamaulipas, Abasolo points first appear in earliest Nogales times (7,000–5,000 years ago) and are the dominant type. They continue in relatively large numbers though the Almagre Phase (4,200–3,500 years ago) and then occur as a minority in subsequent parts of the sequence. At Cueva de la Zona de Derrumbes, Abasolo points occur throughout Levels 2–18, dating between 1500 B.C. and A.D. 800 (3450–1150 BP). The Variety I Abasolo points, the largest variety, are most common in Levels 4–8, dating roughly between A.D. 100–800 (1850–1150 BP). Variety III points, the smaller variants, are most

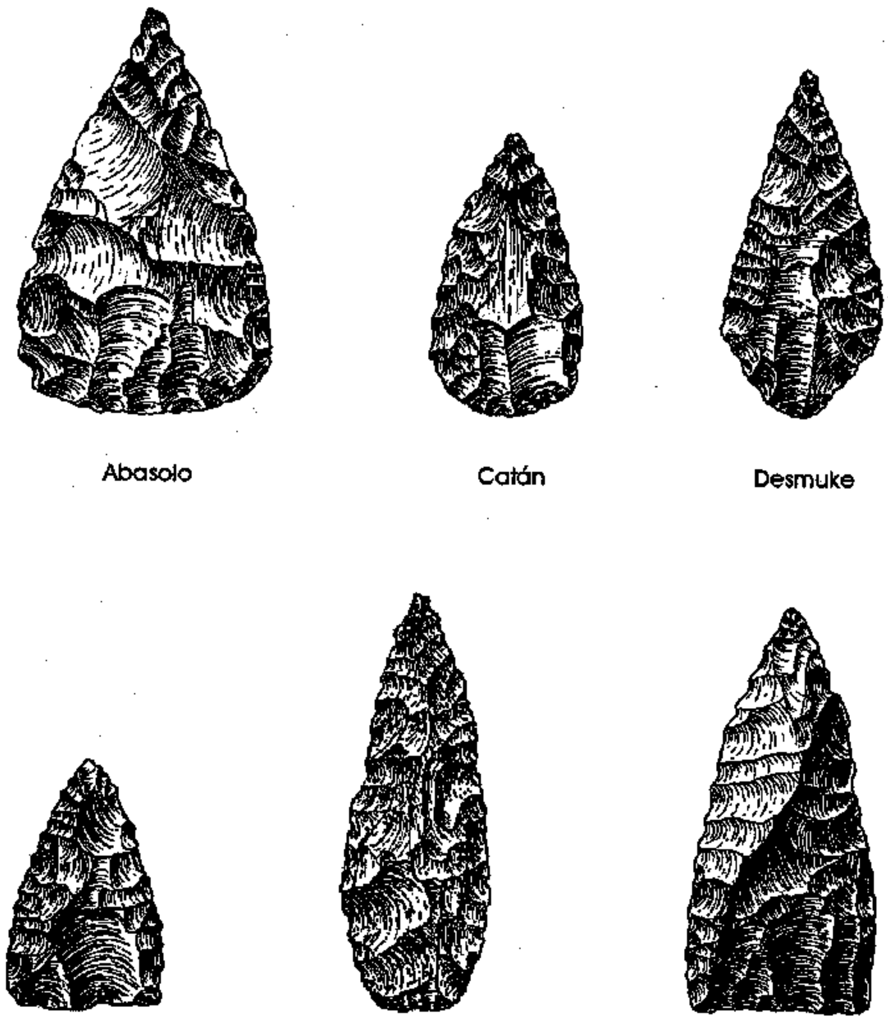


Figure 38. *Common dart point types found in South Texas.* Adapted from Turner and Hester 1993.

Table 13. Projectile point varieties and dimensions for the common South Texas-North Mexico types

Type Name	Max. Length	Max Width	Max. Thickness	Sample	Reference	Named by
Abasolo Round-Base	38-76	20-42	8-17		MacNeish 1958	MacNeish 1958
Abasolo	40-55	21.5-29.5	6.5-10		Hester et al. 1969	
Abasolo	40-80	20-50			Suhm et al. 1954	
Abasolo Variety I	48-67	26-30	6-10		McClurkan 1966	McClurkan 1966
Abasolo Variety II	44-47	26-31	9-11		McClurkan 1966	McClurkan 1966
Abasolo Variety III	39-48	20-29	5-10		McClurkan 1966	McClurkan 1966
Abasolo	52-70	26-33	5-10	36	Bettis 1997	
Catan Round Base	15-37	15-26	3-13		MacNeish 1958	MacNeish 1958
Catan	31-48	17.5-21	5.5-8.5		Hester et al. '69	
Catan	20-45	15-25			Suhm et al. 1954	
Catan Variety I	31-40	21-29	4-9		McClurkan 1966	McClurkan 1966
Catan Variety II	26-35	17-25	4-9		McClurkan 1966	McClurkan 1966
Catan Variety III	27-38	16-21	5-9		McClurkan 1966	McClurkan 1966
Catan Variety IV	18-24	16-17	4-6		McClurkan 1966	McClurkan 1966
Catan	35-50	17-22	6-9	57	Bettis 1997	
Desmuke	35-47	15.5-24	4-6		Hester et al. 1969	Suhm et al. 1954
Desmuke	38-65	19-26	6-9	46	Bettis 1997	
Desmuke	30-50	15-25			Suhm et al. 1954	
Matamoros Triangular	18-40	16-26	6-12		MacNeish 1958	MacNeish 1958
Matamoros	20-40	15-25			Suhm et al. 1954	
Matamoros	25-38	20-25	4.5-7		Hester et al. 1969	
Matamoros	30-41*	20-24	4-8	47	Bettis 1997	
Matamoros	25-54	14-29	4-9	70	McClurkan 1966	
Matamoros	25-29	17-25	3-5	4	Nance 1992	
Matamoros	30-33	19-20		2	Hall et al. 1982	
Nogales Triangular	40-70	21-40	3-6		MacNeish 1958	MacNeish 1958
Refugio	60-100	20-30			Suhm et al. 1954	
Refugio	44-61	18-27	5-13	14	McClurkan 1966	
Tortugas Triangular	38-75	25-46	3-8		MacNeish 1958	MacNeish 1958
Tortugas	35-80	20-40			Suhm et al. 1954	
Tortugas	38-70	20-33	5-10		Hester et al. 1969	
Tortugas	41-45	21-29	4-6	4		
Tortugas Variety I	41-80	23-51	?		McClurkan 1966	McClurkan 1966
Tortugas Variety II	?	?	?		McClurkan 1966	McClurkan 1966

common between Levels 10–18, dating roughly between 1500 B.C. and A.D. 100 (3450–1850 BP). Suhm et al. (1954:400) estimate its age in Texas to be between 5000–3000 B.C. (6950–4950 BP) and surviving perhaps as late as A.D. 500 (1450 BP) and even as late as the eighteenth century along the lower Rio Grande. At the Loma Sandia site (41LK28), Abasolo points were recovered from the late Middle Archaic cemetery zone dating to circa 850–550 B.C. (2810–2500 BP; Taylor and Highley 1995).

Catán

The Catán Round-base type also was named by MacNeish (1958) based on excavated specimens from sites in the Sierra de Tamaulipas (n=20), Sierra Madre (n=131), and surface collected and excavated coastal sites in Tamaulipas (n=22), as well as 50 points from Texas. The type is defined as roughly teardrop-shaped in outline. Specimens have narrow, triangular blades with convex edges and convex to well-rounded bases. The Tamaulipas specimens tend to be percussion flaked and many display the flat ventral faces of the flake blanks used in their manufacture. The distal ends of about one-fourth of the Tamaulipas sample studied by MacNeish are beveled. Beveling seems to be less common on specimens from South Texas (Hester et al. 1969). As in the case of the Abasolo type, Catán specimens also tend to reach their maximum width near the base of the point. However, by definition (Suhm et al. 1954:410), they range from 20 to 40 mm in maximum length, although some specimens measuring 45 mm have been included in the type (Suhm et al. 1954:410; see Table 13). Those specimens greater than 40 mm tend to overlap with the smaller of the Abasolo points.

McClurkan (1966:27–28) distinguished four varieties within his collection from Cueva de la Zona de Derrumbes (see Table 13). The Variety I Catán specimens are leaf-shaped and have slightly convex sides and bases that are strongly convex to well-rounded. The average width/length index is 66. The width/length index (referred to as length/width index in McClurkan 1966) was derived by dividing the mean maximum width of each variety group by the mean maximum length of the variety group and presenting the product as a whole number. The Variety II Catán have the same general outline as Variety I, but are somewhat smaller in overall dimensions, and are somewhat broader in relation to their length than Variety I specimens. The average width/length index is 71. Variety III specimens have the same general outline but are somewhat longer and narrower than Variety II, although not as long as Variety I. The average width/length index is 56. Finally, the Variety IV specimens are the smallest of the four varieties and are also the broadest in relation to length. The average width/length index is 78.

Distribution: Specimens of this type occur over most of Tamaulipas and adjacent parts of Texas, and the Gulf Coast of Texas. Prewitt's (1995:97) distributional analysis indicates that large numbers of Catán points occur in the central portion of South Texas, including the coastal counties, and smaller numbers occur in sites on the Gulf Coastal Plain and in the Lower Pecos. Large numbers have been noted in Travis County, however, many of these may be preforms for arrow points.

Temporal Range: In the Sierra de Tamaulipas this type occurs sparingly with all pottery horizons, but in the Sierra Madre it is numerous in the latest preceramic Guerra Phase, and also in the Laguna, Eslabones, and La Salta phases (2,600–1,100 years ago; MacNeish 1958). However, MacNeish (1958:69) admits that in his initial study many of the larger varieties of Catán Round-base points in the early ceramic levels were considered to be Abasolo points. Suhm et al. (1954:410) suggest that the point may have first appeared around A.D. 500 (1450 BP) and may have continued in use until the eighteenth century. At Cueva de la Zona de Derrumbes, Variety IV specimens, the smallest variant, occur only in Levels 18–19 and 21–22, dated to between 2800–1500 B.C. (4800–3450 BP). In addition, only two Catán Variety I points, the larger variants, occur above Level 9, tentatively dated around A.D. 800 (1150 BP). The early occurrence of Catán points at Cueva de la Zona de Derrumbes is quite different from MacNeish's late temporal assignment of the point. In considering the distinctions between Abasolo and Catán points, McClurkan (1966:28) states that MacNeish's data (1958:68–69) do not show a difference in temporal distribution. Nunley et al. (1965:52) also indicate that there is no particular distributional difference between large (Abasolo) and small (Catán) points in the Amistad Reservoir samples. The same pattern seems to hold for the Cueva de la Zona de Derrumbes. In considering the relationship between the Abasolo and Catán types, McClurkan (1966:73) indicates that the two types are related in form and were divided into morphological varieties on the basis of size and other characteristics. The morphological varieties proved to have little temporal significance. In general, the Abasolo-Catán specimens seemed to behave as a single group being distributed throughout the cultural deposit. Most interestingly, the large specimens (Variety I Abasolo) tended to cluster in higher levels (4–8), while smaller specimens (Variety IV Catán) occurred in lower levels (Levels 18–22; see McClurkan 1966:90–91 and Figure 25). In addition, the smallest Abasolo varieties and the larger Catán varieties occur throughout the deposit.

Desmuke

Suhm et al. (1954:416) first described the Desmuke type. It is characterized by a lozenge-shaped outline, with straight or convex blade edges that meet the stem at a rather distinct angle. The stem edges tend to contract and have either straight or slightly rounded edges, or a combination of both, and terminate in a pointed, convex, or even straight base (i.e., specimens from 41WB557; J. Michael Quigg, personal communication 2001). It is this feature, the easily discernible division between the blade and the stem, which seems to be employed as the primary diagnostic criteria of the type. The frequency of blade beveling is low and, unlike Abasolo and Catán points, the maximum width of the point tends to occur farther above the base than on those two types. Table 13 presents the metric dimensions characterizing the type.

Distribution: The distribution of the type is very similar to that of the Abasolo and Catán points (Prewitt 1995:88, 97), being concentrated in the central and southern portion of South Texas and having smaller numbers in Central Texas and the Lower Pecos. The type is also found in the coastal counties in South Texas but it does not appear to extend onto the Gulf Coastal Plains. Suhm et al. (1954:416) suggest that the Desmuke is most frequent along middle parts of the Frio and Nueces River valleys, occurring in lower frequencies south of there. Hester et al. (1969:161) have shown that although the type is scattered over much of southern Texas, it tends to be concentrated in southern La Salle County (though it does extend into northern La Salle) where the county adjoins Webb, Duval, and McMullen counties. According to MacNeish (1958:64), the Desmuke points known from southern Texas are similar to the larger Abasolo forms from Tamaulipas. If this observation is correct, it may be possible to extend its distribution into southeastern Tamaulipas.

Temporal Range: MacNeish's comment (1958:64) suggests that, at least in Tamaulipas, Desmuke points should be considered contemporaneous with Abasolo points. Suhm et al. (1954:416) originally could only assign the type to the Archaic period. Turner and Hester (1993:105) assign the type to the Late Archaic period.

Matamoros

The Matamoros Triangular type was defined by MacNeish (1958:68) based on 515 surface collected and 35 excavated specimens obtained from sites in the Sierra de Tamaulipas. The specimens are roughly equilateral or isosceles triangles similar in outline to the larger Tortugas type. The bases range from straight to slightly convex and slightly concave, while the blade edges are straight or just slightly convex, although specimens with slightly concave lateral edges also exist (Hester et al. 1969). On concave-based specimens, the depth of the concavity is always less than 2 mm. The Tamaulipas specimens were manufactured primarily by percussion flaking and a portion of the collection displayed part of the ventral face of the parent flake. About one-fourth of the points from Tamaulipas have beveled edges. Bases are thinned either by retouching, the removal of large flute-like scars (MacNeish 1958:68), or short vertical flakes (Hester 1969:14–15) on either surface. By definition (MacNeish 1958:68), one of the diagnostic characteristics of the points is that they range from 20 to 40 mm in maximum length, although some specimens longer than this may also be included (see McClurkan 1966:34). Unfortunately, it is unclear what diagnostic criteria are used to place these larger specimens into the Matamoros rather than Tortugas type. Table 13 presents the range in metric dimensions characterizing the type.

Distribution: The type is common in Tamaulipas (MacNeish 1958) and it is also present in Nuevo León as indicated by specimens from the Cueva de la Zona de Derrumbes (McClurkan 1966:34–35), La Calsada (Nance 1992:38, 40), and San Isidro (Epstein 1969:23–24). Prewitt's distribution analysis indicates that it also occurs in small numbers in the Lower Pecos and in the coastal bend counties (i.e., Aransas, San Patricio, Nueces, Kleberg, and Kenedy; see Campbell 1947, 1952, 1956, and 1958; Corbin 1963; Newton 1963, cited in Hester 1969). Apparently, some points of this type have been encountered as far north as Williamson County (Prewitt 1995:117).

Temporal Range: According to MacNeish (1958:68), this type begins with the earliest pottery in the Sierra de Tamaulipas and reaches its greatest concentration in the Los Angeles Phase (A.D. 1200–1780). McClurkan (1966:34) recovered a total of 70 specimens that he classified as Matamoros from Cueva de la Zona de Derrumbes. Although seven of them came from within Levels 11–16, tentatively dated to between 1500 B.C. and A.D. 100 (1850–1150 BP), the majority were from within Levels 1–8, dated to between A.D. 100–800 or slightly later. McClurkan (1966:70) provides a date range of A.D. 600–1000 (1350–950 BP) for Matamoros points from Cueva de la Zona de Derrumbes based on radiocarbon dates from the site. However, an examination of his report indicates that McClurkan's Tortugas Variety II and Matamoros points are morphologically nearly identical and the former is actually even slightly smaller than Matamoros points (McClurkan 1966:34, 71). An examination of the distribution of the Variety II Tortugas (McClurkan 1966:Figure 25) indicates that they occur exclusively within Levels 11–16. This distribution is identical to the lower zone of Matamoros points mentioned earlier and suggests that, based on size alone, triangular projectile points matching the Matamoros type occur throughout the Cueva de la Zona de Derrumbes deposits.

In Texas, Suhm et al. (1954:448) suggest that the type may have first appeared about A.D. 500 (1450 BP) and may have survived into the historic period. At 41ZP364, a well-defined Occupation 2 containing a single Matamoros point appears to date roughly to A.D. 600 (1350 BP; Quigg and Cordova 2000:123). A Matamoros point was also recovered from 41LK67 from deposits dating between A.D. 500-800 (1450–1150 BP; Brown et al. 1982:49–50, Figure 11, t). At Loma Sandia, a number of burials and/or associated features seem to contain what appear to be both Matamoros and Tortugas points (see F11-L, F-12, F-124A, F161, F173, and F192 in Taylor and Highley 1995:131, 140, 197, 224, 237, and 258). These features seem to date to the period between A.D. 450–850 (1500–1100 BP). Although from an undated context, two Matamoros points also have been recovered from 41LK106, from a hearth also containing 41 undecorated bone-tempered pottery sherds (Creel et al. 1979:23).

Refugio

The Refugio type was first described by Suhm et al. (1954:474) as being leaf-shaped with a long and slender blade. In describing the traits of the Carrollton and Elam Foci of the no-longer-used Trinity Aspect of the Archaic, Crook and Harris (1954) call points similar to the Refugio type "Wheeler Leaf." The blade edges of Refugio points are convex but can occasionally be nearly straight. The bases vary from convex to nearly semicircular and convex but with a straight middle segment. The body of the point is rather thick and the base is usually thinned by short thinning flakes. One of the diagnostic characteristics of the point is that it often exhibits a rather long blade and parallel blade edges. Therefore, it is often the case that the maximum width of the blade does not occur near the base of the point but rather farther up on the blade. Table 13 presents the range in metric dimensions that characterize the type.

Distribution: MacNeish (1958) does not recognize the type in his materials from southeastern Tamaulipas. McClurkan (1966:36), on the other hand, identified 14 Refugio points from his excavations at Cueva de la Zona de Derrumbes. Prewitt's (1995:127) distributional analysis indicates that the type is common in the southwestern part of South Texas extending as far north as Bexar County and surrounding counties. Smaller numbers are found in the Lower Pecos and on sites in the Coastal Bend counties (Campbell 1956:22; Corbin 1963:22).

Temporal Range: At 41WB437, Quigg et al. (2000:Figure 13.1) recovered two Refugio points in Occupation 5, dating to roughly 3,260-3,400 years ago. A second Refugio point came from Occupation 3, dated to about 2,700 years ago, and was in association with Tortugas points, suggesting either continued use, contemporaneity, recycling, or some degree of mixing of deposits. A single Refugio point associated with two Tortugas points in Feature 111 from the Loma Sandia site was dated to between 2,400–2,800 years before the present (Taylor and Highley 1995:188). These finds also support the contemporaneity of the two types.

Tortugas

The Tortugas point (Tortugas Triangular Blade [Kelley 1947]; Tortugas Triangular [MacNeish 1958]) was originally named by Kelley (1947) and more fully discussed by Suhm et al. (1954:482 and Plate 120). MacNeish's description of the type refers to about 1,000 specimens, only 111 of which came from excavated sites in the Sierra de Tamaulipas (MacNeish 1958:64). The Tortugas type is described as having large triangular blades with straight to slightly convex edges. Blades vary from rather narrow to relatively broad. MacNeish (1958:64) originally included only concave base specimens in the definition reserving the Nogales type name (ibid:64) for triangular specimens with convex bases. Nogales points also were characterized by a lack of large base thinning flakes that created a "fluted" appearance and were contemporaneous with Abasolo points (ibid:64). Later definitions of the point by other authors incorporated the entire range of basal shapes and base treatments in the type. In discussing specimens from sites in La Salle County, Hester et al. (1969:142) indicate that the basal edges of these Tortugas points are generally straight, although a number of slightly concave-edged and convex-based specimens are also present. In the majority of the specimens, basal thinning is achieved through the removal of several short longitudinal flakes on one or both faces (Hester et al. 1969:142). On a smaller number of specimens, basal thinning has been achieved by the removal of a single flake or two parallel large flakes (accompanied by smaller, vertical flakes) on one or both faces (Hester et al. 1969:142). About one-half of the collection in Tamaulipas, on which the type was defined, have alternately beveled edges near their tips. A smaller number of specimens are beveled only along one edge of one face, while some appear to have no beveling present. There is a considerable size range in these points. One of the diagnostic characteristics of the type is that, in general, only triangular points matching the above-described attributes and exceeding 40 mm in maximum length are defined as Tortugas. Nonetheless, some specimens that are as small as 34 mm have been included in the type (Hester 1969:16). These smaller specimens overlap with Matamoros points in dimensions (Hester 1969:15).

McClurkan (1966:37–38) distinguishes two varieties (I and II) based on work at Cueva de la Zona de Derrumbes (see Table 13). Variety I Tortugas points are relatively large, triangular points. Sides and bases may vary from slightly convex to straight to slightly concave. Basal corners are generally sharp and well-defined, but may occasionally be slightly rounded. Beveling is absent from the Cueva de la Zona de Derrumbes sample while basal thinning is present in most of the specimens. These specimens range from 41 to 80 mm in maximum length and 23 to 51 mm in maximum width. The Variety II Tortugas has the same general outline as the Variety I specimens, however, the Variety II specimens are smaller in size and are broader in relation to their length than the Variety I specimens. The Variety II specimens range from 20–41 mm in length, 19–34 mm in width, and 4–8 mm in thickness. They are similar to the Matamoros type in length. Beveling is not common on these specimens while basal thinning is present on most. Although they are similar to Matamoros points, according to McClurkan (1966:38), the two types differ in their width/length index. The average width/length index of the Variety II Tortugas is 83, the same figure for the Matamoros is 63, the Variety I Tortugas have a width/length index of 61. As mentioned earlier, at Cueva de la Zona de Derrumbes, the small Variety II Tortugas occurred in levels also containing the Matamoros type (McClurkan 1966:125).

Distribution: The type is common throughout Tamaulipas and Nuevo León (McClurkan 1966; Nance 1992) in Mexico. They are most common in South Texas, in counties adjacent the Falcon Reservoir, although they extend into the Lower Pecos and are also present in coastal counties extending north to the coastal bend (Campbell 1952, 1956, 1964 [cited in Hester 1969]; Corbin 1963; Nunley and Hester 1966; Prewitt 1995:132).

Temporal Range: In the Sierra de Tamaulipas, Tortugas points first appear in Late Nogales times (7,000–5,000 years ago), and reached their maximum concentration in La Perra times (5000–4200 BP), and diminished to a minority type during the Almagre period (4200–3500 BP). MacNeish (1958:64) remarks that although points matching the Tortugas definition are occasionally found in components belonging to later phases, he does not think that the type is made after Almagre times. Based on radiocarbon dates from Cueva de la Zona de Derrumbes, McClurkan (1966:70) identifies the date range for Tortugas as between 1200 B.C. to 400 B.C. (3150–2350 BP). However, if the Matamoros points from the upper zones are nothing more than heavily resharpened Tortugas, it would greatly expand the temporal range of the type into Late Prehistoric times. Hester (1995) considers the Tortugas point as a common South Texas point type with its greatest occurrence during the Middle Archaic (2500–400 B.C. [4500–2350 BP]). In northern Tamaulipas and adjacent parts of Texas the type may have lasted until somewhat later.

Within the Choke Canyon sites, unstemmed triangular points similar to the Tortugas type appear to have been most common between roughly 4450–2350 BP (Hall et al. 1986:399). At site 41LK67 in the Choke Canyon project, three triangular Tortugas points (see Brown et al. 1982:Figure 11, p-r) were recovered in deposits dating to between 2,750–2,350 years ago (Brown et al. 1982:309). A triangular point from 41LK67 was associated with charcoal radiocarbon dated to between 800–400 B.C. (Brown et al. 1982:309). Triangular point fragments from 41LK31/32 date between 3380–2340 B.C. (Brown et al. 1982:309). Tortugas points at 41WB437 appear as early as 3,000 years ago (Occupation 4) and continue until 2,000 years before the present (Occupation 1). Feature 111, a small cluster of mortuary items at the Loma Sandia site (Taylor and Highley 1995), yielded two Tortugas points in association with a Refugio point. Associated charcoal dates suggest an age range of between 2,400–2,800 years before the present for the feature. Tortugas occupation at 41SR42 (Hartle and Stephenson 1951) was charcoal dated to 4,650 ± 300 years ago (see Suhm et al. 1954:565), while at 41ZP364, Quigg and Cordova (2000:123) obtained dates ranging between 3900–5100 BP for Occupation 3, containing a single Tortugas point. At 41WB314, a discrete Tortugas reduction station was dated to 2740 ± 60 BP (Miller et al. 2000:67).

Selected South Texas Distally Beveled Tools

A number of consistently recurring tool forms have been identified as a result of the numerous archeological investigations conducted at the regional level across South Texas. These distally beveled tools include Dimmit and Nueces tools and Olmos bifaces (Figure 39). Although the temporal range of these forms is not well defined, this writer (SAT; see also Hester 1995) assumes that they are Middle to Late Archaic forms and therefore each of the types will be discussed in turn below.

Nueces Scrapers

This tool form was originally defined by Hester et al. (1969:131) based on specimens from the Oulline Site and other sites in La Salle County. Nueces scrapers were defined as having a distinctive trapezoidal outline with straight to convex edges. The working edge is steeply beveled, and varies from slightly convex, to straight and slightly concave. Both bifacial and unifacial specimens have been noted, and accordingly, their transverse cross-sections vary from biconvex to plano-convex. Finally, an additional tool form described by Hester et al. (1969) is the Lunate scraper from the Oulline site. These specimens are roughly lunate in outline, with plano-convex cross-sections. The widest edge (bit) varies from straight to concave, and is always steeply beveled; the opposite edge is convex and rarely shows evidence of use. Both unifacially and bifacially manufactured tool forms were included in the original definition. Based on the characteristics of working edge rejuvenation, these tool forms may represent Nueces scrapers with heavily resharpened working edges.

Distribution: A number of distally beveled tool forms were recovered from the Choke Canyon project where, because of the morphological classificatory system being used, they were identified as Group 3 short, broad, triangular to subtriangular distally beveled bifaces and unifaces (Brown et al. 1982:326–328, Figures 72 and 73). Of the 63 distally beveled tools, 21 specimens were identified as Form 3, triangular to subtriangular forms identical to the Nueces scrapers defined by Hester et al. (1969).

The Nueces scrapers are found primarily on sites in the northern part of South Texas. Hester (1969) describes a number of them from site 41MC1 in northern McMullen County. Although distally beveled tool forms were found at Choke Canyon, they appear to be less common than farther south of the Three Rivers area. Lunate scrapers are widespread in southern Texas, occurring in Dimmit, Duval, McMullen, Webb, and Zavala counties.

Dimmit Scrapers

These distally beveled scrapers were defined by Nunley and Hester (1966:233–253) based on work in Dimmit County. The scraper is triangular in form and

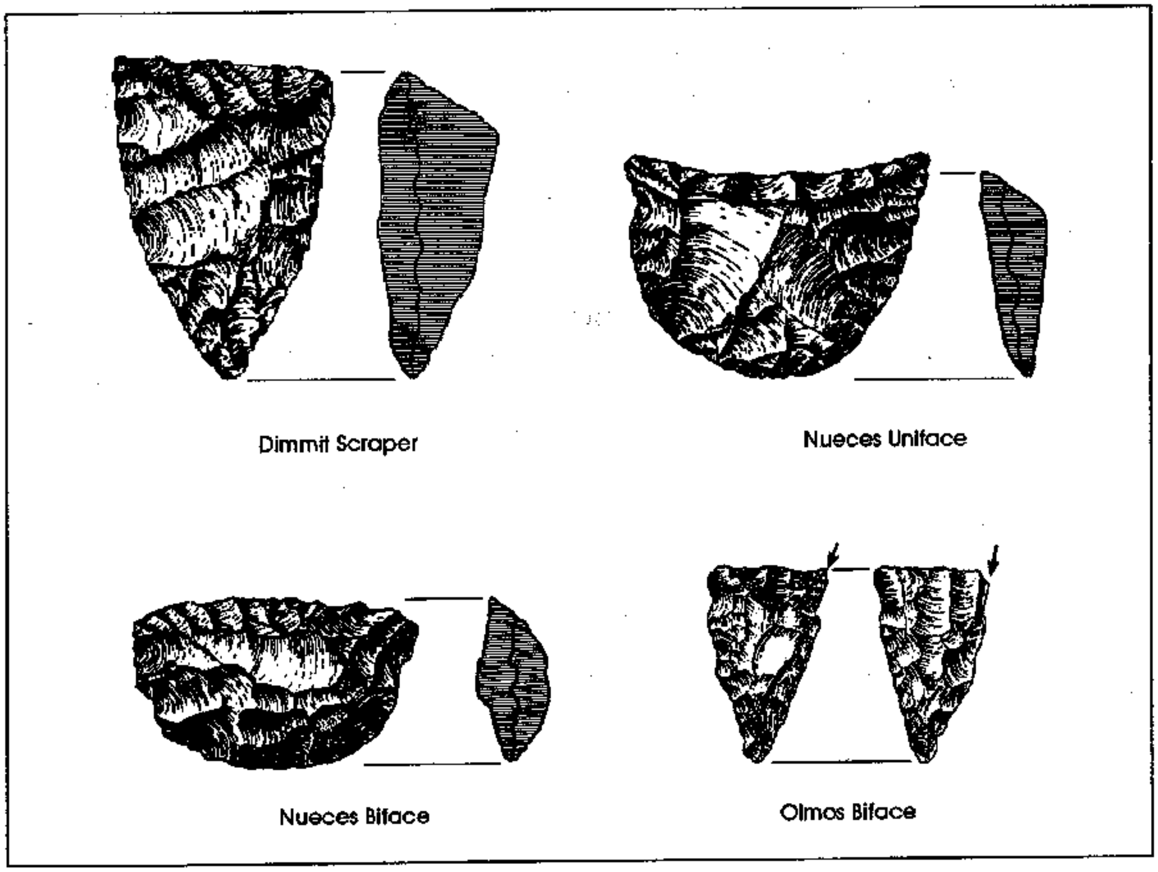


Figure 39. *Distally beveled tool forms common in South Texas sites.* Adapted from Turner and Hester 1993.

plano-convex in cross-section. The two specimens illustrated in Nunley and Hester (1966:Figure 2g) appear to have pointed proximal ends. Dimmit scrapers are unifacially worked and have a plano-convex, hump-backed appearance. The flat face is very smooth and often highly polished. This scraper is the same as Ray's (1941:154–155) "Clear Fork 2" or "Planner Gouge," although it should not be considered a Clear Fork tool.

A number of distally beveled tool forms recovered from the Choke Canyon project and identified as Group 3, Form 1 (triangular, proximal end pointed) and Form 2 (triangular, proximal end rounded), probably represent Dimmit scrapers (Brown et al. 1982:326, 328). Although the type was originally defined as a unifacial tool form, only some of the specimens included in Forms 1 and 2 are unifacial (eight in each form), while the majority is bifacially made (14 and 12 specimens, respectively). Nonetheless, the morphological similarity and the macro and microscopic use-wear indicate that both unifacial and bifacial tool forms were used in an identical manner, and therefore should be considered the same functional tool.

Distribution: The distribution of Dimmit scrapers appears to be roughly equivalent to that of Nueces scrapers, centered primarily in the southwestern portion of South Texas including Dimmit, Maverick, Starr, Webb, and Zapata counties (Hester et al. 1969:152).

Olmos Bifaces

Hester (1969:33) defined this distally beveled bifacial tool form based on work conducted in Kleberg and Kenedy counties. Olmos tools are small triangular bifaces with straight or slightly convex lateral edges and straight to slightly convex distal ends that are steeply beveled.

Working edge angles are often greater than 60 degrees and the maximum thickness of the specimens tends to be found immediately proximate of the working edge. The tools range from plano-convex to biconvex in transverse cross-sections.

Distribution: When originally defined, the small sample suggested that the form had a relatively limited distribution having originally been found in Kleberg County but also having been noted in collections from southeastern Duval County (Rios-Santa Cruz locality) and Nueces County (Campbell 1956). Based on a more comprehensive study of their distribution, Shafer and Hester (1971:7) identify the distribution of Olmos bifaces as concentrating within a narrow band, 70–80 miles wide, extending from western Kleberg County on the east to central Webb County on the west. In addition, however, small numbers of these tool forms have been recovered in other counties along the Texas-Mexico border (Starr and Zapata counties) and south of the border in northern Tamaulipas (Ciudad Mier, Tamaulipas; see Shafer and Hester 1971:8).

A Technological Analysis of Tool Forms, Designs, and Use-Life Histories

The analysis of any tool forms, be they single- or multi-functional, is most productive when the analysis looks not only at the morphology of a tool but also attempts to explain the design characteristics of the tool in terms of functional requirements and performance characteristics. Furthermore, the more complete the understanding of the changes in tool morphology through the use-life of the tool, the more likely that the morphological variants generated through the use-life of a form will be recognized as representative of the same functional, and perhaps typological, category at different stages of rejuvenation.

The following section discusses the sequence of manufacture, resharpening, and rejuvenation (i.e., repair) of the principal and most common unstemmed projectile point types and distally beveled tools reviewed in the previous section. The goals of this section are threefold: 1) document the changes in projectile point morphology during the use-life of the various types; 2) relate this variability to the diagnostic attributes used to define these types and/or functional categories; and 3) consider the validity of the projectile point types and the ease of their consistent recognition.

The sample of artifacts used in this analysis consists of three main collections: the Loma Sandia (41BX28) points, the Prevost Family Collection, and selected specimens from the Riley Family Collection. A number of triangular and round-base points were analyzed from the Loma Sandia collection (Table 14). In some instances typological designations were changed compared to their original assignments in Taylor and Highley (1995) and as they were cataloged at the CAR curation facility. The Prevost collection is a collection of projectile points and tools from the privately owned property found immediately across the fence and to the west of 41WB556 and 41WB557. The collection comes from three campsites found on the banks of Becerra Creek but some two to three miles upstream from sites 41WB556 and 41WB557. The collection was acquired over many years of surface collecting. Both triangular and round-base points and Nueces/Dimmit and Olmos tools were present in the collection (Table 14). The Riley Family Collection is an enormous collection of tools and arrow and dart points from throughout South Texas and northern Mexico in the vicinity of the international border. Only a small fraction of the thousands of projectile points and tools were formally analyzed (Table 14), although thousands were inspected to assure that the analyzed samples are representative of the collection. Finally, a small fraction of the analyzed sample comes from 41WB556 (Table 14).

The assignment of the distally beveled tool forms to either Nueces or Olmos forms was not difficult given the significant morphological differences between them (see Historical Overview section). Dimmit scrapers were not analyzed for this study.

Prior to analysis of the projectile points, it was hoped that the data would be measured, recorded, and entered into the computer and used as the basis from which to generate the typological groupings. As the analysis began, it became evident that it would be useful to assign a type to each point analyzed based on the diagnostic criteria summarized in the previous section. In assigning the types, complete round- and/or convex-based, teardrop-shaped points smaller than or equal to 41 mm in maximum length were assigned to the Catán type. Specimens larger than 41 mm

Table 14. Breakdown of artifact collections analyzed in this study

Analyzed Collection	Artifact Category	Analyzed Sample
Loma Sandia (41BX28)	Triangular points	58
	Round base points	34
	Nueces tools	0
	Olmos tools	0
Prevost Family Collection	Triangular points	73
	Round base points	50
	Nueces tools	100
	Olmos tools	3
Riley Family Collection	Triangular points	201
	Round base points	203
	Nueces tools	118
	Olmos tools	91
41WB556	Triangular points	3
	Round base points	2
	Nueces tools	0
	Olmos tools	0
Total Sample		936

were assigned to the Abasolo type. Similarly, complete triangular points measuring less than or equal to 41 mm in maximum length were grouped into the Matamoros type. Those larger than 41 mm were assigned to the Tortugas type. In the case of both the round-base and triangular forms, proximal fragments measuring less than 41 mm in maximum length were typed as indeterminate. As the analysis continued, it became evident that some technological features of the points may be more accurate indicators of projectile point type than maximum size. Therefore, in addition to classifying the points in terms of traditional diagnostic criteria (i.e., maximum size), all points were also classified into types based on technological characteristics indicative of their manufacture, resharpening, and rejuvenation histories. This classification allowed many proximal fragments that otherwise were classified as indeterminate to be classified into a type group based on morphological/technological features rather than maximum size. Therefore, each projectile point received two type classifications: one based on traditional diagnostic criteria ("traditional type" i.e., maximum length), and one based on technological criteria ("technological type").

Given that the manufacture techniques involved in the making of round-base projectile point types are relatively similar regardless of size, the manufacture of Abasolo, Catán, Desmuke, and Refugio points will be discussed under one section. Similarly, given the similarity in the manufacture of triangular projectile points, regardless of size, the Tortugas and Matamoros types also will be discussed as a single group. This does not necessarily mean that the author (SAT) assumes that the six types can and should be lumped into two main types. Rather, it is due to the fact that so much similarity in manufacture techniques is present within these groups that individual point type descriptions would yield too many repetitive statements without contributing substance to the descriptions. Nonetheless, where differences exist in the manner in which one or another feature of a type is manufactured or responds to failure probability, the intragroup differences will be highlighted and discussed.

The Abasolo-Catán-Desmuke-Refugio Group

A total of 98 Abasolo points, 84 Catán, 65 Refugio, and 29 Desmuke points were analyzed. Of the 98 Abasolo points, 65 (66%) have rounded bases, 32 (33%) have convex bases, while the remaining specimen has a slightly convex base. Among the Catán projectile points, convex-base points are more common (n=51, 61%) than rounded bases (n=33, 39%). A variety of base shapes can be observed in the small Desmuke sample. Contracting and pointed bases are the most common (ten specimens each), followed by rounded and straight bases, with four specimens each. Among the Refugio specimens, rounded bases are the most common (n=40, 61.5%) followed by convex bases (n=24, 37%). Descriptive statistics on the metric attributes recorded on this sample are presented in Tables 15–18.

Point Manufacture and Failure

Based on the examination of a sample of complete and fragmentary manufacture failed specimens, the manufacture of the round-base points in this group begins with relatively large and thick hard hammer flake blanks or small nodular cores. Since even the early stage blanks examined from the Prevost and Riley collections lacked cortex on their faces, the relative frequency of nodule cores versus flake cores could not be established from the samples studied. No doubt, the manufacture of the larger forms (Abasolo and Refugio) could have begun with nodule cores. Unfortunately, the reductive nature of lithic technology tends to eliminate the diagnostic indicators of the core type as one continues along the reduction sequence from early to late. The smaller size of the Catán points would suggest that their manufacture begins with medium-sized flake blanks. However, at least some complete round-base points that measure less than 41 mm in maximum length may have started out as larger forms (i.e., Abasolo and/or perhaps even Refugio points). The same is possible for at least those Desmuke points that exhibit a well-defined blade as opposed to stem segment developed as a result of blade resharpening

Once the blank is produced or selected, the specimen is thinned and shaped using percussion flaking with either small hard hammerstones or small billets or a combination of both. The use of pressure retouch may also be introduced relatively early in the reduction depending on blank form and size. The earliest manufacture failures tend to occur during the initial thinning of the blanks. Failure to properly thin a blank often resulted in the production of thick stacked areas of material surrounded by step- or hinge-fractured removal scars (Figure 40). Specimens showing such features tend to represent the early to middle stages of reduction. Given that such features would inhibit the thinning of the blank, specimens possessing such features were often discarded.

If and when the reduction proceeded beyond the middle stages, the next most common failure type appears to be the actual breakage of the blank from excessive force produced during lateral flake removal (i.e., perverse fractures). These lateral snaps produce a perverse snap fracture common of manufacture-failed specimens. In some instances, fractures initiated as a result of excessive force applied to the edge propagated until reaching an imbedded fracture line, eventually snapping the specimen along this line (see also Miller et al. 2000:Figure 7.5[150]). Specimens exhibiting this type of breakage tend to be middle and late reduction stage bifaces.

Of the four types discussed in this section, complete Refugio points have the highest mean maximum length (57.3 mm) and maximum thickness (complete and fragmentary specimens; 8.3 mm) dimensions, although they are relatively narrow in both maximum width and base width (Table 18). All things being equal, the added thickness of these specimens may provide them with greater resistance against bending fractures (i.e., snapping). Abasolo points have the next highest mean maximum thickness (7.8 mm) and their maximum and minimum values overlap quite nicely with those of the Refugio points (Table 15). The mean maximum thickness of the Desmuke points is nearly identical to that of Refugio points, although they are significantly shorter than their Refugio counterparts (Table 17). Catán points have the lowest mean maximum length and maximum thickness (Table 16). This, of course, is a product of the criteria used in defining the type.

The maximum width of Desmuke points is virtually identical to that of Refugio points, although their bases are significantly narrower than any of the other three types. Catán points are, by definition, the shortest and thinnest of the round-base points. They are also the narrowest points in terms of mean maximum width (Table 16). Abasolo points have the highest mean maximum widths and mean maximum base widths (Table 15), this again is a product of type definition.

Base thinning is initiated relatively early in the reduction process and it is carried out in a semicircular arc around the base of the point rather than concentrating on the midsection of the base (Figure 41). Early in the reduction, thinning flakes may be removed with a small hard hammer, while during the later stages of reduction removals appear to be the products of pressure flaking and rarely approach the length of the base thinning flakes noted on Tortugas points. Nonetheless, a total of 53 (54%) of the Abasolo specimens have between one and two base thinning scars that rival in length those noted on Tortugas points (Table 15). On 25 (47%) of these specimens base thinning flakes are present on both faces. Interestingly, 49 (58%) of the Catán points have base thinning flakes and 21 (43%) of these have at least one thinning flake on each of the two faces (Table 16). This proportion of base thinning flakes and their occurrence on both faces is similar to the Abasolo points and suggests a strong relationship between the two types. Desmuke points do not commonly exhibit base thinning flakes, as only three specimens (10%) from the sample have this feature (Table 17). All three of them, however, retain at least one thinning flake per face. Only

Table 15. Descriptive statistics for Abasolo points (n=98)

Max. Thickness		Dist. of Max. Thickness		Thickness 5 mm Base		Max. Length		Max. Width		Dist. Max. Width		Base Width	
Mean	7.79	Mean	24.03	Mean	3.65	Mean	48.19	Mean	23.91	Mean	11.94	Mean	20.35
Standard Er.	0.10	Standard Er.	0.61	Standard Er	0.06	Standard Er.	0.62	Standard Er.	0.31	Standard Er.	0.43	Standard Er.	0.41
Median	7.8	Median	23.15	Median	3.6	Median	47	Median	23.45	Median	11.9	Median	20.6
Mode	7	Mode	21.4	Mode	3.7	Mode	46.2	Mode	23.4	Mode	15.2	Mode	22
Standard Dev.	1.02	Standard Dev.	6.01	Standard Dev.	0.59	Standard Dev.	5.34	Standard Dev.	3.05	Standard Dev.	4.22	Standard Dev.	4.03
Sample Var.	1.05	Sample Var.	36.12	Sample Var.	0.35	Sample Var.	28.52	Sample Var.	9.31	Sample Var.	17.78	Sample Var.	16.20
Kurtosis	0.30	Kurtosis	-0.19	Kurtosis	0.46	Kurtosis	0.90	Kurtosis	1.07	Kurtosis	0.09	Kurtosis	0.78
Skewness	0.55	Skewness	0.51	Skewness	0.60	Skewness	1.09	Skewness	0.77	Skewness	0.26	Skewness	-0.25
Range	5.5	Range	27.7	Range	2.9	Range	24.4	Range	16.2	Range	21.6	Range	23.6
Minimum	5.6	Minimum	13.5	Minimum	2.6	Minimum	41.3	Minimum	17.8	Minimum	3.7	Minimum	9.5
Maximum	11.1	Maximum	41.2	Maximum	5.5	Maximum	65.7	Maximum	34	Maximum	25.3	Maximum	33.1
Sum	763.7	Sum	2354.5	Sum	357.9	Sum	3614.6	Sum	2343.6	Sum	1170.6	Sum	1994
Count	98	Count	98	Count	98	Count	75	Count	98	Count	98	Count	98

Face 1 thinning flakes		Face 2 thinning flakes		Face 1 flake length		Face 2 flake length		Face 1 resharp., length		Face 2 resharp., length		Weight	
Mean	1.47	Mean	1.45	Mean	16.98	Mean	15.49	Mean	39.72	Mean	39.78	Mean	8.62
Standard Er.	0.10	Standard Er.	0.10	Standard Er.	0.77	Standard Er.	0.79	Standard Er.	0.67	Standard Er.	0.63	Standard Er.	0.29
Median	1	Median	1	Median	17.6	Median	15.2	Median	39.65	Median	39.2	Median	8
Mode	1	Mode	1	Mode	18.9	Mode	13.1	Mode	39.3	Mode	35.9	Mode	7.4
Standard Dev.	0.65	Standard Dev.	0.65	Standard Dev.	4.72	Standard Dev.	4.96	Standard Dev.	6.40	Standard Dev.	5.95	Standard Dev.	2.55
Sample Var.	0.42	Sample Var.	0.42	Sample Var.	22.30	Sample Var.	24.61	Sample Var.	40.95	Sample Var.	35.42	Sample Var.	6.52
Kurtosis	0.08	Kurtosis	0.31	Kurtosis	-0.36	Kurtosis	0.23	Kurtosis	0.55	Kurtosis	0.77	Kurtosis	1.07
Skewness	1.05	Skewness	1.16	Skewness	-0.24	Skewness	0.26	Skewness	0.19	Skewness	0.49	Skewness	1.04
Range	2	Range	2	Range	20.4	Range	22.6	Range	36.1	Range	33.3	Range	12
Minimum	1	Minimum	1	Minimum	6.2	Minimum	5.5	Minimum	21.6	Minimum	23.7	Minimum	4.5
Maximum	3	Maximum	3	Maximum	26.6	Maximum	28.1	Maximum	57.7	Maximum	57	Maximum	16.5
Sum	56	Sum	55	Sum	645.2	Sum	604.3	Sum	3575	Sum	3540.1	Sum	646.3
Count	38	Count	38	Count	38	Count	39	Count	90	Count	89	Count	75

All measurements in mm.

Table 16. Descriptive statistics for Catán points (n=84)

Max. Thickness		Dist. of Max. Thickness		Thickness 5 mm Base		Max. Length		Max. Width		Dist. Max. Width		Base Width	
Mean	6.79	Mean	20.45	Mean	3.78	Mean	35.40	Mean	20.89	Mean	8.69	Mean	19.33
Standard Er.	0.10	Standard Er.	0.59	Standard Er.	0.20	Standard Er.	0.46	Standard Er.	0.26	Standard Er.	0.44	Standard Er.	0.33
Median	6.65	Median	20.8	Median	3.6	Median	36.2	Median	20.95	Median	8.4	Median	19.45
Mode	6.3	Mode	20.8	Mode	3.6	Mode	38.8	Mode	19.7	Mode	10.7	Mode	18.2
Standard Dev.	0.93	Standard Dev.	5.44	Standard Dev.	1.79	Standard Dev.	3.84	Standard Dev.	2.42	Standard Dev.	4.06	Standard Dev.	3.01
Sample Var.	0.86	Sample Var.	29.63	Sample Var.	3.21	Sample Var.	14.73	Sample Var.	5.85	Sample Var.	16.50	Sample Var.	9.07
Kurtosis	-0.36	Kurtosis	-0.44	Kurtosis	66.13	Kurtosis	-0.99	Kurtosis	0.18	Kurtosis	0.48	Kurtosis	1.13
Skewness	0.25	Skewness	-0.14	Skewness	7.71	Skewness	-0.49	Skewness	-0.10	Skewness	0.78	Skewness	-0.53
Range	4.2	Range	25.6	Range	16.5	Range	14.6	Range	12.7	Range	18.3	Range	16.1
Minimum	5	Minimum	7.6	Minimum	2.6	Minimum	26.2	Minimum	13.7	Minimum	1.9	Minimum	9.7
Maximum	9.2	Maximum	33.2	Maximum	19.1	Maximum	40.8	Maximum	26.4	Maximum	20.2	Maximum	25.8
Sum	570.5	Sum	1717.4	Sum	317.4	Sum	2513.7	Sum	1754.5	Sum	729.9	Sum	1624
Count	84	Count	84	Count	84	Count	71	Count	84	Count	84	Count	84

Face 1 thinning flakes		Face 2 thinning flakes		Face 1 flake length		Face 2 flake length		Face 1 resharp., length		Face 2 resharp., length		Weight	
Mean	1.38	Mean	1.69	Mean	14.04	Mean	13.42	Mean	29.24	Mean	29.6013	Mean	4.96
Standard Er.	0.13	Standard Er.	0.16	Standard Er.	0.70	Standard Er.	0.59	Standard Er.	0.49	Standard Er.	0.49674	Standard Er.	0.14
Median	1	Median	1	Median	14.9	Median	13	Median	29.6	Median	29.3	Median	5
Mode	1	Mode	1	Mode	13.8	Mode	13	Mode	32.5	Mode	27.9	Mode	5
Standard Dev.	0.79	Standard Dev.	0.93	Standard Dev.	4.23	Standard Dev.	3.50	Standard Dev.	4.38	Standard Dev.	4.33047	Standard Dev.	1.16
Sample Var.	0.63	Sample Var.	0.87	Sample Var.	17.92	Sample Var.	12.22	Sample Var.	19.16	Sample Var.	18.7529	Sample Var.	1.34
Kurtosis	11.64	Kurtosis	3.22	Kurtosis	0.49	Kurtosis	0.93	Kurtosis	0.16	Kurtosis	0.33726	Kurtosis	-0.31
Skewness	3.06	Skewness	1.62	Skewness	-0.70	Skewness	0.92	Skewness	-0.18	Skewness	-0.467	Skewness	0.04
Range	4	Range	4	Range	18.4	Range	15.6	Range	22.4	Range	20.4	Range	5.2
Minimum	1	Minimum	1	Minimum	2.9	Minimum	7.4	Minimum	17.3	Minimum	16.8	Minimum	2.6
Maximum	5	Maximum	5	Maximum	21.3	Maximum	23	Maximum	39.7	Maximum	37.2	Maximum	7.8
Sum	51	Sum	59	Sum	519.3	Sum	469.7	Sum	2339.4	Sum	2249.7	Sum	352
Count	37	Count	35	Count	37	Count	35	Count	80	Count	76	Count	71

Table 17. Descriptive statistics for Desmuke points (n=29)

Max. Thickness		Dist. of Max. Thickness		Thickness 5 mm Base		Max. Length		Max. Width		Dist. Max. Width		Base Width	
Mean	7.59	Mean	21.44	Mean	3.86	Mean	45.88	Mean	22.12	Mean	14.89	Mean	10.92
Standard Er.	0.19	Standard Er.	1.14	Standard Er.	0.12	Standard Er.	1.50	Standard Er.	0.52	Standard Er.	0.54	Standard Er.	0.81
Median	7.7	Median	21.3	Median	3.8	Median	45.1	Median	22	Median	14.9	Median	10.7
Mode	7.8	Mode	15.9	Mode	3.4	Mode	38	Mode	20.6	Mode	13.1	Mode	12.6
Stand. Dev.	1.01	Stand. Dev.	6.12	Stand. Dev.	0.62	Stand. Dev.	6.86	Stand. Dev.	2.79	Stand. Dev.	2.89	Stand. Dev.	4.37
Sample Var.	1.02	Sample Var.	37.51	Sample Var.	0.39	Sample Var.	47.13	Sample Var.	7.80	Sample Var.	8.36	Sample Var.	19.07
Kurtosis	-0.69	Kurtosis	0.73	Kurtosis	-0.28	Kurtosis	-0.68	Kurtosis	1.37	Kurtosis	-0.02	Kurtosis	-0.82
Skewness	-0.06	Skewness	0.63	Skewness	0.45	Skewness	0.47	Skewness	0.92	Skewness	0.02	Skewness	0.27
Range	4	Range	27.4	Range	2.4	Range	24.4	Range	12.7	Range	12.7	Range	16.3
Minimum	5.5	Minimum	11.2	Minimum	2.7	Minimum	36	Minimum	17.2	Minimum	8.9	Minimum	3.4
Maximum	9.5	Maximum	38.6	Maximum	5.1	Maximum	60.4	Maximum	29.9	Maximum	21.6	Maximum	19.7
Sum	220.2	Sum	621.9	Sum	111.8	Sum	963.5	Sum	641.4	Sum	431.9	Sum	316.6
Count	29	Count	29	Count	29	Count	21	Count	29	Count	29	Count	29

Face 1 thinning flakes		Face 2 thinning flakes		Face 1 flake length		Face 2 flake length		Face 1 resharp., length		Face 2 resharp., length		Weight	
Mean	1.67	Mean	1.33	Mean	13.87	Mean	15.03	Mean	32.43	Mean	33.03	Mean	6.84
Standard Er.	0.33	Standard Er.	0.33	Standard Er.	2.15	Standard Er.	4.29	Standard Er.	1.11	Standard Er.	1.36	Standard Er.	0.38
Median	2	Median	1	Median	13.4	Median	12.9	Median	32.2	Median	32.5	Median	7
Mode	2	Mode	1	Mode	#N/A	Mode	#N/A	Mode	40.7	Mode	#N/A	Mode	5.3
Stand. Dev.	0.58	Stand. Dev.	0.58	Stand. Dev.	3.72	Stand. Dev.	7.43	Stand. Dev.	5.79	Stand. Dev.	7.08	Stand. Dev.	1.76
Sample Var.	0.33	Sample Var.	0.33	Sample Var.	13.85	Sample Var.	55.25	Sample Var.	33.56	Sample Var.	50.06	Sample Var.	3.11
Kurtosis	#N/A	Kurtosis	#N/A	Kurtosis	#N/A	Kurtosis	#N/A	Kurtosis	-1.18	Kurtosis	-0.68	Kurtosis	0.14
Skewness	-1.73	Skewness	1.73	Skewness	0.56	Skewness	1.19	Skewness	0.01	Skewness	0.32	Skewness	0.40
Range	1	Range	1	Range	7.4	Range	14.4	Range	19.3	Range	25.4	Range	6.5
Minimum	1	Minimum	1	Minimum	10.4	Minimum	8.9	Minimum	22.6	Minimum	21.6	Minimum	3.9
Maximum	2	Maximum	2	Maximum	17.8	Maximum	23.3	Maximum	41.9	Maximum	47	Maximum	10.4
Sum	5	Sum	4	Sum	41.6	Sum	45.1	Sum	875.5	Sum	891.8	Sum	143.7
Count	3	Count	3	Count	3	Count	3	Count	27	Count	27	Count	21

Table 18. Descriptive statistics for Refugio points (n=65)

Max. Thickness		Dist. of Max. Thickness		Thickness 5 mm Base		Max. Length		Max. Width		Dist. Max. Width		Base Width	
Mean	8.34	Mean	26.31	Mean	3.79	Mean	57.30	Mean	22.08	Mean	18.87	Mean	17.25
Standard Er.	0.17	Standard Er.	0.88	Standard Er.	0.07	Standard Er.	1.37	Standard Er.	0.41	Standard Er.	0.81	Standard Er.	0.52
Median	8.2	Median	25.2	Median	3.7	Median	57	Median	22.3	Median	18.1	Median	18.2
Mode	8.5	Mode	22.5	Mode	3.3	Mode	44	Mode	20.4	Mode	19.1	Mode	13
Standard Dev.	1.39	Standard Dev.	7.06	Standard Dev.	0.58	Standard Dev.	9.81	Standard Dev.	3.34	Standard Dev.	6.56	Standard Dev.	4.20
Sample Var.	1.92	Sample Var.	49.82	Sample Var.	0.34	Sample Var.	96.23	Sample Var.	11.18	Sample Var.	43.06	Sample Var.	17.64
Kurtosis	-0.67	Kurtosis	-0.05	Kurtosis	-0.09	Kurtosis	1.03	Kurtosis	4.84	Kurtosis	1.09	Kurtosis	-0.74
Skewness	0.31	Skewness	0.74	Skewness	0.26	Skewness	0.72	Skewness	-1.07	Skewness	0.88	Skewness	-0.02
Range	5.6	Range	30.4	Range	2.6	Range	50	Range	22.5	Range	34.9	Range	18.2
Minimum	5.6	Minimum	14.2	Minimum	2.6	Minimum	37.3	Minimum	7.4	Minimum	5.5	Minimum	8.5
Maximum	11.2	Maximum	44.6	Maximum	5.2	Maximum	87.3	Maximum	29.9	Maximum	40.4	Maximum	26.7
Sum	542.4	Sum	1710.3	Sum	246.3	Sum	2922.4	Sum	1435.1	Sum	1226.8	Sum	1121.2
Count	65	Count	65	Count	65	Count	51	Count	65	Count	65	Count	65

Face 1 thinning flakes		Face 2 thinning flakes		Face 1 flake length		Face 2 flake length		Face 1 resharp., length		Face 2 resharp., length		Weight	
Mean	1.61	Mean	1.65	Mean	16.05	Mean	13.69	Mean	44.68	Mean	45.72	Mean	10.68
Standard Er.	0.15	Standard Er.	0.17	Standard Er.	0.93	Standard Er.	1.14	Standard Er.	1.47	Standard Er.	1.41	Standard Er.	0.53
Median	1	Median	2	Median	16.8	Median	13.4	Median	44.7	Median	45.2	Median	10.35
Mode	1	Mode	1	Mode	19.4	Mode	#N/A	Mode	37.3	Mode	41.1	Mode	8.9
Standard Dev.	0.72	Standard Dev.	0.70	Standard Dev.	4.48	Standard Dev.	4.69	Standard Dev.	11.23	Standard Dev.	10.46	Standard Dev.	3.91
Sample Var.	0.52	Sample Var.	0.49	Sample Var.	20.11	Sample Var.	21.97	Sample Var.	126.03	Sample Var.	109.39	Sample Var.	15.31
Kurtosis	-0.59	Kurtosis	-0.58	Kurtosis	-0.97	Kurtosis	0.09	Kurtosis	0.71	Kurtosis	0.93	Kurtosis	1.02
Skewness	0.77	Skewness	0.63	Skewness	0.13	Skewness	0.72	Skewness	0.10	Skewness	0.20	Skewness	0.90
Range	2	Range	2	Range	16	Range	16.4	Range	59.8	Range	57.9	Range	18
Minimum	1	Minimum	1	Minimum	9.3	Minimum	7.2	Minimum	16.8	Minimum	17.3	Minimum	4.9
Maximum	3	Maximum	3	Maximum	25.3	Maximum	23.6	Maximum	76.6	Maximum	75.2	Maximum	22.9
Sum	37	Sum	28	Sum	369.2	Sum	232.7	Sum	2591.6	Sum	2514.8	Sum	576.6
Count	23	Count	17	Count	23	Count	17	Count	58	Count	55	Count	54

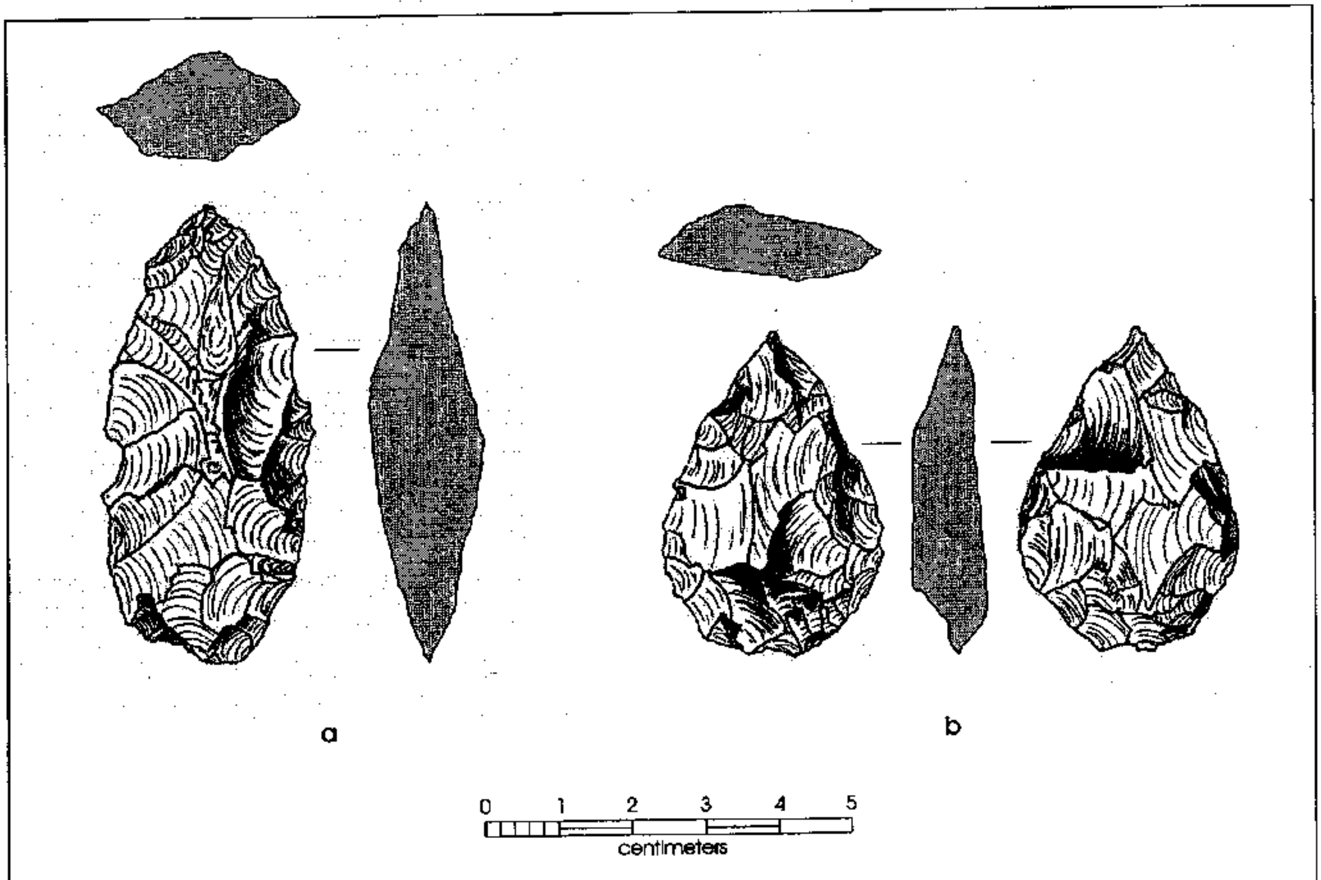


Figure 40. *Manufacture failed round-base projectile point blanks: a) Refugio blank; b) Catán-Abasolo blank.*

23 (35%) of the Refugio points exhibit base thinning flakes and only 13 (56%) of these retain thinning flakes on both faces (Table 18).

On Abasolo points, the mean length of the base thinning flakes ranges from 16.9 to 15.5 mm on the two faces, with the longest flakes reaching 28.1 mm and the shortest barely more than 6 mm in length (Table 15). The mean length of the base thinning flakes on Catán points is nearly identical on the two faces (14.0 and 13.4 mm) and it is between 2–4 mm less than on Abasolo points (Table 16). This pattern is not surprising, however, since as points are resharpened, the lateral flake scars begin impinging on the basal thinning scars resulting in a gradual shortening of the maximum length of these scars with repeated resharpening. Base thinning flake scars on Desmuke points are only slightly longer than on Catán points (Table 17) but the small sample size does not allow a great deal of confidence in this pattern. The mean length of the base thinning flake scars on Refugio points is intermediate between Abasolo and Catán points, being slightly shorter than in the case of Abasolo points but longer than on Catán points (Table 18).

The common use of pressure flaking to thin the bases of these leaf-shaped points and the added thickness of the blank appears to reduced the possibility of end-shock snaps. Pressure flakers may reduce failure rates given the lesser amount of force they exert on the bifacial edges. The combined effect of the pressure thinning of bases and the lack of base notching may result in overall lower manufacture failure rates compared to certain stemmed types, where the flaking associated with notching can increase the likelihood of manufacture failures.

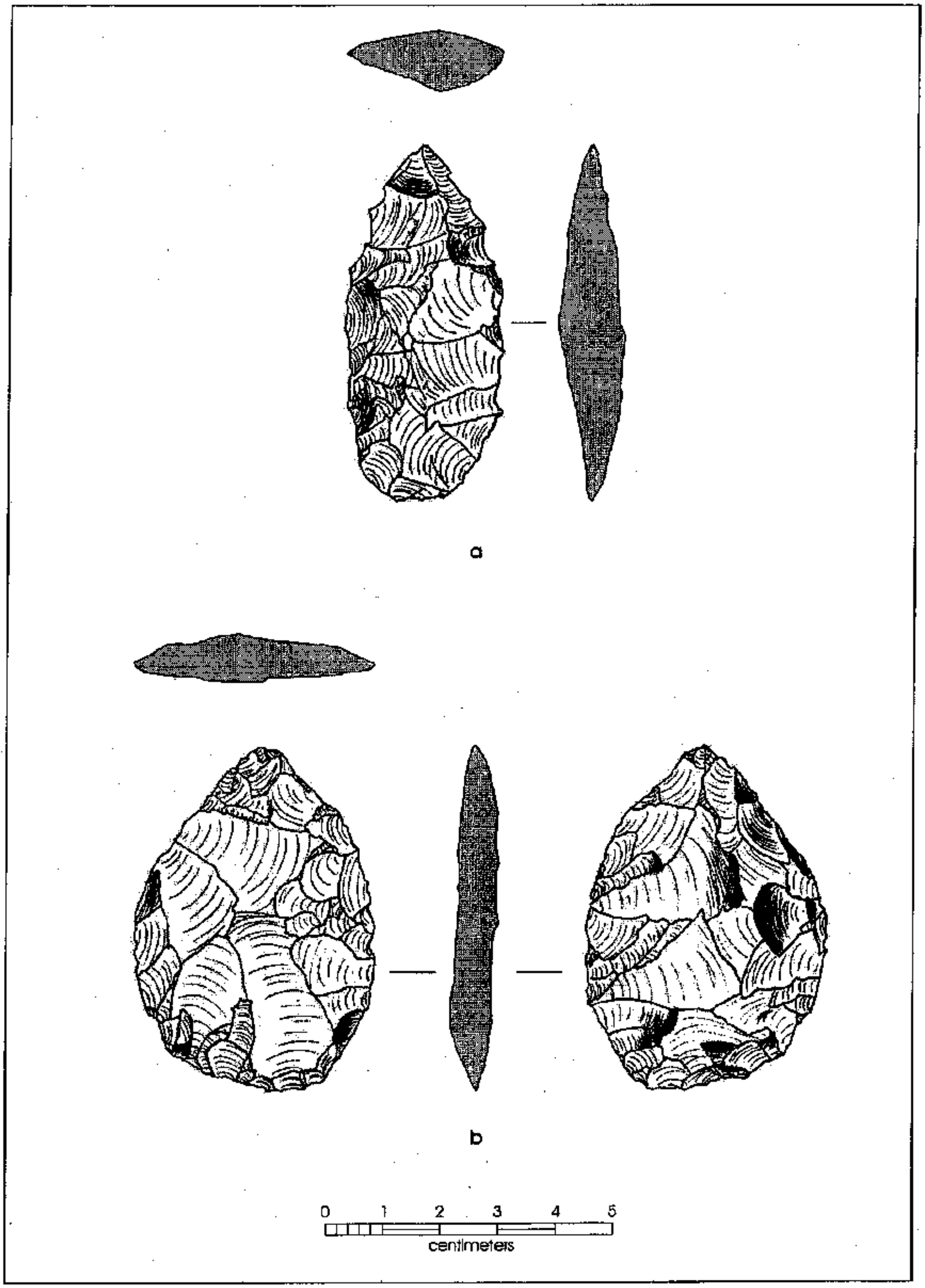


Figure 41. *Basally thinned blanks: a) Refugio; b) Abasolo.*

Resharpening

The use of bifacial tools such as projectile points in cutting tasks necessitates a sharp working edge. Although perhaps less obvious, edge sharpness is also an important feature of projectile points in that it improves cutting efficiency and speeds up internal hemorrhaging leading to the death of an animal. Therefore, whether used as uni-functional (i.e., projectile points) or multi-functional tools, the use of these leaf-shaped specimens results in dulling of the working edges and their subsequent need for resharpening. Resharpening can be carried out using relatively invasive flakes that penetrate deep onto the face of the tool or using steeply angled removals that produce a steep bevel along the edge of the tool without invading the face. Although the first method resharpens a dulled edge it also decreases the strength of the tool by reducing the thickness of the blade. The beveled form of resharpening also refreshes the working edge while maintaining the thickness of the tool's body.

Beveling is relatively uncommon on Refugio points, the largest of the four types. Only 19 (29%) of the points exhibit beveling, with alternate left beveling representing the bulk (89.5%) of the occurrences. Their relatively narrow maximum width and base width dimensions in conjunction with their thickness makes it more difficult to resharpen these points. When resharpening does occur, it is not in the form of beveling. In total, 45 percent (n=45) of the Abasolo points exhibit beveled resharpening. Alternate left beveling is present on 43 specimens, while alternate right beveling is observed on only two specimens. Their greater mean maximum width and base width dimensions extend the use-life of the Abasolo points by allowing for a greater number of resharpening episodes. Beveling is also common on Desmuke points (n=13, 46%) with all specimens having alternate left bevels. Finally, nearly half (n=38, 45%) of the Catán points have beveled edges. Alternate left beveling is again more common (n=35, 92%) than right beveling (n=3, 8%). It is interesting to note that the larger the type, the smaller the percentage of alternately beveled specimens and conversely, the smaller the type, the more likely that many of its members have alternate beveling. This trend suggests that as a group, regardless of projectile point type affiliation, a decrease in point size is accompanied by an increase in beveling frequency. These figures, however, do not mean for instance that only 38 Catán points exhibit resharpening. On the contrary, of the nearly 1,000 specimens analyzed, only three specimens did not exhibit any recognizable signs of resharpening. It does mean, however, that on the remaining 45 Catán points (those without beveling) resharpening is irregular occurring either on only one face or a portion of it; or both faces but not in a systematic fashion.

Another aspect of resharpening that has the potential to directly influence projectile point shape is the length of the resharpening along the edges of the point. Resharpening that runs from the tip to the base or to the widest portion of the specimen can influence both the length and the maximum width of subtriangular specimens. Resharpening that stops short of the stem/base may result in less change in the morphology of the projectile point. Figures 42 and 43 illustrate a sequence of resharpening and the corresponding changes in the morphology of Abasolo and Refugio points, respectively. It is clear that in both types the maximum length and the maximum width of the projectile points are altered as a result of resharpening.

It was mentioned earlier that the mean length of the complete Abasolo points studied here is 48.2 mm. The mean length of the resharpening along the two edges of the blade is 39 mm. In general then, resharpening stops about 9 mm short of the base of the Abasolo points. Given that Abasolo points have a convex to rounded base, this resharpening results in a decrease in the length of the point as well as a decrease in the maximum width of the point. In the case of the smaller Catán points, on average, resharpening stops 5–6 mm above the base. As in the case of the Abasolo points, this "degree" of resharpening results in both a decrease in the maximum length as well as the maximum width of the points, resulting in smaller and smaller versions of the original forms. In the case of the larger Refugio type, resharpening stops, on average, about 12 mm above the base. Similarly, among the Desmuke points, on average, resharpening stops 12–13 mm above the base of the points, and unlike in any of the other forms, it actually results in a well-defined shoulder described by the sudden end to point rejuvenation

Resharpening of a small bifacial knife replica made of black Georgetown flint, using a sharp deer antler tine as a pressure flaking tool, indicted that on average 1 mm (ranging between .8 to 1.2 mm) of material is removed

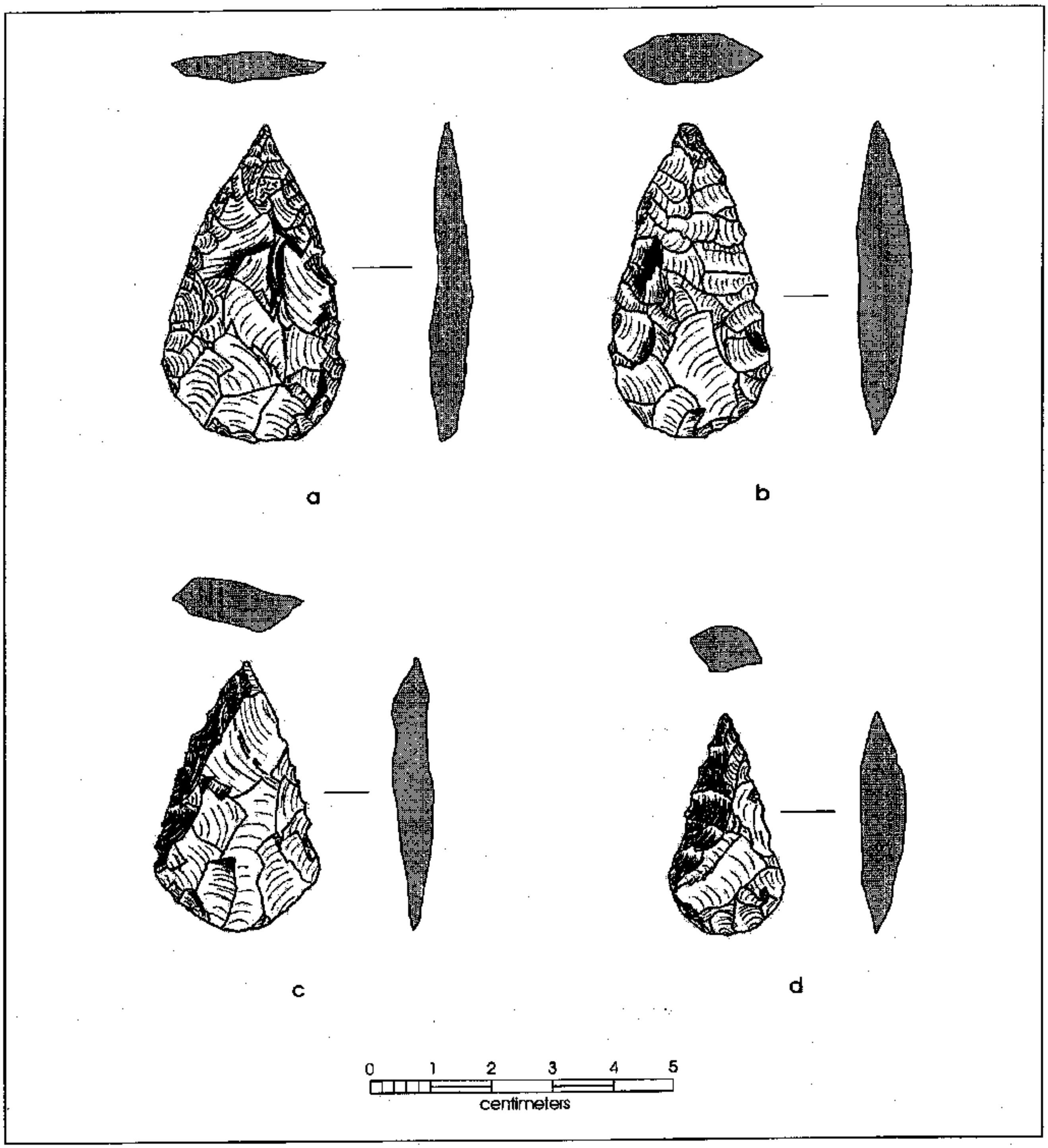


Figure 42. *Resharpened Abasolo series: a) minimally resharpened; b) moderately resharpened; c) alternate left beveled; d) shortened and narrowed.*

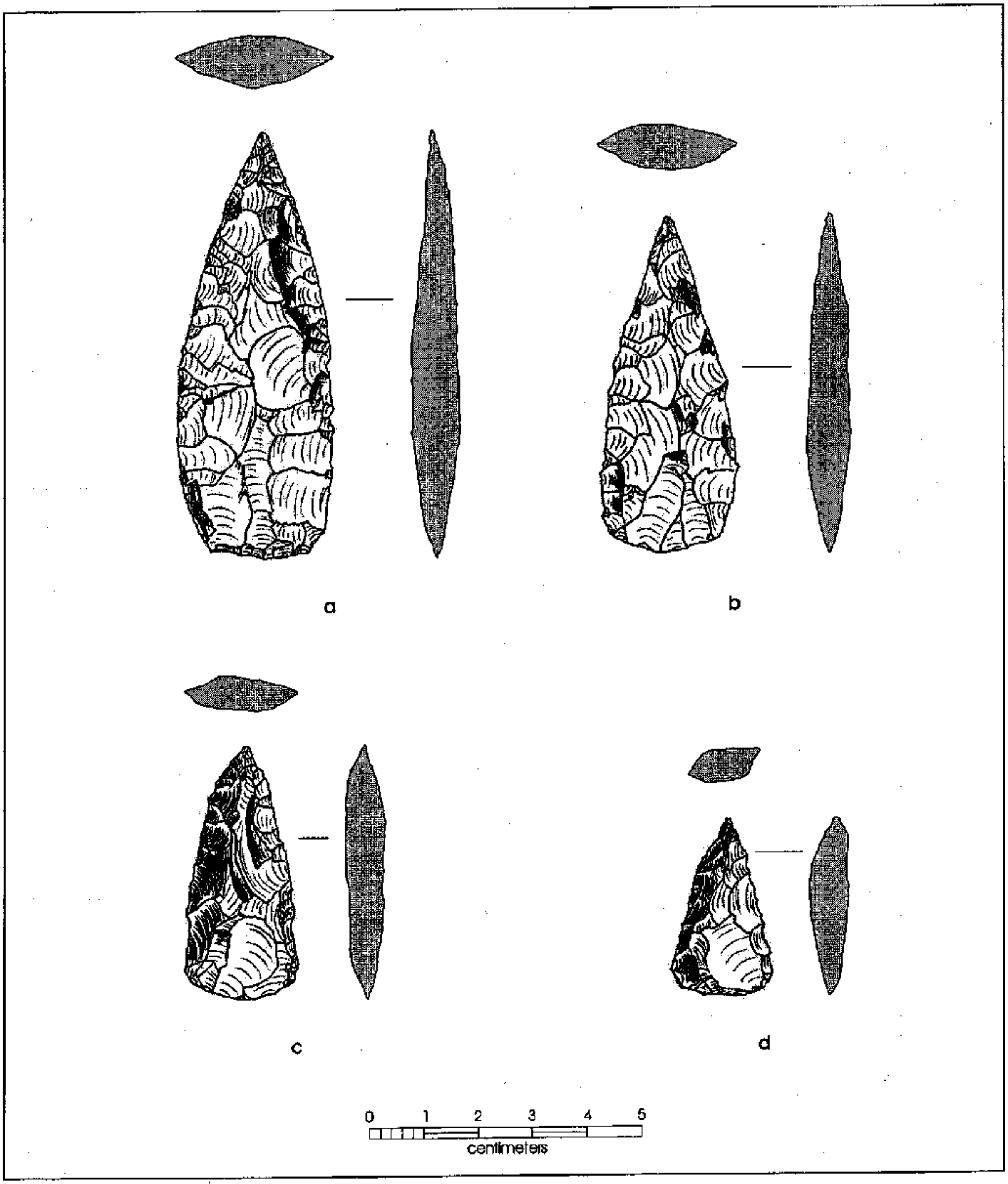


Figure 43. *Resharpened Refugio series: a) minimally resharpened; b) moderately resharpened; c) alternate left beveled; d) shortened and narrowed.*

from the edge of the tool with each resharpening episode. This dimension represents the thickness of the platforms of resharpening flakes removed from the biface edge. This experimental study (carried out by SAT) indicates that tool attrition resulting from resharpening may be a relatively slow process. If we take the widest (33.1 mm) and narrowest (9.5 mm) base widths of Abasolo specimens as starting points and end points of resharpening, we can see that each point may be sharpened a maximum of 23 times (33.1–9.5 mm) before it reaches the narrowest form in the samples analyzed. Using the same logic, a Refugio point can be resharpened a maximum of 18 times (26.7–8.5 mm), and a Desmuke point can be resharpened 16 times (19.7-3.4 mm) before reaching the narrowest form in the collection. Finally, a Catán point may be resharpened 16 times (25.8–9.7 mm) before reaching "the exhausted state," assuming that points do not break before they reach their narrowest state and that resharpening proceeds from the tip to the widest portion of the point, so that both width and length are diminished as the point is resharpened. This comparison indicates that, all things being equal, Abasolo points have the longest use-lives while the use-lives of all other forms range between 70 (Refugio) to 78 (Catán and Desmuke) percent of the Abasolo points.

The examination of the large Riley collection indicates that some specimens may end up being discarded even during resharpening. Two general reasons why a specimen may be discarded during resharpening are repeated step-fracturing of the resharpening scars or a lateral perverse break of the blade. The first failure yields a complete specimen with a series of step-fractured resharpening scars along the beveled blade edge. These scars prevent the removal of subsequent flakes from the same edge unless a substantial portion of the edge is sacrificed. Lateral perverse fractures occur as a result of excessive force developed during resharpening, either using small percussors or pressure flaking tools.

Use Failures and Their Rejuvenation

Eventually, during use these leaf-shaped tools will fail. Two use-failure types have been noted in the collections examined: 1) impact scars and burins; and 2) end shock. Impact scars and burins are the result of the use of the specimens as projectile tips and their contact with hard materials. The most common use break in such cases is a snap with a fracture plane that is perpendicular to the longitudinal axis of the specimen. However, in the case of some specimens, the distal ends fracture leaving a very noticeable flake scar running towards the base of the point. These are the more "classic" impact scars seen on some projectile points. Impacts can also result in the burination of the tip of a point. This type of break is less common in the samples analyzed and it is likely that on some specimens it represents the resharpening of a graver tip rather than a manufacture failure. Blade failures due to end shock were also observed in the larger samples from the Riley collection, but were not included in the eventual sample analyzed for this study.

Impact scars and burins are the clearest indication of projectile point use. However, it should not necessarily be assumed that the lack of impact scars rules out such use since many points may simply snap as a result of impact and some are rejuvenated following breakage, therefore removing all signs of previous impact failure. Abasolo points exhibited the smallest percentage of specimens bearing use-failure scars (5%; i.e., impact and/or end shock), while Catán points have only slightly higher percentages (7%). Refugio and Desmuke points did not exhibit impact scars. The inspection of a much larger number of points from the Riley collection seems to also suggest that impact breaks are relatively infrequent on the larger Abasolo forms but are present, although infrequently, on the smaller Catán points.

Overall, this pattern may suggest that these triangular tool forms start out as large knives employed primarily in cutting tasks and as they are resharpened and rejuvenated, and reach the smaller forms that have more desirable aerodynamic properties, they may be employed as projectile points. This hypothesis may also be supported by the fact that the longer forms, with their longer blade edges, serve as more efficient cutting tools while the shorter forms are much less efficient as cutting tools, given their shorter effective cutting edges.

Exhausted Specimens

Abasolo and Refugio points that do not experience blade failure but continue to be resharpened during their use-life, gradually become narrower even though their length may not decrease substantially (see difference between Figure 42a and b and Figure 43a and b). As the points become narrower, they may effectively be considered "exhausted" since there may be no remaining opportunities to resharpen the blade without its failure. The encounter of these narrow but complete points may be indicative of a preventive tool replacement strategy that is geared towards replacing tools within the context of "down time" rather than waiting for their failure during use. The second form of exhausted points are the short specimens that have been resharpened or rejuvenated as a result of blade failures (compare Figure 42a and d and Figure 43a and d). In these instances, while the tools may still function reasonably effectively as projectile points, since they maintain a piercing tip, their reduced length makes them less efficient in the performance of cutting tasks.

Morphological Changes and Their Consequences

As they move though their use-life the leaf-shaped specimens tend to decrease in length and width. Much of this change is caused by the resharpening of worn blade edges and tool rejuvenation to repair failed blades. Given that the key diagnostic distinction between Abasolo and Catán points, in particular, is maximum length, it is easy to see how the same point may start out as an Abasolo point and change into a Catán point during its use-life cycle (Figure 42). A similar morphological change can also occur in the case of the Refugio points (Figure 43). These changes in point morphology are due to point resharpening and rejuvenation and should be common during their use-life.

In a similar fashion, the inspection of a large number of points from the Riley collection suggests that certain forms of base failure rejuvenations among round-based and perhaps even straight-based unstemmed points may also result in the production of Desmuke-like forms. Figure 44 shows two examples of rebased points. It is evident in Figure 44 that rebasing a leaf-shaped point can change the morphology of the base so that it is more reminiscent of Desmuke bases.

The cautions raised by the changes in the morphology noted above do not necessarily mean that Abasolo, Catán, and Desmuke points did not represent distinct types of material culture manufactured and manipulated by distinct groups of people. However, types are contemporary analytical units established by archeologists, and the types of morphological changes described above do bring into question the archeologists' ability to consistently and accurately differentiate these morphological forms.

The Tortugas-Matamoros Group

A total of 134 Tortugas points and 92 Matamoros points were analyzed. Of the 134 Tortugas points, 74 (55%) have straight bases, 42 (31%) have slightly concave to concave bases, and 18 (13%) have slightly convex to convex bases. On average, the depth of the basal concavity rarely reaches more than 2 mm in depth and convex bases rarely protrude more than 3 mm from the horizontal. Among the Matamoros projectile points, straight bases constitute about half of the collection (n=47, 51%), slightly concave to concave bases are relatively common (n=28, 30%), while only 17 specimens (18%) have slightly convex to convex bases. In general, the breakdown of base shapes is relatively similar between the two types and suggests some potential technological relationships. Descriptive statistics on the metric attributes recorded on this sample are presented in Tables 19 and 20.

Point Manufacture and Failure

The manufacture of Tortugas points begins with hard hammer flake blanks that are relatively thick and possess large bulbs of percussion. Judging from the presence of few, rather thick and biconvex manufacture discards, in some instances these points may be made from smaller nodular cores. These nodular blanks, however, appear to be less common given the overall lack of manufacture-failed specimens with cortex on both faces. Nonetheless, some nodule cores could have been reduced to the degree that no diagnostic traits of the nature of the core would have been preserved, making it appear as if these core types were less often utilized.

The examination of triangular points from the extremely large Riley collection also identified a small number of finished specimens that retained a large portion of the parent flake's ventral surface (Figure 45). These flakes appear to have been removed by soft hammer, given their diffuse bulbs of percussion. Alternatively, they may

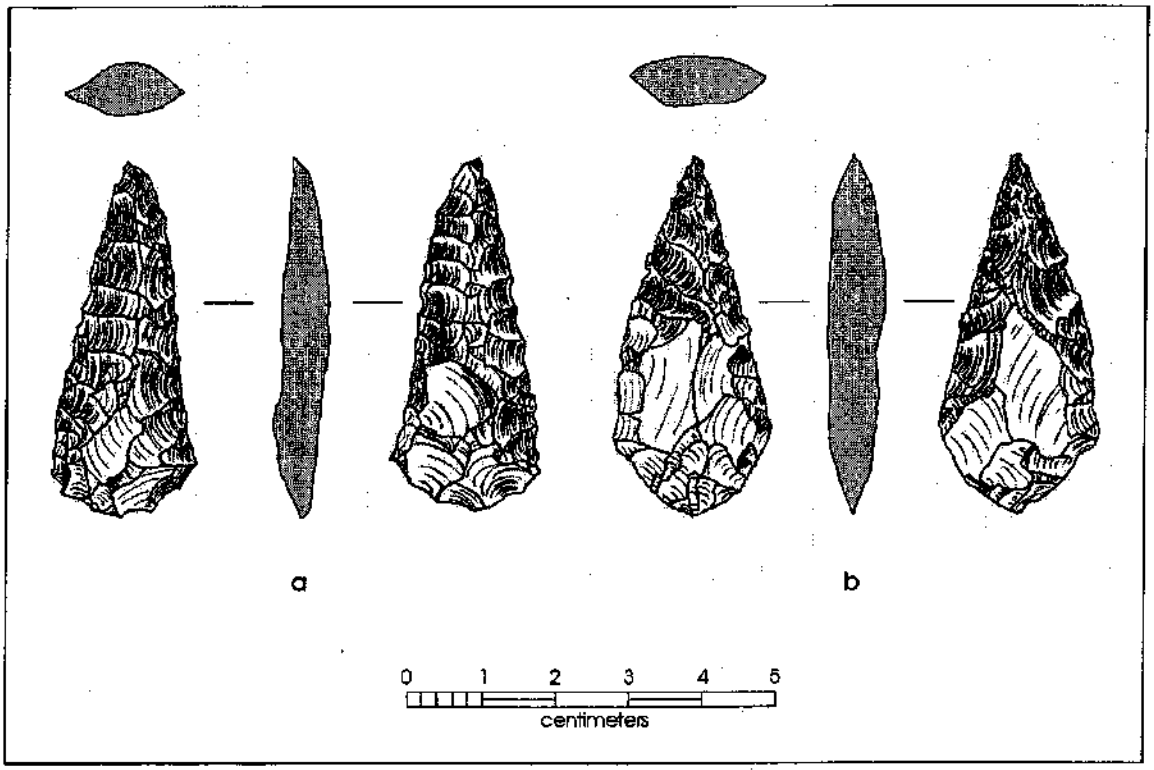


Figure 44. *Rebased round-base projectile points: a) Catán-like; b) Desmuke-like.*

represent the extremely well-controlled production of blanks using hard hammerstone percussors. These specimens are only marginally retouched on the ventral face of the blank and exhibit no base thinning flakes, although a series of 5–11 mm long pressure flakes were removed from the ventral face of the specimens along the entire length of the base. In general, the purpose of these flake removals appears to be the shaping of the concave base. Nonetheless, morphologically they have the triangular form characteristic of Tortugas points.

Following the selection of the flake blank, the reduction proceeds using percussion flaking with either small hard hammerstones or small billets, or a combination of both. The earliest manufacture failures tend to occur during the early and middle stages of reduction as the blank is shaped and thinned to the desired form and dimensions. As in the case of the round-base point types, failure to properly thin a blank will often result in thick specimens with multiple hinge- or step-fractured flake scars and stacked areas (Figure 46). Such specimens can be considered manufacture failures even though they are often discarded as complete artifacts.

As the manufacture sequence proceeds beyond the middle stage of reduction, the next most common failure type observed in the Prevost and Riley collections was the actual breakage of the blank from excessive force produced during lateral flake removal (i.e., perverse fractures). In a few instances, blank or biface failure resulted from fractures along imbedded fracture lines. Only a few incomplete manufacture-failed specimens were encountered, particularly in the Riley collection, due at least in part to the biased collection strategy employed.

It is no surprise that of the two point types discussed in this section, Tortugas points have the highest mean maximum length (50.8 mm), maximum thickness (7.3 mm), and maximum width (28.0 mm) given that the specimens assigned to this group are restricted to those that the point was not resharpened. It simply indicates that the resharpening was not sufficiently patterned and regular enough to produce a beveled edge. All Tortugas and Matamoros dart points in the study exhibited resharpening.

If we can assume, as before, that on average, each resharpening episode removes about 1 mm of material from the edge of a point, and if we take the widest (42.8 mm) and narrowest (18.3 mm) base widths of Tortugas specimens as beginning and end points of resharpening, we see that each point may be sharpened a maximum of 25 times (43–18 mm) before reaching the narrowest form in the sample. Using the same logic, a Matamoros point can be resharpened a maximum of 19 times (35–16.2 mm) before reaching "the exhausted state," assuming that points do not break before they reach their narrowest and that resharpening proceeds from the tip to the widest portion of the point, so that both width and length are diminished as the point is resharpened. This comparison indicates that, all things being equal, Tortugas points have the longest use-lives, while the use-lives of Matamoros points are only 76 percent of the larger form. Interestingly, similar figures were obtained among the round-base points with the smaller forms having a use-life that was between only 70 to 78 percent of the larger form (i.e., Abasolo).

Assuming that a triangular projectile point is not broken during its use-life, resharpening changes two aspects of the point's morphology, its length and its width. Figure 47a and b illustrate the manner in which projectile point length can decrease as a result of resharpening, while Figure 47c indicates how projectile point maximum width is narrowed during the use-life of a triangular specimen.

The mean length of complete Tortugas points analyzed is 50.8 mm. On the other hand, the mean length of resharpening on the two edges of Tortugas points ranges from 46.9 to 50.4 mm (Table 19). It is clear that resharpening of the blade edges runs virtually the entire length of the points. In the case of the smaller Matamoros points, the mean maximum length is 34.2 mm, while the mean length of resharpening on the two edges of these points ranges from 32.8 to 32.9 mm. Again, on average, all but 1 mm of the maximum length of the point is not reached by resharpening.

This technique of resharpening triangular points from their tip to their base has important implications because it leads to morphological changes in the larger Tortugas points that can mimic smaller triangular forms (Matamoros points) and can lead to incorrect typological assignment. One of the diagnostic aspects of this degree of resharpening is the invasive nature of the resharpening or beveling flakes on the base thinning flake scars (see Figure 47a-c and Figure 48a-c). As resharpening continues, less and less of the original outline of the base thinning flakes will remain on the two faces of the point as it decreases in length and width. This type of resharpening strategy is quite distinctive from that employed for the resharpening of Early Triangular points manufactured during the Early Archaic. Often, in the case of this type, rejuvenation yields an equilateral triangle with concave blade edges and base so that it becomes difficult to differentiate the base from the blade edges. In other words, in resharpening Early Triangular specimens there is a real effort to preserve width, while in resharpening the Tortugas during the Middle Archaic the preservation of the width of the tool is not critical.

The examination of the large Riley and smaller Prevost collections contained specimens that appeared to have been discarded as a result of failure during resharpening. Two types of failures were noted: beveled proximal fragments with perverse break morphologies and complete specimens with multiple adjoining step-fractured resharpening flakes. These scars prevent the removal of subsequent flakes from the same edge unless a substantial portion of the edge is sacrificed. Lateral perverse fractures occur as a result of excessive force developed during resharpening carried out with pressure flake removals.

Use Failures and Their Rejuvenation

As these triangular tools progress through their use-life, they fail. A number of use-failure types have been noted in the collections examined, including: 1) impact scars and burins; 2) end shock; and 3) base snaps. Impact scars and burins are the result of the use of the specimens as projectile tips and their contact with hard materials. The most common use break in such cases is a snap with a fracture plane that is perpendicular to the longitudinal axis of the specimen. However, in the case of some

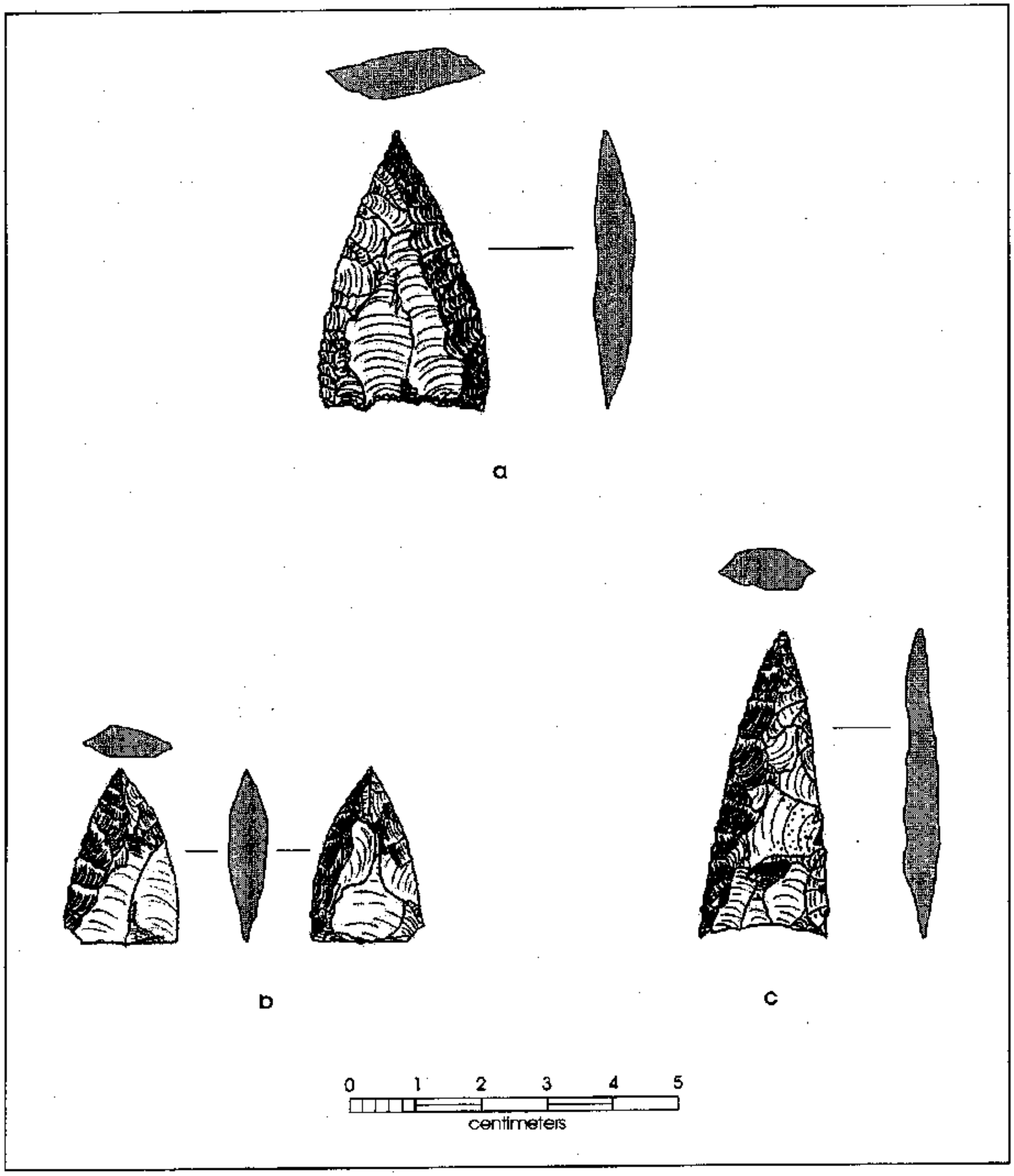


Figure 47. *Changes in projectile point morphology and size due to resharpening: a) moderately shortened Tortugas; b) extremely shortened Tortugas; c) Tortugas with narrow blade.*

Table 19. Descriptive statistics for Tortugas points (n=134)

	Max. Thickness	Dist. of Max. Thickness	Thickness 5 mm Base	Max. Length	Max. Width	Dist. Max. Width	Base Width
Mean	7.35	22.81	3.38	51.77	28.01	27.33	27.33
Standard Er.	0.10	0.56	0.15	0.90	0.47	0.49	0.49
Median	7.2	21.6	3.2	49.8	27.05	26.6	26.6
Mode	8.2	22.3	2.9	41	25	25	25
Stand. Dev.	1.21	6.45	1.74	8.08	5.47	5.60	5.60
Sample Var.	1.47	41.64	3.02	75.89	29.97	31.36	31.36
Kurtosis	0.85	-0.07	96.59	0.14	-0.33	-0.23	-0.23
Skewness	0.72	0.56	9.10	0.54	0.61	0.61	0.61
Range	6.9	32.7	20.3	35.6	24.6	24.5	24.5
Minimum	5.1	8.4	1.5	41.5	18.3	18.3	18.3
Maximum	12	41.1	21.8	77.1	42.9	42.8	42.8
Sum	985.2	3056.48	452.42	4721.2	3753.35	3635.42	3635.42
Count	134	134	134	93	134	133	133

	Face 1 thinning flakes	Face 2 thinning flakes	Face 1 thin., flake length	Face 2 thin., flake length	Face 1 resharp., length	Face 2 resharp., length	Weight
Mean	2.00	2.01	18.23	16.90	50.38	46.87	9.76
Standard Er.	0.07	0.07	0.43	0.47	3.97	0.79	0.37
Median	2	2	17.7	16.3	45	45.7	9
Mode	2	2	19.3	16.3	41	41	6.6
Stand. Dev.	0.78	0.82	4.80	5.26	45.44	8.98	3.56
Sample Var.	0.61	0.67	23.08	27.69	2065.22	80.70	12.65
Kurtosis	-0.55	-1.06	-0.44	-0.16	120.87	0.44	0.36
Skewness	0.31	0.16	0.57	0.35	10.79	0.47	0.83
Range	3	3	20.1	25.5	528.3	52.8	16.9
Minimum	1	1	10	5.7	28.2	24.2	3.6
Maximum	4	4	30.1	31.2	556.5	77	20.5
Sum	250	251	2278.73	2112.4	6599.4	6046.3	907.9
Count	125	125	125	125	131	129	93

Table 20. Descriptive statistics for Matamoros points (n=92)

	Max. Thickness	Dist. of Max. Thickness	Thickness 5 mm Base	Max. Length	Max. Width	Dist. Max. Width	Base Width
Mean	6.19	17.84	3.12	34.44	23.06	22.92	22.92
Standard Er.	0.10	0.52	0.15	0.49	0.39	0.40	0.40
Median	6.05	17.2	3	35	22.9	22.65	22.65
Mode	6	20.7	2.9	36.3	24.1	24.1	24.1
Stand. Dev.	0.98	5.02	1.42	4.63	3.75	3.79	3.79
Sample Var.	0.97	25.17	2.01	21.39	14.03	14.39	14.39
Kurtosis	0.65	0.54	62.96	-0.76	1.35	1.34	1.34
Skewness	0.66	0.12	7.27	-0.40	0.89	0.93	0.93
Range	5.2	26.6	13.7	18.3	18.6	18.8	18.8
Minimum	4.3	5.1	1.7	22.6	16.4	16.2	16.2
Maximum	9.5	31.7	15.4	40.9	35	35	35
Sum	569.4	1640.9	286.7	3047	2121.8	2108.4	2108.4
Count	92	92	92	89	92	92	92

	Face 1 thinning flakes	Face 2 thinning flakes	Face 1 flake length	Face 2 flake length	Face 1 resharp., length	Face 2 resharp., length	Weight
Mean	1.92	1.89	15.75176	14.18	32.92	32.77	4.56
Standard Er.	0.08	0.09	0.40009	0.36	0.49	0.49	0.15
Median	2	2	15.3	13.95	33.3	33	4.5
Mode	2	2	11.6	14.2	39	36	5.1
Stand. Dev.	0.76	0.81	3.688644	3.19	4.71	4.65	1.43
Sample Var.	0.58	0.66	13.6061	10.21	22.17	21.65	2.05
Kurtosis	-1.24	1.63	-0.220154	0.34	-0.67	-0.74	2.58
Skewness	0.14	0.94	0.566031	0.35	-0.27	-0.27	1.03
Range	2	4	17	16.8	19.6	19.1	8.4
Minimum	1	1	9	6.1	21.4	21.3	2.2
Maximum	3	5	26	22.9	41	40.4	10.6
Sum	163	151	1338.9	1134.2	3028.3	2982.2	400.9
Count	85	80	85	80	92	91	88

greater than 40 mm in length (Table 19). It is also no surprise that the mean maximum width and maximum thickness of the Matamoros points is less than that of the Tortugas (Table 20). Starting the manufacture process from a smaller overall blank may yield a smaller and thinner finished product, as would the repeated resharpening and rejuvenation of the larger Tortugas form as it progresses through its use-life. The range in minimum and maximum thickness and width values does suggest that the primary differences between the two types lie in the dimensions of length and thickness.

As in the case of the round-base points, base thinning also is initiated early in the reduction of triangular blanks with much of the thinning focused in the center of the blank and being accomplished with flake removals oriented parallel to the longitudinal axis of the blank (Figure 46a and c). In a few instances, thinning flakes may also be angled inward from the corners of the blanks, although these removals are not intended to round the corners of the specimen (see Figure 46b). The added thickness of the blank during the early stage of reduction reduces the possibility of end-shock snaps, however, as the reduction proceeds toward the late stage, the probability of end-shock failure increases. Failure of the blanks due to incorrect support during base thinning attempts may be relatively common in the case of these triangular points, although the thinning scars do not approach the width and length of those noted on Clovis and Folsom points. At least in the Prevost collection, including all classes of complete and incomplete lithic artifacts and debitage, and the material from 41WB556, the thinning of the base does not appear to have resulted in excessive rates of failure. This is an important observation when compared to the rates of failure that may occur among stemmed projectile points, where the flaking associated with the notching of the specimen can increase the likelihood of manufacture failure.

The break morphology resulting from end shock is similar to the break morphology resulting from snapping a knife during use (i.e., prying tasks). However, in most cases, it should be possible to identify the cause of the break either from the overall unfinished morphology of the broken blanks (Miller et al. 2000:Figures 7.5 and 7.6), or more appropriately, from the lack of use-wear on the margins of the specimen. Early in the reduction, thinning flakes may be removed with hard hammers, while during the later stages of reduction, removals may occur with small soft billets, judging from the shallowness of the negative bulbs of percussion.

A total of 125 (93%) of the Tortugas points have between one and four base thinning scars on either one or both of their faces (Table 19). A similarly high proportion (85 of 92 specimens, 92%) of Matamoros points retain base thinning flake scars on at least one face (Table 20). On Tortugas points, the mean length of the base thinning flakes ranges from 18.2 to 16.9 on the two faces, with the longest flakes reaching 31.2 mm and the shortest barely being 6 mm in length (Table 19). The mean length of the base thinning flakes on Matamoros points ranges from 15.7 to 14.2 mm on the two faces, with the longest thinning flake measuring 26 mm and the shortest only 6.1 mm (Table 20). The smaller size of the Matamoros thinning flakes is not surprising given that as points are resharpened the lateral flake scars begin impinging on the basal thinning scars resulting in a gradual shortening of the maximum length of these scars.

Resharpening

Regardless of whether Tortugas and Matamoros tools are projectile points, knives, or multi-functional tools, their repeated use in cutting tasks will dull their working edges reducing their efficiency. While resharpening of the working edges can re-establish tool efficiency, it may result in the weakening of the blade if it is done using relatively invasive flakes that penetrate deep into the face of the tool. Beveling, on the other hand, using short steeply angled removals, can resharpen the working edge without invading the face while preserving blade strength.

Beveling is present on 75 (56%) of the Tortugas points in this study. Alternate left beveling is present on 81 percent (n=61) of these specimens. A total of 61 (66%) of the Matamoros points in this study have been beveled. Alternate left beveling dominates (n=55, 90%), while few (10%) points exhibit alternate right beveling. The manner and distribution of resharpening scars that form the bevel indicates that resharpening flakes tend to be longest adjacent the tip and the center of the blade and decrease as one moves towards the base. The lack of beveling on a point's edge does not necessarily indicate

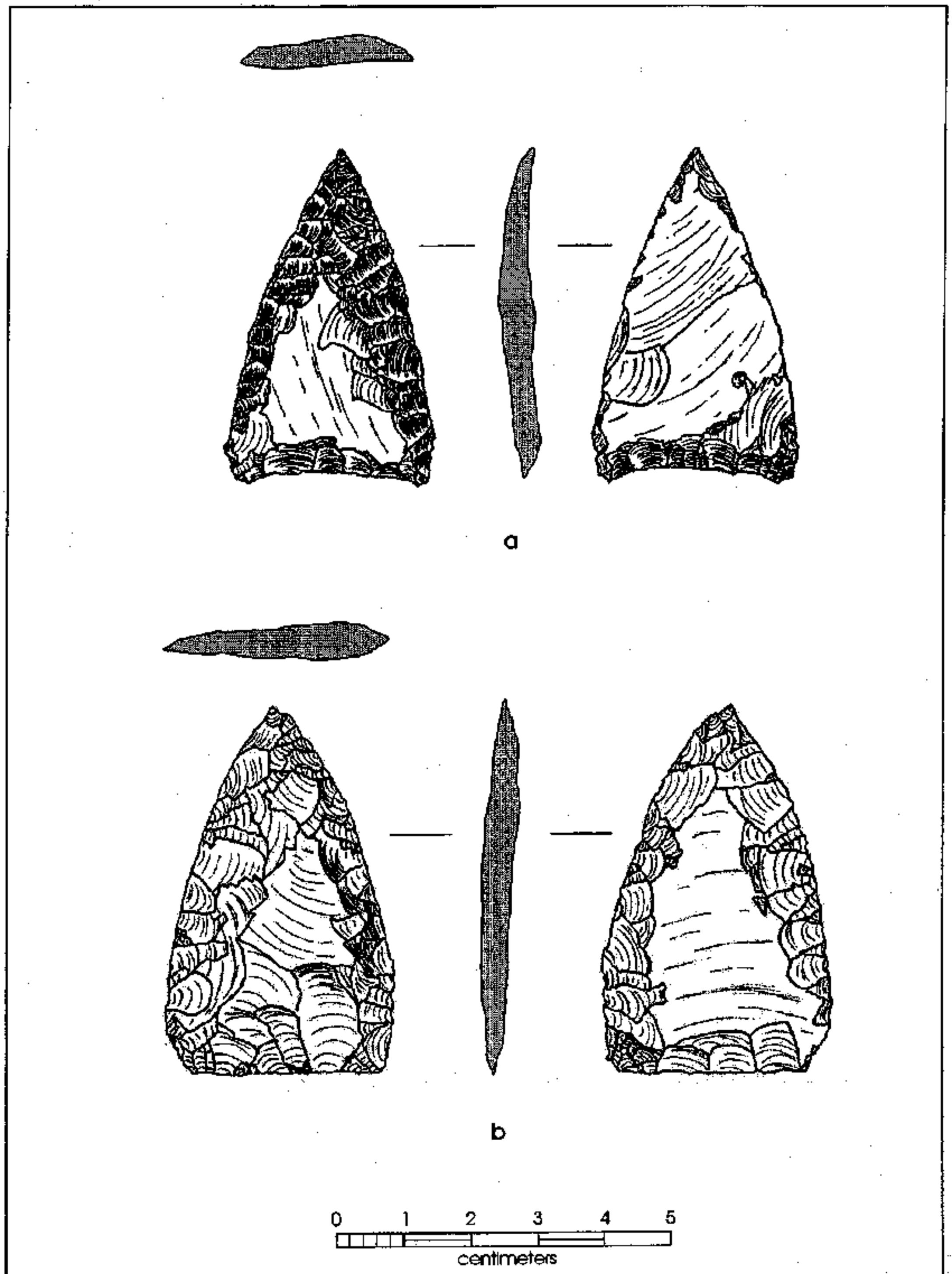


Figure 45. *Partially unifacial Tortugas points made on relatively straight billet flakes.*

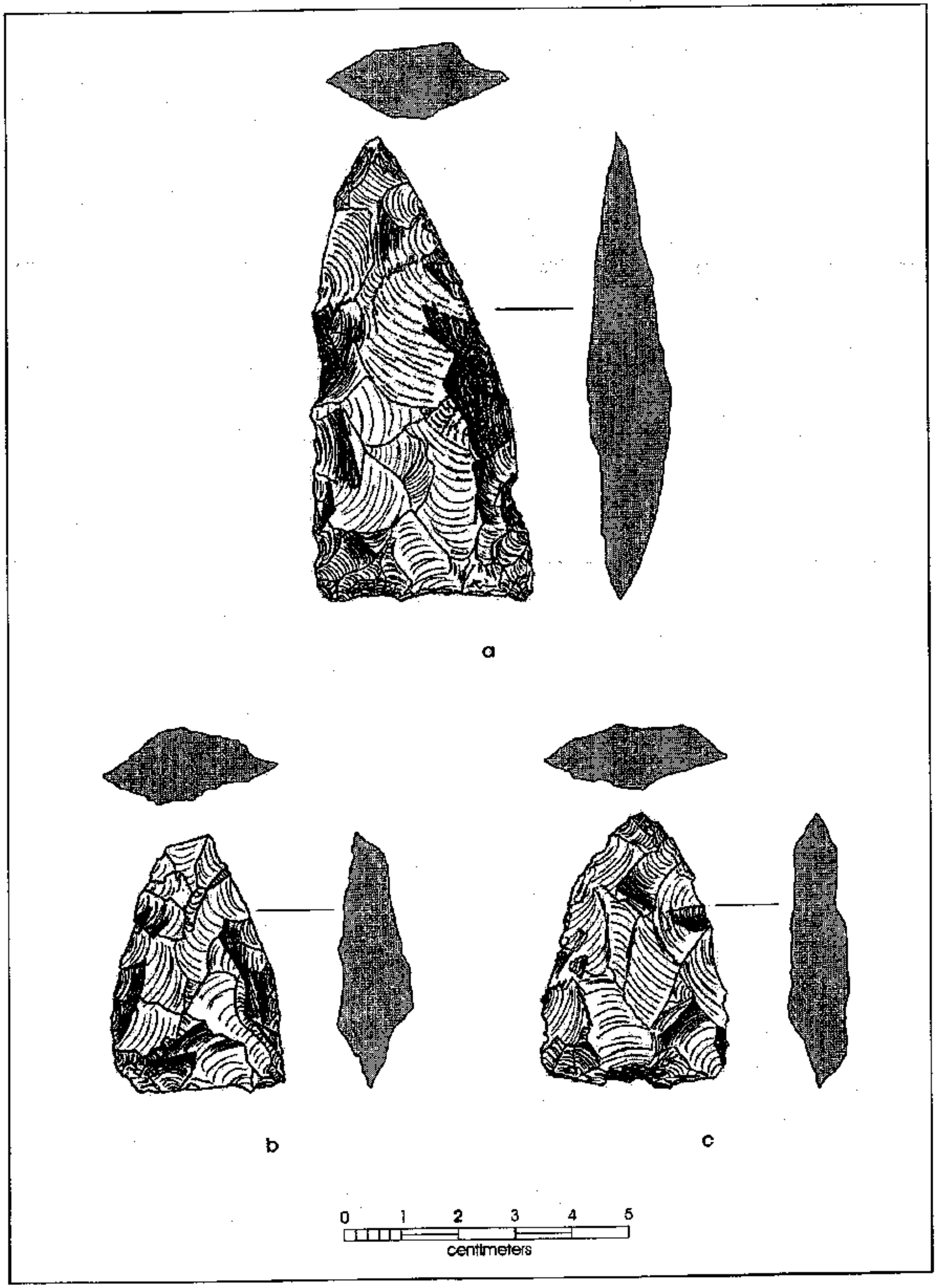


Figure 46. *Manufacture failed Tortugas and Matamoros blanks: a) step-fractured thinning flakes; b-c) stacked step-fractured thinning flakes.*

that the point was not resharpened. It simply indicates that the resharpening was not sufficiently patterned and regular enough to produce a beveled edge. All Tortugas and Matamoros dart points in the study exhibited resharpening.

If we can assume, as before, that on average, each resharpening episode removes about 1 mm of material from the edge of a point, and if we take the widest (42.8 mm) and narrowest (18.3 mm) base widths of Tortugas specimens as beginning and end points of resharpening, we see that each point may be sharpened a maximum of 25 times (43–18 mm) before reaching the narrowest form in the sample. Using the same logic, a Matamoros point can be resharpened a maximum of 19 times (35–16.2 mm) before reaching "the exhausted state," assuming that points do not break before they reach their narrowest and that resharpening proceeds from the tip to the widest portion of the point, so that both width and length are diminished as the point is resharpened. This comparison indicates that, all things being equal, Tortugas points have the longest use-lives, while the use-lives of Matamoros points are only 76 percent of the larger form. Interestingly, similar figures were obtained among the round-base points with the smaller forms having a use-life that was between only 70 to 78 percent of the larger form (i.e., Abasolo).

Assuming that a triangular projectile point is not broken during its use-life, resharpening changes two aspects of the point's morphology, its length and its width. Figure 47a and b illustrate the manner in which projectile point length can decrease as a result of resharpening, while Figure 47c indicates how projectile point maximum width is narrowed during the use-life of a triangular specimen.

The mean length of complete Tortugas points analyzed is 50.8 mm. On the other hand, the mean length of resharpening on the two edges of Tortugas points ranges from 46.9 to 50.4 mm (Table 19). It is clear that resharpening of the blade edges runs virtually the entire length of the points. In the case of the smaller Matamoros points, the mean maximum length is 34.2 mm, while the mean length of resharpening on the two edges of these points ranges from 32.8 to 32.9 mm. Again, on average, all but 1 mm of the maximum length of the point is not reached by resharpening.

This technique of resharpening triangular points from their tip to their base has important implications because it leads to morphological changes in the larger Tortugas points that can mimic smaller triangular forms (Matamoros points) and can lead to incorrect typological assignment. One of the diagnostic aspects of this degree of resharpening is the invasive nature of the resharpening or beveling flakes on the base thinning flake scars (see Figure 47a-c and Figure 48a-c). As resharpening continues, less and less of the original outline of the base thinning flakes will remain on the two faces of the point as it decreases in length and width. This type of resharpening strategy is quite distinctive from that employed for the resharpening of Early Triangular points manufactured during the Early Archaic. Often, in the case of this type, rejuvenation yields an equilateral triangle with concave blade edges and base so that it becomes difficult to differentiate the base from the blade edges. In other words, in resharpening Early Triangular specimens there is a real effort to preserve width, while in resharpening the Tortugas during the Middle Archaic the preservation of the width of the tool is not critical.

The examination of the large Riley and smaller Prevost collections contained specimens that appeared to have been discarded as a result of failure during resharpening. Two types of failures were noted: beveled proximal fragments with perverse break morphologies and complete specimens with multiple adjoining step-fractured resharpening flakes. These scars prevent the removal of subsequent flakes from the same edge unless a substantial portion of the edge is sacrificed. Lateral perverse fractures occur as a result of excessive force developed during resharpening carried out with pressure flake removals.

Use Failures and Their Rejuvenation

As these triangular tools progress through their use-life, they fail. A number of use-failure types have been noted in the collections examined, including: 1) impact scars and burins; 2) end shock; and 3) base snaps. Impact scars and burins are the result of the use of the specimens as projectile tips and their contact with hard materials. The most common use break in such cases is a snap with a fracture plane that is perpendicular to the longitudinal axis of the specimen. However, in the case of some

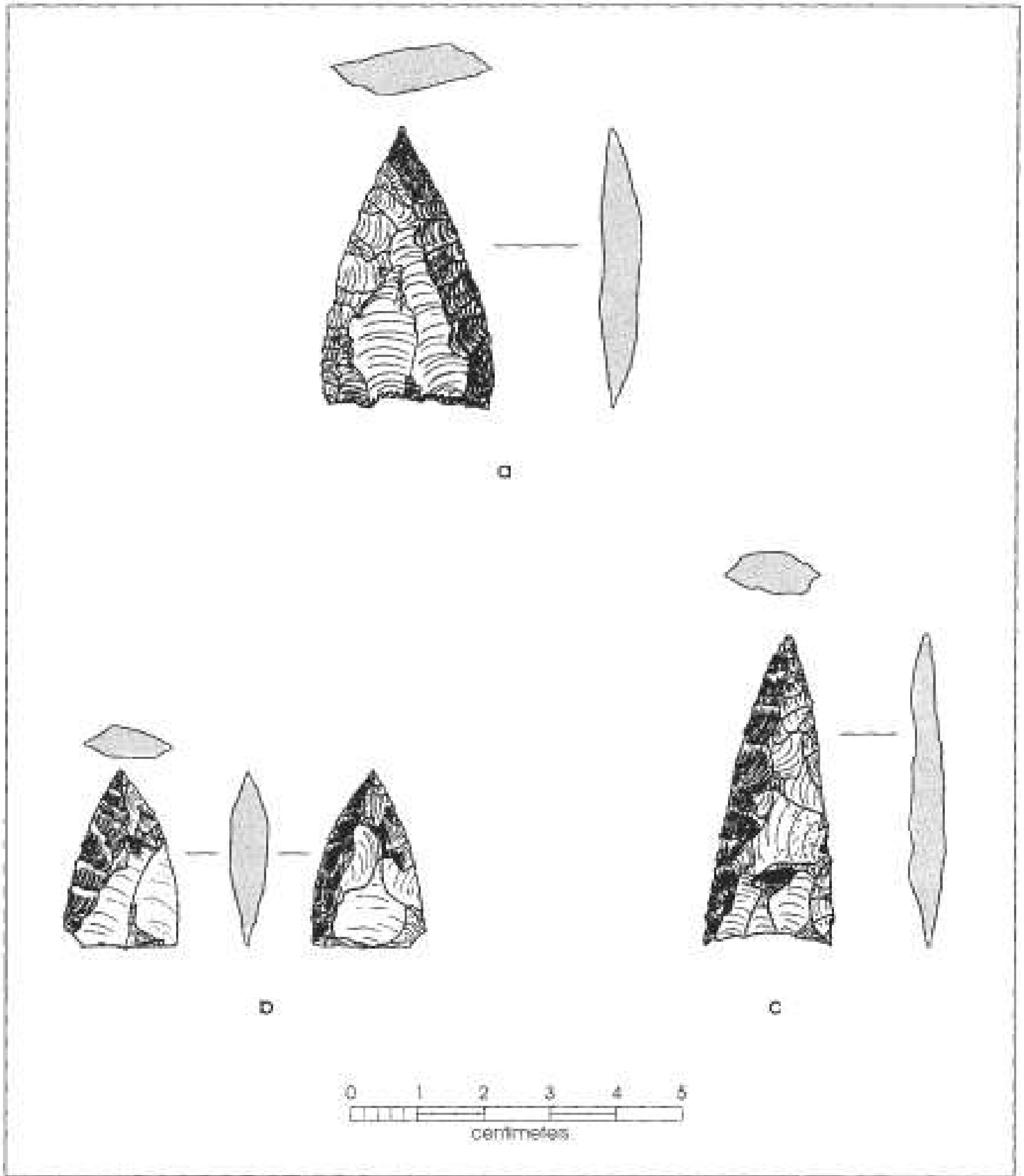


Figure 47. *Changes in projectile point morphology and size due to resharpening: a) moderately shortened Tortugas; b) extremely shortened Tortugas; c) Tortugas with narrow blade.*

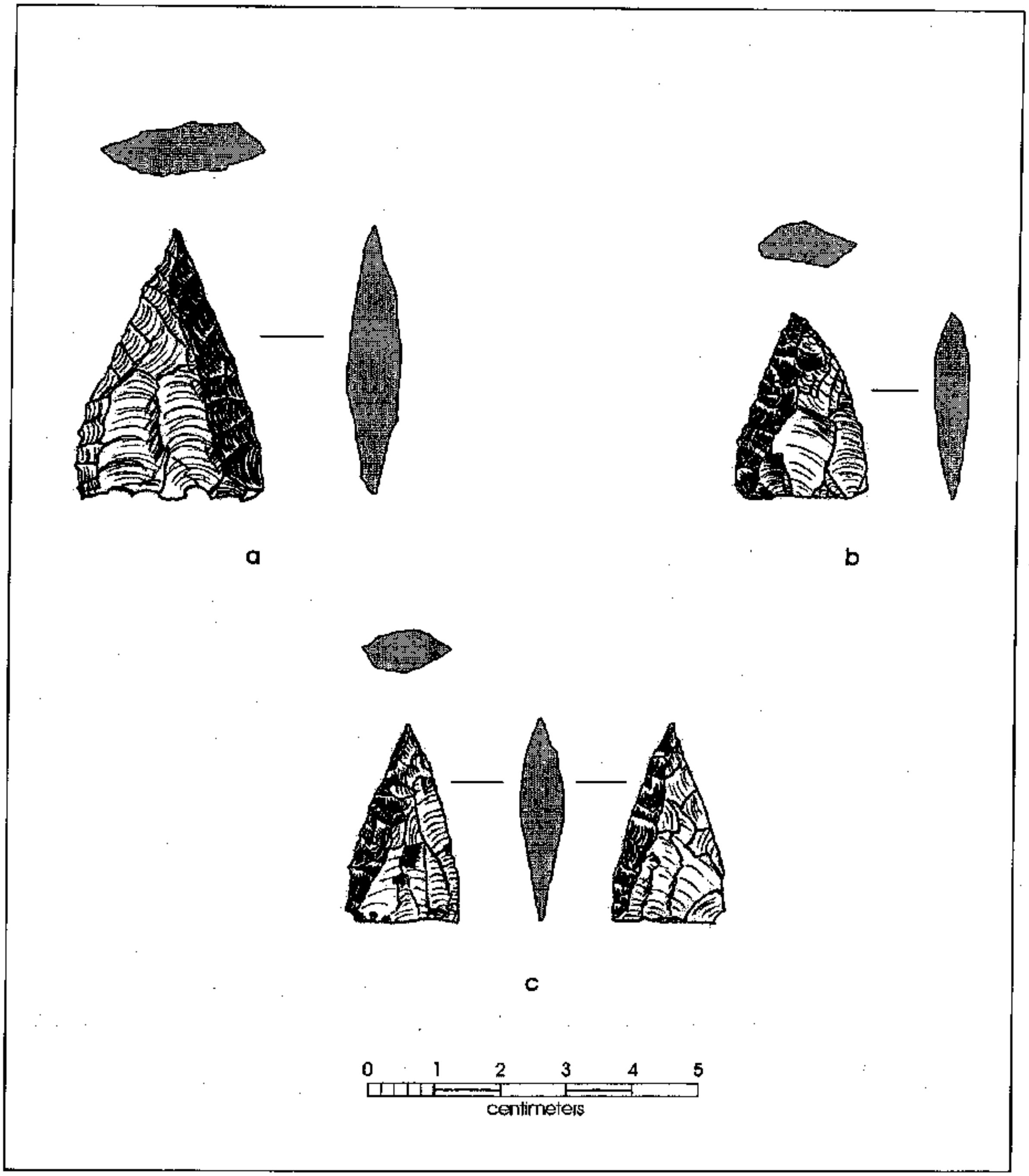


Figure 48. *Invasive nature of beveled resharpening onto base thinning flakes: a-b) Tortugas points –technologically; c) Matamoros point.*

specimens, the distal ends fracture leaving a very noticeable flake scar running towards the base of the point (Figure 49a). These are the more "classic" impact scars seen on some projectile points. On triangular projectile points, burinated impact scars were noted only in the larger Riley collection, but none of the samples analyzed had this failure type. Finally, the majority (n=35, 85%) of the Tortugas and two (66%) of the three Matamoros proximal fragments had snap fractures caused by bending forces exceeding the elasticity of the material.

Partial base snaps resulting from bending fractures are also present on a number (n=15, 10%) of these triangular points (Tortugas and Matamoros combined; Figure 49b). Fragments with partial base snaps were considered complete for this analysis. Using the Cueva de Candelaria specimens as an example (Aveleyra Arroyo de Anda et al. 1956), it is assumed that the triangular forms are hafted in split fore shafts, with only a small portion of the base inserted into the haft with mastic and lashing immediately below the joint holding the two elements adjoined. This assumption is supported by the fact that on archeological specimens the resharpening scars extend the entire length of the point suggesting that the haft was not secured to the point using lashing as is the assumed hafting method of stemmed points.

Base snaps result from the hafting of only a short segment of the very thin base as it is held in the split fore shaft. The resulting fragment is similar to a narrow angular sliver that creates a flat concave break and a relatively thin break face. Due to its thinness, this face can easily be rejuvenated and can change the base shape of a point from a straight or slightly convex-based variant to a concave-based specimen (similar to the Nogales/Tortugas distinction made by MacNeish 1958). Examples of triangular points that have one or two long base thinning flakes adjacent their base, and three to four shorter flakes that were removed after the original thinning flakes to rebase a failed base are not uncommon in the collections (Figure 49c-d). This is not to say that all concave-based Tortugas points began as straight-based specimens, but that some specimens may have reached this morphology through use breakage and subsequent rejuvenation, and that some other concave-based points may have actually had their concavity deepened as a result of such failures. However, this type of rebasing is significant, because in some instances it does remove all previous indications of the base thinning flakes. When this happens, one of the key diagnostic characteristics of the type is removed, potentially causing mistyping of the specimen.

This form of rejuvenation, where only a section of the base needs to be re-flaked, is different from failures where the blade of the triangular point snaps at some distance from the base leaving sizable proximal and distal fragments. In at least one instance, an attempt to unsuccessfully rebase a blade fragment using the relatively thick break face as a platform was noted (Figure 49e). This attempt was unsuccessful because of the lack of suitable thin platform surfaces along the break face. It is perhaps this reason why few rejuvenation attempts of this type have been noted in the collections inspected.

Tortugas, as well as Matamoros, points tend to be thinnest near their tip and at the base. In the vicinity of the tip the points thicken very rapidly reaching maximum thickness not far below the tip. On the other hand, the base is thinned for an average length of about 17-18 mm on Tortugas points and 14-16 mm on Matamoros points. Figure 50 shows the longitudinal cross-section of a number of Tortugas and Matamoros points. It is evident that as the points become shorter in length, their maximum thickness moves closer and closer toward the tips of the points. As a result of this progression, the tips of the points become more resistant to bending fracture failure since they are located immediately behind the impact area. On the other hand, although the points are thinnest near their bases, they are also widest near their bases. It is possible that the increased width of these triangular points at the base compensates for the greater thinness of the specimens and therefore reduces failure risk. Therefore, it is possible that as these triangular points decrease in length their reliability increases due to reduced failure probability. This progression through their use-life would place two competing aspects of these points side-by-side. Decreased length would result in lowered cutting efficiency, but increased reliability as a projectile point.

Exhausted Specimens

Tortugas points that do not experience blade failure but continue to be resharpened during their use-life become gradually narrower even though their length may not

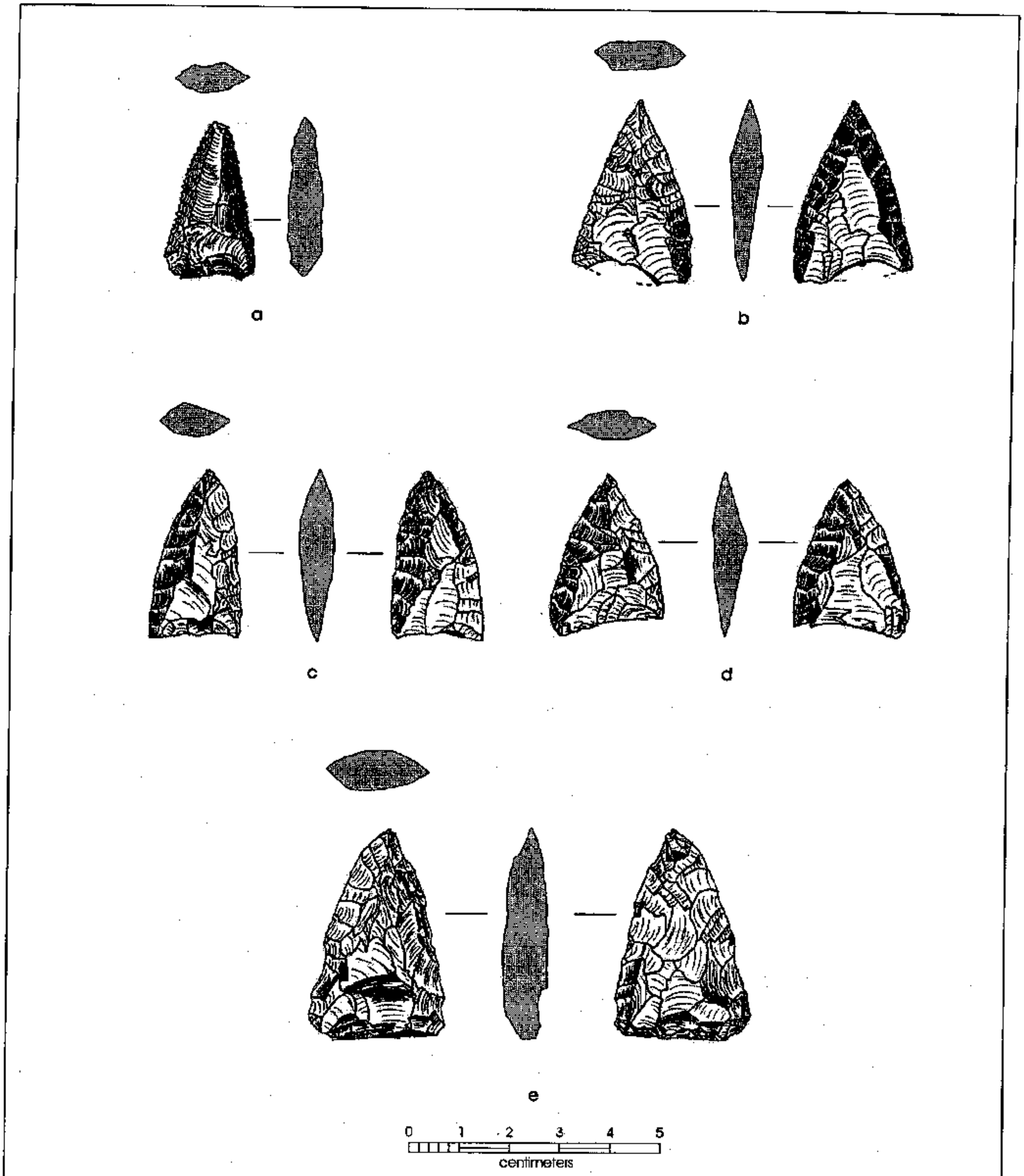


Figure 49. *Use failures and base rejuvenations on triangular projectile points: a) impact scar; b) base failure; c-d) points with rejuvenated bases; e) blade failure with rejuvenation attempts.*

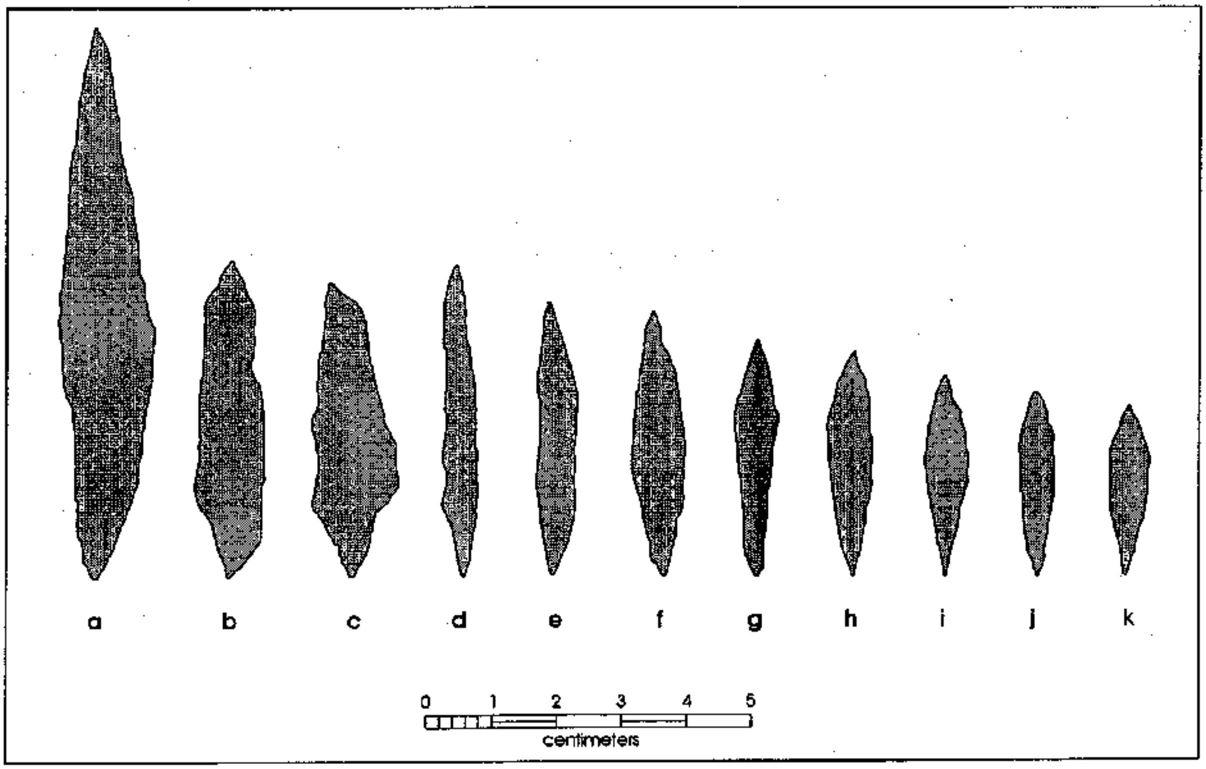


Figure 50. *Longitudinal cross-sections of triangular preforms and points, note change in location of maximum thickness with decreasing point size: a-c) blanks; d-k) points in various stages of resharpening.*

decrease substantially (Figure 47c). Such specimens may be considered "exhausted" since there may be no remaining opportunities to resharpen the blade without its failure. As mentioned previously, the encounter of these narrow but complete points may be indicative of a preventive tool replacement strategy that is geared towards replacing tools within the context of "down time" rather than waiting for their failure during use. Due to the resharpening of Tortugas points along their entire length, the points automatically undergo a narrowing of their maximum width. If, in addition to this narrowing, the points suffer numerous blade failures they will not only become narrower, but will also become shorter, reaching an "exhausted" form as small and rather narrow variants of their original forms (Figures 47b and 48b-c).

Nueces Tools

A total of 218 distally beveled tools that fall within the Nueces tool category have been analyzed for this report. Slightly less than half (n=100, 46%) are from the Prevost Collection, while the remainder is from the Riley Family Collection. Morphologically these specimens range from semicircular, to crescent-shaped and triangular, and even pointed forms.

Manufacture and Failure

The analysis of the sample and visual inspection of a much larger number of similar specimens from the Prevost and Riley collections indicate that the manufacture of Nueces tools is characterized by two distinct trajectories, one unifacial (Figure 51) and the other bifacial (Figure 52). The unifacial forms are slightly more common in the sample analyzed (n=118, 54%) than their bifacial counterparts (n=100, 46%). Hard hammerstone flake blanks are employed when making the unifacial forms. Apparently decorticate flakes are preferred (n=177, 81%) over corticated blanks (n=41, 19%) suggesting that the cores are well prepared to set up the preferred platform angle and flake morphology prior to blank removal. Care is taken to select and/or produce flake blanks that have very diffuse bulbs of percussion in the making of the unifacial form. The diffuse bulb provides better purchase for the haft element and assures that a long segment of the working edge contacts the surface to be worked at all times, since more convex edges would contact primarily in the center while more concave edges may contact solely at the two outer edges, unless the material being worked is curved.

The bifacial variants of the Nueces tools tend to have a bi-convex or plano-convex transverse cross-section (Figure 52). Based on the examination of a large number of these specimens in the Riley collection, and more importantly on the symmetrical shape and well-patterned flake scars over the entire surface of many of the bifacial Nueces tools, it would appear that many of these are the result of the rejuvenation of broken bifaces into distally beveled tools (see Figure 52b). The author's (SAT) experiments in replicating these forms resulted in highly diagnostic debitage that would be key in identifying whether similar rejuvenation methods create the archeological specimens. The evidence for at least some of the tools being made of recycled failed bifacial artifacts is even more clear in the case of failed projectile points (Figure 52c). In this example, the alternate left beveling present on a former triangular projectile point is a clear indication of the nature of the original blank employed in the manufacture of the tool. The examination of the larger Riley collection has indicated that while additional Nueces tools with beveled edges are present, they are not very common in the collection. This pattern might suggest that most Tortugas and/or Matamoros points may not be large enough in their broken state to be consistently and systematically recycled into Nueces tools.

The mean maximum length of the bifacial Nueces tools is 34.8 mm, ranging from 68.1 to 19.8 mm (Table 21). This figure is about the same as the mean length of the Matamoros points and it is well under the mean length of Tortugas specimens (see Tables 19 and 20). The mean maximum width of the bifacial Nueces tools is 36.3 mm while their mean maximum thickness is 9.7 mm. The

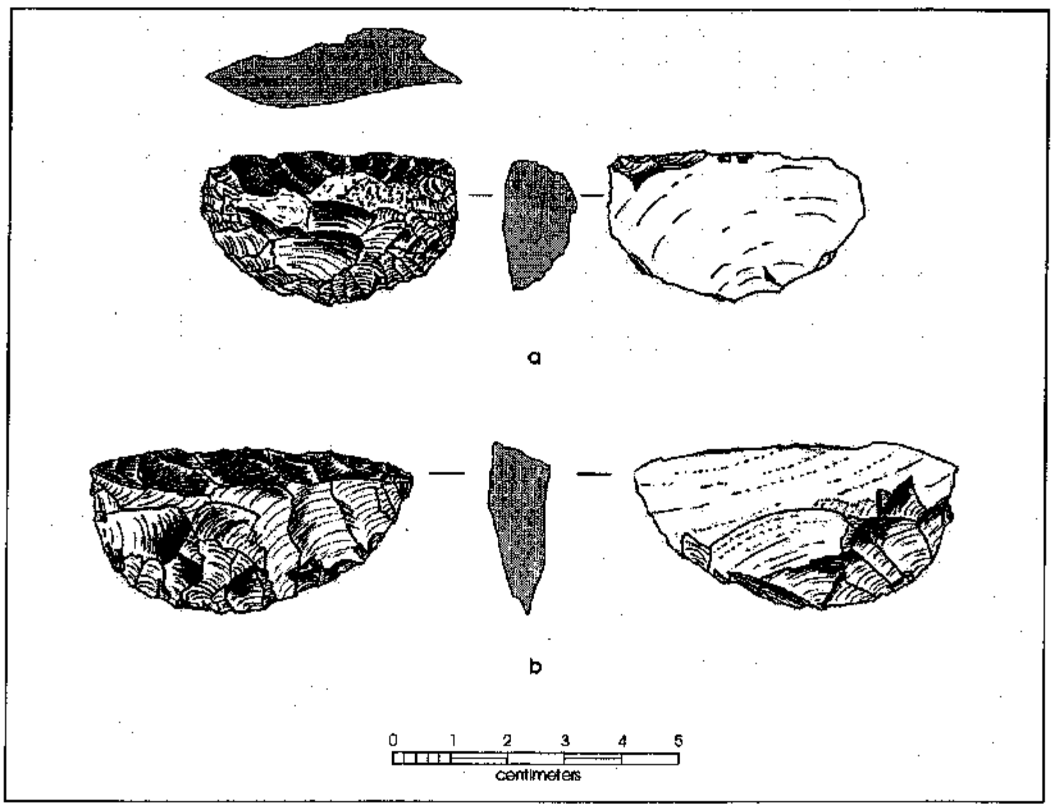


Figure 51. *Unifacial Nueces tools: a) no bulbar thinning, note reuse flakes on distal end; b) moderate bulbar thinning.*

last two figures are greater than the mean maximum width and thickness values for Tortugas points suggesting, perhaps, that if bifacial Nueces tools are made from recycled bifaces, these artifacts are often not likely to be projectile points.

The mean maximum length of unifacial Nueces specimens is very similar to their bifacial counterparts (Table 21). However, unifacial specimens made from flake cores tend to be both thicker and wider than their bifacial counterparts (Table 21).

As a result of careful blank manufacture and/or selection, in looking at the profile of the working edges on these Nueces tools, it can be noted that among the unifacial forms straight and convex working edges occur in identical proportions (n=41 each, 35% each). Recurved or undulating edges (n=27, 23%) and concave edges (n=9, 8%) are relatively infrequent. Among the bifacially manufactured Nueces tools, specimens with convex working edges constitute 51 percent of the collection followed by specimens with straight working edges (41%). Seven (8%) bifacial tools have recurved working edges.

Based on these figures, working edges with a convex ventral profile are relatively common among the Nueces tools. In order to gauge the degree of convexity of these working edges, measurements were taken of the protrusion of the ventral face from a vertical line connecting the two corners of the working edge. The mean ventral protrusion among all Nueces tools is 2.4 mm, with a range of 7.5 to .2 mm (Table 22). These measurements again reiterate that working edge profiles tend to be maintained relatively flat among the Nueces tools and that those tools that offer large areas of contact with the worked material (i.e., those tools that have a flatter edge profile) are likely to be more effective than the other shapes.

Identifying the location of the flake blank's platform can inform one about the strategy of blank production as well as tool orientation. Of the 88 unifacial specimens on which platform location could be identified, 45 (51%) had platforms located on the side of the finished tool, that is, the parent flake's longitudinal edge was used as the tool's working edge. On an additional 35 (40%) specimens, the parent flake's platform was located at the proximal end of the tool. Only in eight (9%) identifiable cases was the parent flake's striking platform located at the distal or working edge of the tool. This distribution of platforms assures the craftsmen and tool user that the ventral surface of the working edge will be as flat as possible allowing for greater tool efficiency.

The production of flake blanks with diffuse bulbs of percussion is not an easy task and flakes often retain larger and more bulbous cones of percussion than can be accommodated by the hafting element into which the tools are mounted. In only 26 (22%) of the unifacial forms was the bulb of percussion sufficiently diffuse not to require additional thinning of the blank's ventral face. Minimal retouch of the bulb of percussion had to be employed in 25 (27%) of the remaining unifacial forms (Figure 51a), 43 (47%) others had to be moderately thinned (Figure 51b), while 24 (26%) of the specimens have been extensively retouched on their ventral faces.

Resharpening

The mean edge angle of Nueces tools is 63.1 degrees, and ranges from a maximum of 89 to a minimum of 41 degrees (Table 22). An examination of the 17 specimens that have edge angles higher than or equal to 80 degrees indicates that these working edges are heavily step-fractured due to failure to properly resharpen an already steep edge. Interestingly, a majority of these edges are also straight (75%) or only slightly convex, and a concave edged specimen is also present in the group (Figure 52d), suggesting that resharpening reduces the degree of convexity of the working edges.

This observation is supported by the breakdown of working edge shapes within the overall Nueces tool collection. Convex edges (n=153, 70%) greatly outnumber all other shapes, and straight edges are present on only 26 percent (n=56) of the collection. Concave edges on Nueces tools are infrequent (n=9, 4%). This breakdown in working edge shape suggests that the preferred shape is a convex edge and that as tools are resharpened their edges become straighter.

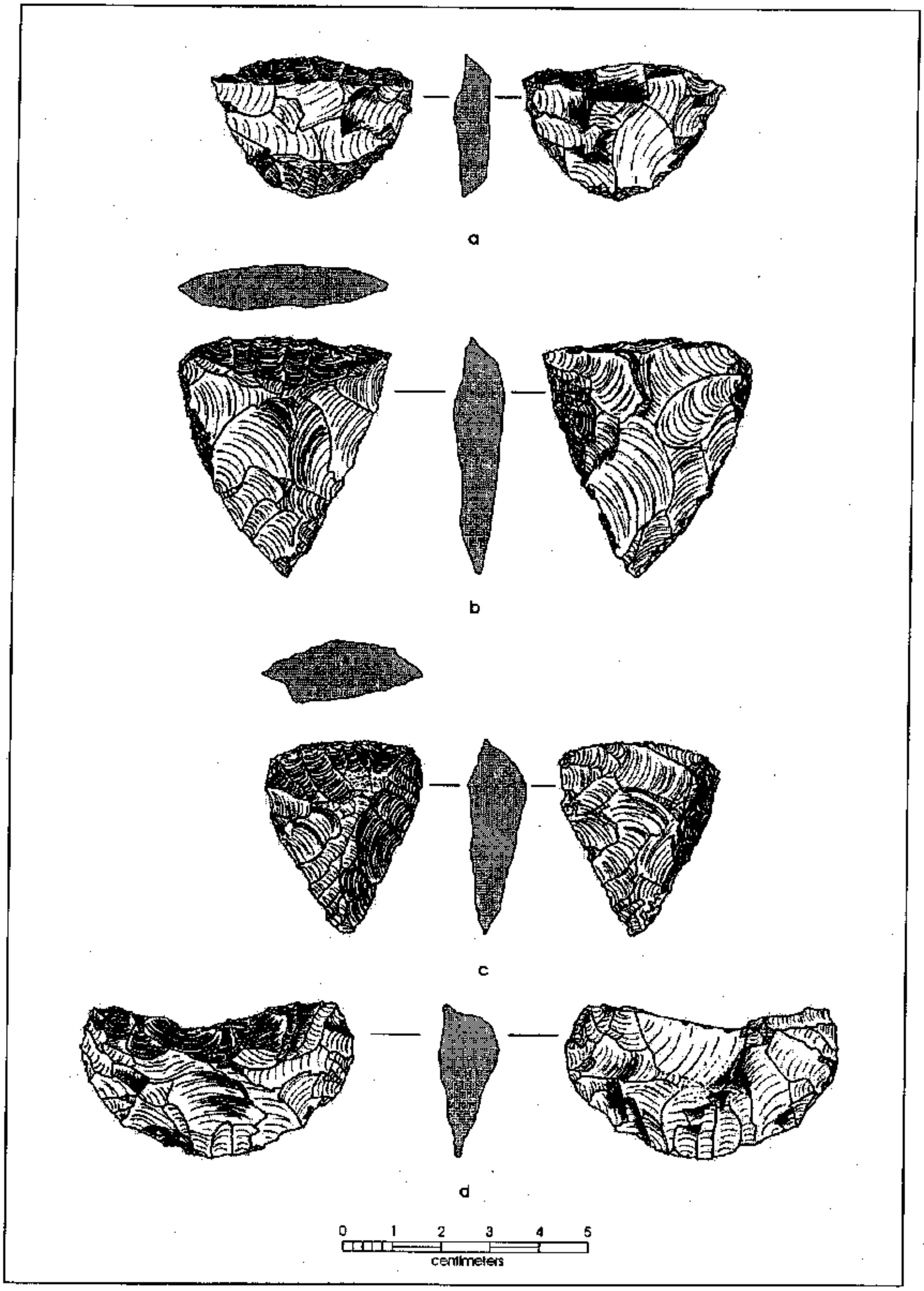


Figure 52. *Bifacial Nueces tools: a-b) made on recycled biface fragments; c) made on recycled alternately beveled point fragment; d) heavily resharpened tool with concave working edge.*

Table 21. Descriptive statistics for selected Nueces tools (n=118)

Bifacial Nueces

Max. Length		Max. Width		Max. Thickness	
Mean	34.62	Mean	36.33	Mean	9.72
Standard Error	0.86	Standard Error	0.62	Standard Error	0.24
Median	33.5	Median	35.8	Median	9.4
Mode	33.8	Mode	43.9	Mode	7.9
Standard Deviation	8.63	Standard Deviation	6.22	Standard Deviation	2.43
Sample Variance	74.55	Sample Variance	38.67	Sample Variance	5.88
Kurtosis	2.87	Kurtosis	0.67	Kurtosis	2.15
Skewness	1.27	Skewness	0.66	Skewness	1.20
Range	48.3	Range	33.5	Range	12.9
Minimum	19.8	Minimum	25.5	Minimum	5.5
Maximum	68.1	Maximum	59	Maximum	18.4
Sum	3461.5	Sum	3632.6	Sum	972.2
Count	100	Count	100	Count	100

Unifacial Nueces

Max. Length		Max. Width		Max. Thickness	
Mean	33.25	Mean	43.41	Mean	11.79
Standard Error	0.76	Standard Error	0.61	Standard Error	0.25
Median	31.85	Median	42.25	Median	11.6
Mode	30.4	Mode	41.8	Mode	10.2
Standard Deviation	8.24	Standard Deviation	6.63	Standard Deviation	2.68
Sample Variance	67.93	Sample Variance	44.00	Sample Variance	7.16
Kurtosis	3.63	Kurtosis	1.03	Kurtosis	0.41
Skewness	1.43	Skewness	0.65	Skewness	0.43
Range	51.5	Range	37.2	Range	15.4
Minimum	18.3	Minimum	30	Minimum	5.6
Maximum	69.8	Maximum	67.2	Maximum	21
Sum	3923.7	Sum	5121.93	Sum	1391.7
Count	118	Count	118	Count	118

Use-wear Analysis

Two macroscopic aspects of use-wear were systematically investigated on all of the Nueces tools in the sample. One of these was the observation of use-polish on the ventral faces of the tools, concentrating primarily in the vicinity of the working edge. Prior to making these observations, tools were washed in warm water using dishwashing detergent. If doubt remained about the nature of the polish, the specific surface was cleaned with rubbing alcohol using a cotton swab. Each polished surface was than examined under direct light at 40X magnification. Tools were handled with white cotton gloves to prevent the deposition of oily substances on their surfaces.

Of the 218 specimens examined, 21 specimens (10%) had no discernible polish on their ventral faces. In addition, the presence or absence of polish could not be determined on two chalcedony specimens that retained a high degree of natural polish. The majority (n=124, 64%) of the remaining 195 specimens with polish retained minimal polish in localized areas across the ventral face of the tool. This polish tended to be strongest on flake scar ridges although low-lying areas of micro-topography also retained polish. In the majority of these cases, the polish was not associated with striations. A moderate degree of polish was present on 64 (33%) of the specimens while extensive polish was present on only seven (3%) specimens. Although, even on specimens with moderate and heavy polish the flake scar ridges retained brighter polish; extensive polish also was present even in the low-lying areas of the faces. In addition to bright polish on the faces, it was noted that the working edges themselves were polished and micro-striations (grooves) were present along the edges. This bright polish, in combination with a lack of striations on the faces of these tools and polish and striations on the working edges, is similar to use-wear traces noted on hide scrapers replicated by this author.

In addition to polish and limited striations, many of the tools also retained single or multiple step fractures on their ventral faces, distributed immediately behind the working edge and originating from that edge. These step- and shallow hinge-fractured flake scars are superficial and expand broadly toward their distal ends (Figure 51a). Finally, the dorsal faces of the working edges of many of the tools retained multiple step-fractured flake scars. These scars ranged from 2–4.5 mm in maximum length and tended to be relatively narrow, 1.5–25 mm. This author (SAT) was able to replicate both types of use-damage scars while using a hafted adze in chopping through seasoned Bois d'arc wood. The motion and force of the chopping action resulted in use-damage in the form of thin flake removals from both the ventral and dorsal faces of the working edge.

The combination of Nueces tools with bright polish and no striations, polished and striated working edges, and step-fractured use-wear flakes indicates that these tools were employed in a variety of tasks including the working of very soft and also very hard materials. Similarly, the occurrence of wear traces that are indicative of scraping (i.e., striations on the edges) in combination with those indicative of chopping suggests that the tool form is multi-functional, employed, perhaps opportunistically, in the performance of a variety of tasks and in the processing of a variety of materials.

Olmos Bifaces

A total of 94 distally beveled tools that fall within the Olmos biface category have been analyzed for this report. The large majority (n=91, 94%) is from the Riley collection, with only three (6%) coming from the Prevost collection. Morphologically, these specimens form a much more homogeneous group than the Nueces tools. These specimens are triangular in outline, often have alternately beveled edges and always have beveled distal working edges. Some specimens retain burin scars off one corner of the working edge, although this is not a diagnostic trait of the tool.

Table 22. Descriptive statistics for two Nueces tool attributes

Ventral Protrusion		Edge Angle	
Mean	2.40	Mean	63.13
Standard Error	0.10	Standard Error	0.67
Median	2.1	Median	64
Mode	1.5	Mode	65
Standard Deviation	1.44	Standard Deviation	9.89
Sample Variance	2.08	Sample Variance	97.78
Kurtosis	1.11	Kurtosis	-0.31
Skewness	1.02	Skewness	0.13
Range	7.3	Range	48
Minimum	0.2	Minimum	41
Maximum	7.5	Maximum	89
Sum	468.53	Sum	13763
Count	195	Count	218

Tool Manufacture and Failure

It is interesting that in attempting to reconstruct the blanks used in the manufacture of these tools, no specimens representing the early stages of manufacture were found in the collections. Rather, all Olmos bifaces in this study and all previously described Olmos bifaces encountered in the literature (see Bettis 1997; Hester 1969; Shafer and Hester 1971) appear to be finished specimens. That is, they are fully bifacially flaked and have steeply beveled distal ends.

In examining the overall morphology of the specimens in the sample, it was noted that a number had beveled lateral edges (Figure 53a). The systematic counting indicated that 38 (40%) of the specimens were made on biface fragments with alternately beveled edges. Alternate left beveled specimens greatly outnumbered (n=30, 79%) alternate right beveled specimens. This figure is similar to the high percentage of alternate left beveled Matamoros and Tortugas points. The presence of specimens with beveled lateral edges is puzzling yet probably indicative of the nature of the blank used in tool manufacture. The beveled edges seem to serve no practical purpose, especially since they are on the margins of the tools rather than their working edges.

Two other aspects of Olmos tool morphology are worthy of mention. One is the fact that some of these bifaces retain what appear to be former base thinning flake scars (Figure 53b) on their faces. However, the number of specimens that retain this characteristic is very low (n=3). Another interesting aspect of the morphology of Olmos bifaces is the large number of specimens with broken proximal ends. An examination of the 94 specimens indicated that 56 (60%) of the specimens have a small break off their pointed proximal ends (Figure 53c). A close scrutiny of the morphology of these breaks indicates that some of them clearly represent impact breaks. However, the remaining break morphologies suggest the intentional breakage of the pointed ends. Such an intentional breakage of pointed ends may make sense, if we consider the fact that pointed proximal ends do not provide a good purchase in a haft because the specimen will tend to simply pivot on this point. However, the intentional breakage of the proximal end broadens the area and provides a more stable purchase in the haft.

Overall, the presence of specimens with beveled edges, in combination with the presence of thinning flake remnants on the faces of some tools and the frequency of impact scarred proximal ends, strongly suggests that at least some of the tools were made on recycled dart point fragments. Given the predominance of beveled Tortugas and Matamoros points in South Texas, and the morphological affinities of Olmos tools to these points, it is not unreasonable to suggest that Olmos bifaces are contemporaneous with these projectile points and functioned in the same tool kit.

The mean maximum length of the Olmos bifaces is 28.7 mm and ranges from 44.8 to 17 mm (Table 23). This figure is smaller than the mean maximum length of the Matamoros points and it is well under the mean length of Tortugas specimens (see Tables 19 and 20). The mean maximum width of the Olmos bifaces is 22.5 mm while their mean maximum thickness is 7.0 mm. The last two figures are about the same as the mean maximum width and thickness values for Matamoros points and the maximum thickness of Olmos bifaces is very similar to the maximum thickness of Tortugas points.

In looking at the profile of the working edges of Olmos bifaces, it was noted that all but one of the specimens have either straight or convex working edges and that the former shapes (n=49, 52%) are slightly more common than the latter (n=44, 47%). A concave working edge profile was present on a single specimen. To quantify the degree of convexity of these working edges, measurements were taken of the protrusion of the ventral face from a vertical line connecting the two corners of the working edge. The mean ventral protrusion among all Olmos bifaces is 2.0 mm, with a range from 4.5 to 0.2 mm (Table 23). As in the case of the Nueces tools, these working edge profiles again reiterate that working edge profiles also tend to be maintained relatively flat among Olmos bifaces.

Resharpening

The mean edge angle of Olmos bifaces is 63.9 degrees, and ranges from a maximum of 84 to a minimum of 45 degrees (Table 23). These figures are very similar to the respective figures among Nueces tools. The similarity may imply that the manner of use and the tasks in which the two forms are employed are relatively similar. As in the case of the Nueces tools, an examination of the five specimens that have edge angles higher than or equal to 80 degrees indicates that these working edges are heavily step-fractured due to failure to properly resharpen an already steep edge. Interestingly, a majority (n=51, 54%) of these edges are convex, and straight working edges constitute only 38 percent of the collection. Seven specimens in the collection (7%) have concave working edges. This pattern suggests that convex to slightly convex edges are preferred and that resharpening reduces the degree of convexity of the working edges.

Use-wear Analysis

As was the case with the Nueces tools, two macroscopic aspects of use-wear were systematically investigated on all of the Olmos bifaces in the sample. One of these was the observation of use-polish on the ventral faces of the tools, concentrating primarily in the vicinity of the

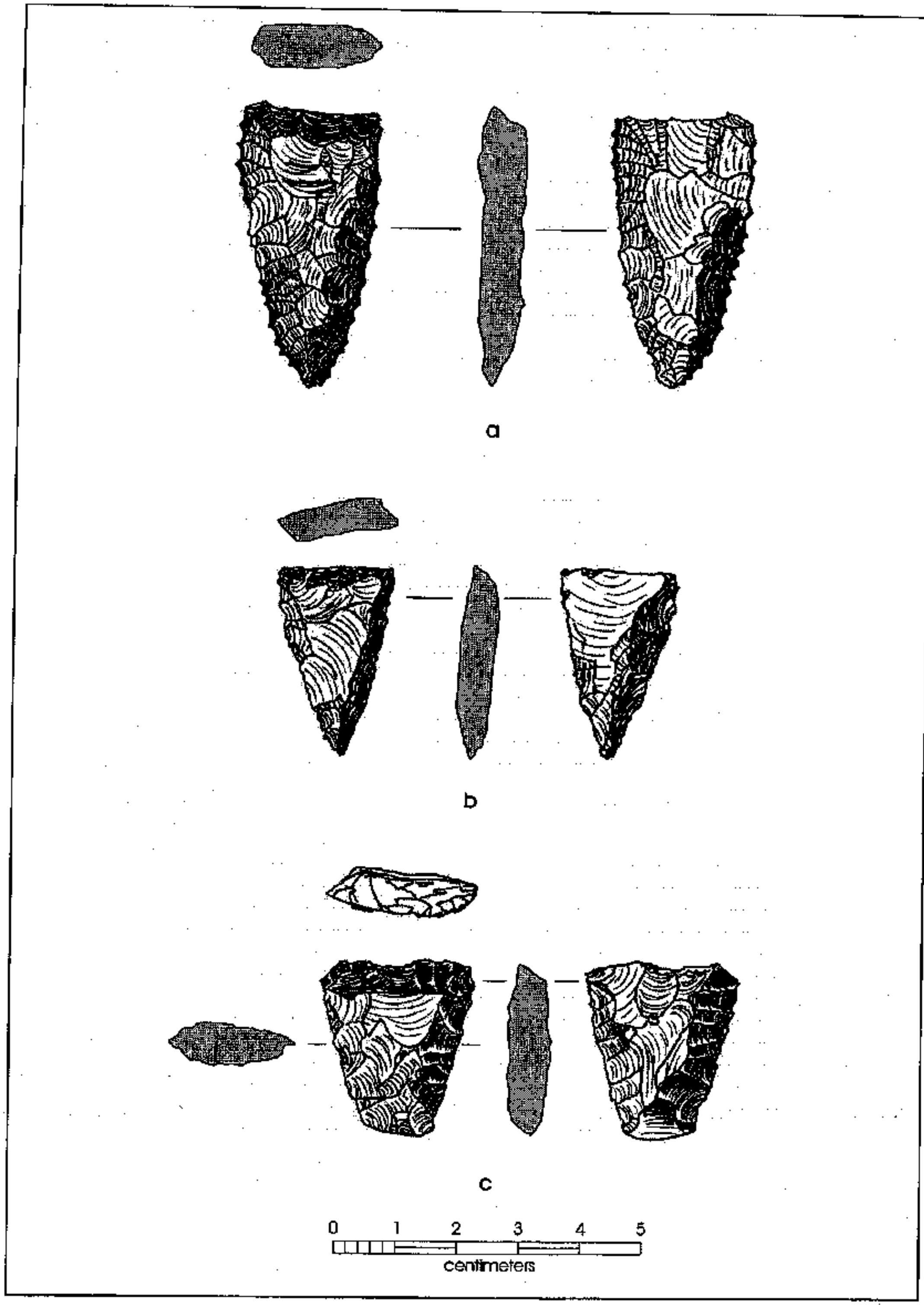


Figure 53. *Olmos bifaces made on recycled projectile points: a) note alternate left beveled edges; b) note beveled edges and former base thinning scar on ventral face of tool; c) note beveled edges and former impact scar on proximal end of complete tool.*

Table 23. Descriptive statistics for Olmos biface attributes (n=94)

Edge Angle		Ventral Protrusion		Thickness 5 mm	
Mean	63.95	Mean	1.98	Mean	5.05
Standard Error	0.87	Standard Error	0.09	Standard Error	0.12
Median	64	Median	1.95	Median	4.85
Mode	64	Mode	2.8	Mode	4.7
Standard Deviation	8.47	Standard Deviation	0.89	Standard Deviation	1.20
Sample Variance	71.69	Sample Variance	0.79	Sample Variance	1.44
Kurtosis	-0.04	Kurtosis	0.28	Kurtosis	-0.41
Skewness	0.09	Skewness	0.48	Skewness	0.37
Range	39	Range	4.3	Range	5.5
Minimum	45	Minimum	0.2	Minimum	2.6
Maximum	84	Maximum	4.5	Maximum	8.1
Sum	6011	Sum	186.22	Sum	474.55
Count	94	Count	94	Count	94

Maximum Length		Maximum Width		Maximum Thickness	
Mean	28.76	Mean	22.55	Mean	7.03
Standard Error	0.52	Standard Error	0.35	Standard Error	0.11
Median	28.5	Median	22.45	Median	6.85
Mode	26.3	Mode	21.9	Mode	6.6
Standard Deviation	5.07	Standard Deviation	3.44	Standard Deviation	1.03
Sample Variance	25.74	Sample Variance	11.84	Sample Variance	1.05
Kurtosis	0.07	Kurtosis	-0.31	Kurtosis	-0.34
Skewness	0.28	Skewness	0.12	Skewness	0.43
Range	27.8	Range	16.2	Range	4.7
Minimum	17	Minimum	15.3	Minimum	4.9
Maximum	44.8	Maximum	31.5	Maximum	9.6
Sum	2703.8	Sum	2120.1	Sum	660.75
Count	94	Count	94	Count	94

working edge. Prior to observation, the specimens were treated in the same manner as described for the Nueces tools. Each polished surface was than examined under direct light at 40X magnification.

Of the 94 specimens examined, 15 (16%) had no discernible polish on their ventral faces. In addition, the presence or absence of polish could not be determined on a single specimen that retained a high degree of natural polish. The majority (n=56, 72%) of the remaining 78 specimens with polish retained minimal polish distributed across the ventral face of the tool adjacent to and behind (proximal to) the working edges. This polish tended to be strongest on flake scar ridges, although low-lying areas of micro-topography also retained light polish. No striations were noted on the polished surfaces. A moderate degree of polish was present on 18 (23%) of the specimens with use-wear, while extensive polish was present on only four (5%) specimens. Although, even on specimens with moderate and heavy polish the flake scar ridges retained brighter polish, extensive polish also was present in the low-lying areas of the faces. In addition to bright polish on the faces, it was noted that the working edges themselves were polished and micro-striations, similar to those noted on hide scrapers, were present along the edges. This wear pattern and distribution was identical to that noted on the Nueces types, the larger of the distally beveled tools.

As in the case of Nueces tools, in addition to polish and limited striations, 13 (14%) of the 94 Olmos bifaces also retained single or multiple step-fractured flake scars on their ventral faces, distributed immediately behind the working edge and originating from that edge (see Figure 54a-c; ventral faces of the specimens). These step- and hinge-fractured flake scars are very shallow and tend to either expand toward their distal ends (i.e., the proximal end of the tool) or have parallel sides. Shafer and Hester (1971:4) referred to these scars as "distal-to-proximal-trimming" and noted their presence on 17 (27%) of the specimens they studied. On five of these specimens, these flakes occurred in combination with burin facets off the corners of the tools (Shafer and Hester 1971:5).

As mentioned earlier, burin scars occur occasionally on Olmos bifaces (Figure 54a-c). Of the 63 specimens examined by Shafer and Hester (1971:4–5), burin scars were present on 23 (36.5%). In the collection examined in this study, burin scars appear on 23 (24.5%) of the specimens, a slightly lower percentage than in the earlier Shafer and Hester study. Five (22%) of the 23 Olmos bifaces with burin scars retain two scars, one from each of the corners.

Finally, and as in the case of the Nueces tools, the dorsal faces of the working edges of many of the tools retained multiple step-fractured flake scars. These scars are smaller than those on the larger tools forms, (i.e., ranging from 1.5–4.5 mm in maximum length) and tend to be either narrow or trapezoidal in shape. These use-wear flakes have been replicated on larger hafted tools used in chopping hardwood, and although the Olmos bifaces seem too small for such tasks, the presence of both these shallow scars on the ventral faces of the tools, as well as burin scars off the corners of the specimens, suggests a woodworking function for at least some of the Olmos bifaces studied. As was the case with Nueces bifaces, however, the combination of these more obvious use-wear traces with use-polish without striations, and striated working edges that appear to derive from hide scraping, suggest that Olmos bifaces also were used in a variety of tasks and in the processing of a variety of hard and soft materials.

A Metric and Technological Comparison of Matamoros-Tortugas and Abasolo-Refugio-Catán Points

Based on technological characteristics alone there is little if any difference between Matamoros and Tortugas points on the one hand, and Abasolo, Refugio, and Catán points on the other. The two triangular points share similar base thinning approaches, both forms tend to have beveled blades, and both have similar overall shapes. In contrast, base thinning is not a common trait on the three sub-triangular types, and blade beveling is also infrequent. Morphologically, Catán points are reminiscent of small Abasolo points with the maximum width on both types occurring near their bases. In addition, even with the artificial metric distinction between them, there seems to be some overlap in classifying the two forms (see Historical Overview section). Refugio points are in general narrower than Abasolo points and longer than either of the other two. The maximum width of Refugio points tends to occur well above the base of the points.

The classification of the 335 triangular points based on these technological criteria resulted in all but three points being classified as Tortugas points (n=231). The three that were classified as Matamoros lacked base thinning flakes. However, it is possible that even some of these may have been Tortugas. A sub-sample of points (n=89) was classified as indeterminate and twelve were identified as Early Triangular specimens.

As the previously summarized descriptions of the two forms indicate, the primary morphological difference between the two is that by definition the Matamoros points tend to be specimens less than 40 mm in maximum length, while Tortugas tend to be specimens greater than 40 mm in maximum length. When these criteria are applied for the classification, 134 specimens are classified as Tortugas and 92 are classified as Matamoros. The primary difference in the two classifications is that 63 points that were classified as Tortugas due to their technological characteristics are now classified as Matamoros due to their size. In addition, 27 fragmentary points that appear to have been smaller than 40 mm in their complete maximum length, also are classified as Matamoros.

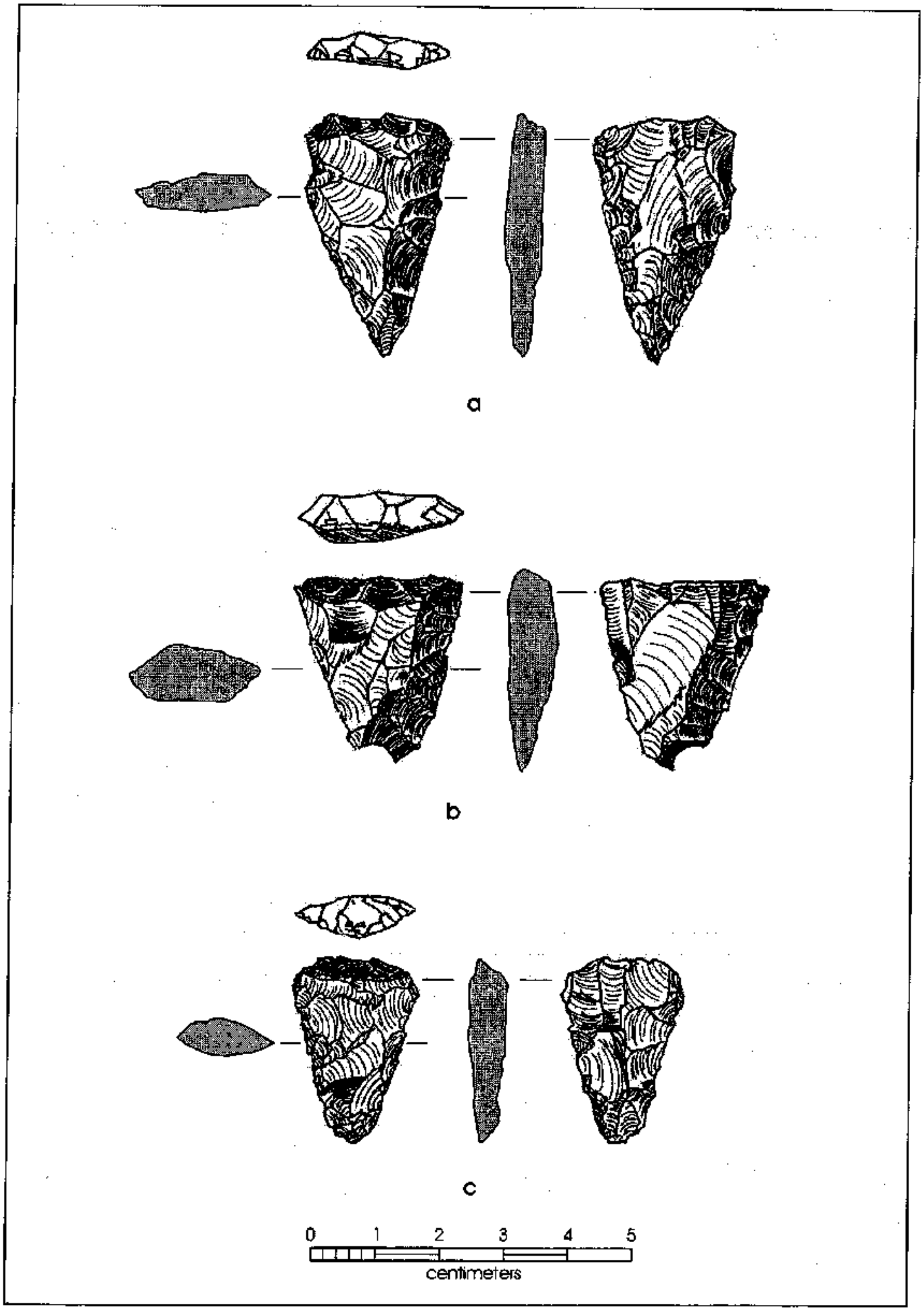


Figure 54. *Olmos bifaces with burin scars off the corners of the working edges –also note transverse cross-sections and step fracturing off distal faces of working edges.*

The classification of the 289 round-base points based on the technological criteria described above resulted in 96 points being classified as Abasolo points, 65 as Refugio points, 86 specimens classified as Catán points, 29 as Desmuke points, and 13 as indeterminate specimens. As the historical overview section indicated, the primary morphological difference between the Catán and Abasolo types is that by definition the Catán points tend to be specimens less than 40 mm in maximum length, while Abasolo tend to be specimens greater than 40 mm in maximum length. When these criteria are applied to the classification of the 182 points previously classified as Abasolo or Catán, 98 specimens are classified as Abasolo and 84 are classified as Catán. More importantly, a total of 13 specimens (13.5% of original group) previously classified as Abasolo are reclassified as Catán, and 16 specimens (19% of original group) classified as Catán are grouped with Abasolo. The following section compares the Tortugas-Matamoros and Abasolo-Refugio-Catán type groups in terms of metric attributes and discusses the typological and functional implications of the patterns in these attributes.

The mean maximum length of complete Tortugas points is 51.7 mm, with a range between 77.1 mm and 41 mm. The median value is 50 mm, while the mode is 41 mm. The plot of the maximum lengths of the complete Tortugas points divided into 2 mm categories (Figure 55) indicates that the distribution is not normal and is right-skewed. The normal distribution curve is overlain on the histogram to show the deviations from normal. The mean maximum length of Matamoros points is 34.4 mm, with a range between 40.9 mm and 22.6 mm. The median value is 35 mm, while the mode is 36.9 mm. The plot of the maximum lengths of the complete Matamoros points divided into 1 mm categories (Figure 56) indicates that the distribution is not normal and is left-skewed.

The mean maximum length of complete Refugio points is 57.3 mm, with a range between 87.3 and 37.3 mm. The median value is 57 mm, while the mode is 44 mm. The plot of the maximum lengths of the complete Refugio points (Figure 57) indicates that the distribution is roughly normal and approximates a bell-shaped curve. The mean maximum length of complete Abasolo points is 48.2 mm, with a range between 65.7 and 40.3 mm. The median value is 47 mm, while the mode is 46.2 mm. The plot of the maximum lengths of the complete Abasolo points divided into 2 mm categories (Figure 58) indicates that the distribution is not normal and is heavily right-skewed. The mean maximum length of complete Catán points is 35.4 mm, with a range between 40.8 mm and 26.2 mm. The median value is 36.2 mm, while the mode is 38.8 mm. The plot of the maximum lengths of the complete Catán points divided into 2 mm categories (Figure 59) indicates that the distribution is not normal and is left-skewed.

These aspects of the distributions illustrate the fact that the respective types within the triangular and round-base projectile point samples are artificially derived by dividing a continuum of sizes into small and large sub-groupings or, in this case, types. Among the triangular Tortugas and Matamoros points, neither type represents a normal population. The right tail of the Matamoros distribution is missing as is the left tail of the Tortugas distribution. Among the round-base points, the distributions indicate that with the possible exception of the Refugio type, neither of the other two represent a normal population described by a bell-shaped curve. The Abasolo distribution seems to be missing the smaller sized specimens at the left side of the distribution, while the Catán distribution seems to be missing the larger specimens at the right side of the plot.

Not surprisingly, however, when the two triangular point samples are combined the resulting population has a distribution that approximates normal more closely by having both tails of the distribution (Figure 60). The same observation holds true for the three round-base point types (Figure 61). These aspects of the distributions simply illustrate the fact that the Matamoros-Tortugas and Abasolo-Catán populations are based on an artificial distinction in size. The relatively normal distribution of Refugio points may result from the possibility that some narrower Abasolo points are included in the Refugio category while the smaller of the Refugio are misclassified as Catán points, since only two Refugio points have been identified in the sample. As in the case of the Tortugas and Matamoros points, the critical aspect of these results is that a simple size-based division between the two types does not allow the clear-cut recognition of changes in types resulting from resharpening and rejuvenation.

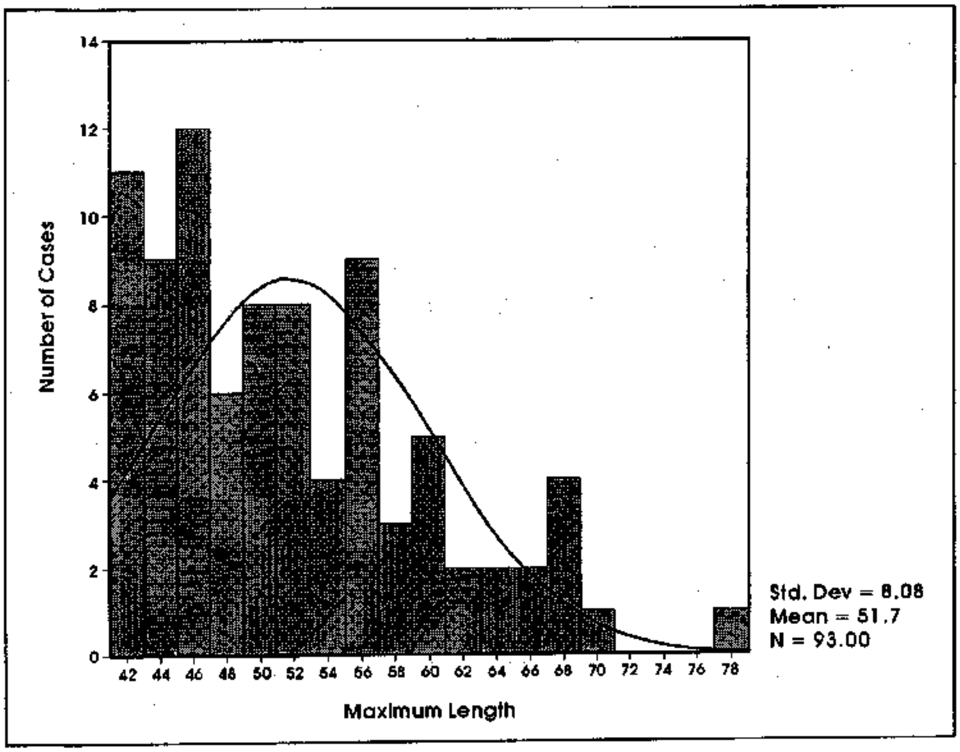


Figure 55. *Maximum lengths of complete Tortugas points.*

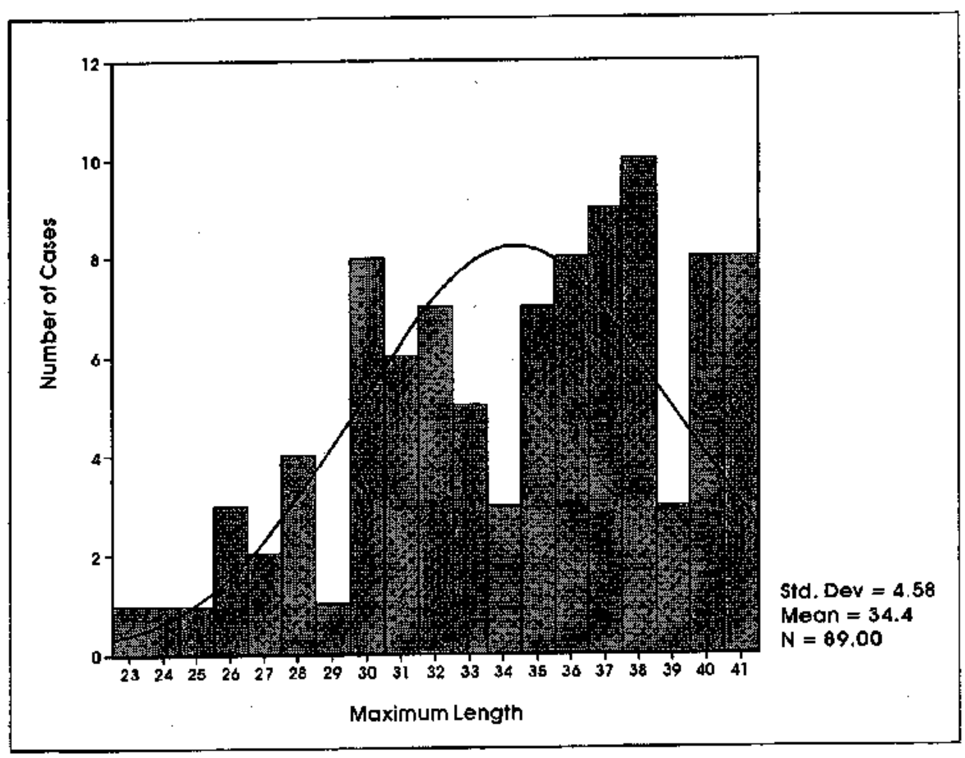


Figure 56. *Maximum lengths of complete Matamoros points.*

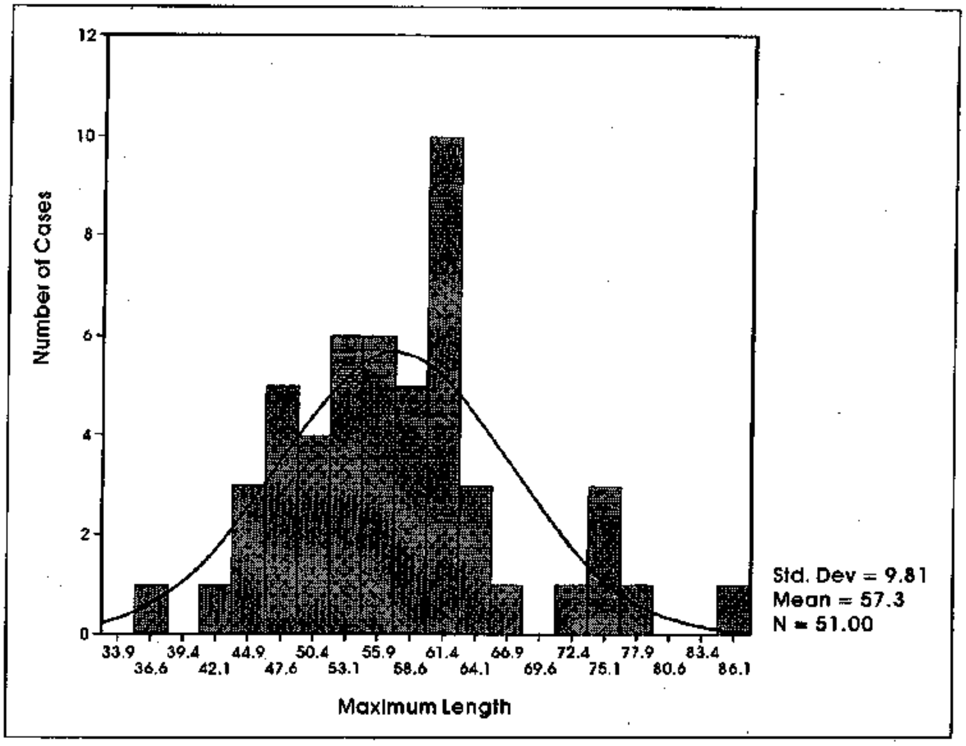


Figure 57. *Maximum lengths of complete Refugio points.*

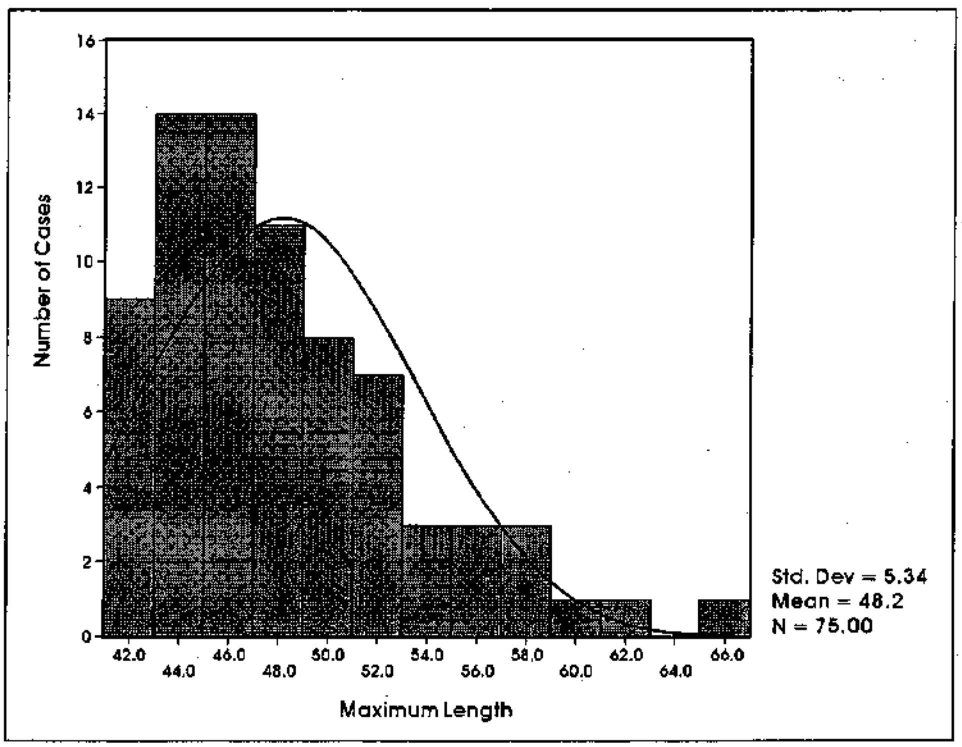


Figure 58. *Maximum lengths of complete Abasolo points.*

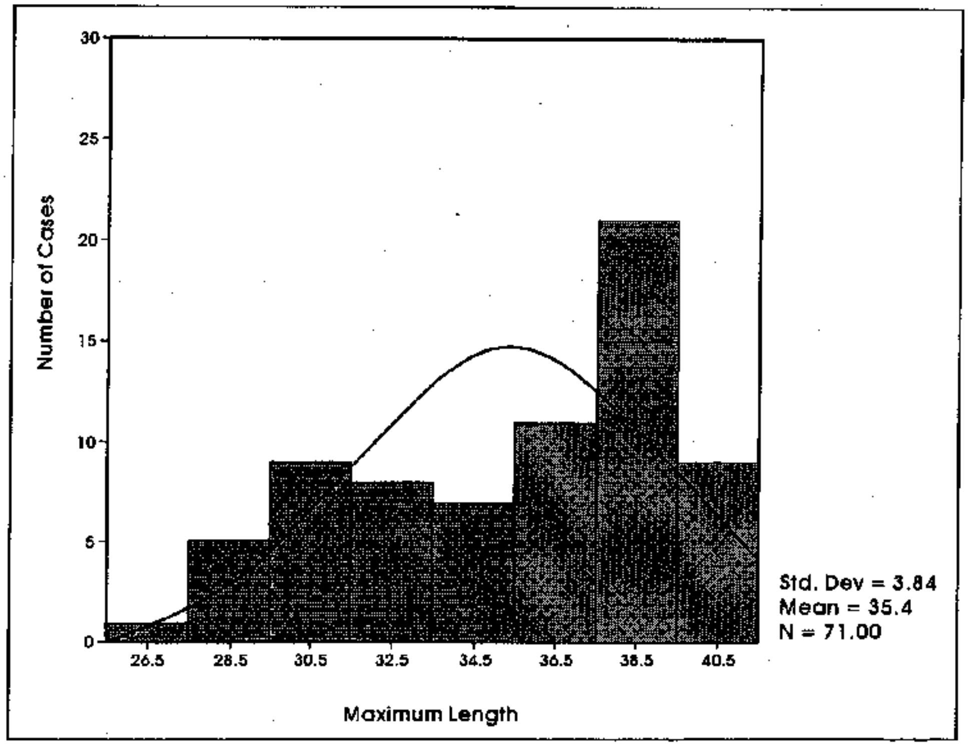


Figure 59. *Maximum lengths of complete Catán points.*

The mean maximum width of the complete Tortugas points is 28.8 mm, with a range between 42.9 mm and 18.3 mm. The median value is 28.2 mm, while the mode is 21.8 mm. The plot of the maximum widths of the Tortugas specimens, divided into 2 mm categories (Figure 62) shows a roughly normal distribution closely approximating a bell-shaped curve. The mean maximum width of the complete Matamoros points is 23 mm, with a range from 35 mm to 16.4 mm. The median is 22.8 mm, and the mode is 24.1 mm. As in the case of the Tortugas points, the plot of the maximum widths is normal and has a bell shape (Figure 63).

The mean maximum width of the complete Refugio points is 22.1 mm, with a range between 29.9 mm and 7.4 mm. The median value is 22.3 mm, while the mode is 20.4 mm. The plot of the maximum widths of the Refugio specimens (Figure 64), divided into 2 mm categories, shows a non-normal distribution that is heavily skewed to the left. Nonetheless, it is evident that only four Refugio specimens are 18 mm or narrower in the sample. The mean maximum width of the complete Abasolo points is 24.1 mm, with a range from 34 mm to 17.8 mm. The median and mode are both 23.4 mm. The plot of the maximum widths is right skewed (Figure 65). Only eight Abasolo specimens in the sample are narrower than 19 mm in maximum width. The mean maximum width of the complete Catán points is 21 mm, with a range from 26.4 mm to 16.1 mm. The median is 10.9 and the mode is 19.7 mm. The plot of the maximum widths is normal (Figure 66).

While the maximum length distribution patterns are not normal and exhibit the affects of arbitrarily defining small and large types within both the triangular and subtriangular forms, the patterns in maximum width distributions do not appear to show this effect in either of the broad groups. The pattern indicates that regardless of what size group of points one examines, within the group (i.e., Matamoros, Tortugas, Abasolo, Catán) there will be some very broad as well as some very narrow points. This pattern is the product of two factors affecting projectile point morphology. During their use-life projectile points continually undergo resharpening. As

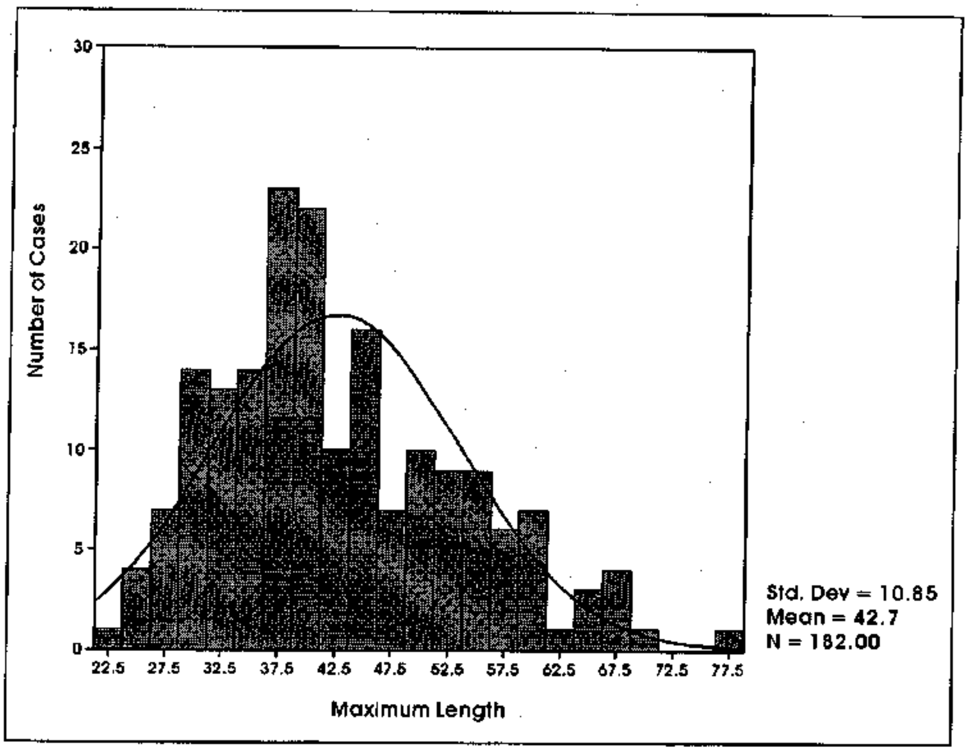


Figure 60. *Maximum lengths of complete Tortugas and Matamoros points.*

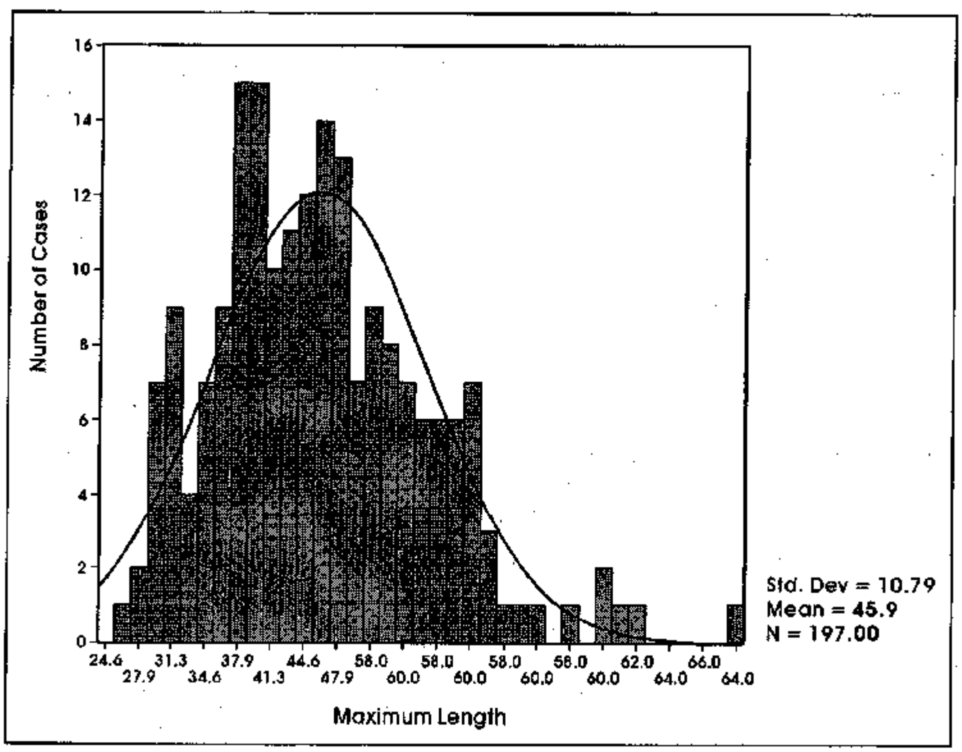


Figure 61. *Maximum lengths of complete Abasolo, Catán, and Refugio points.*

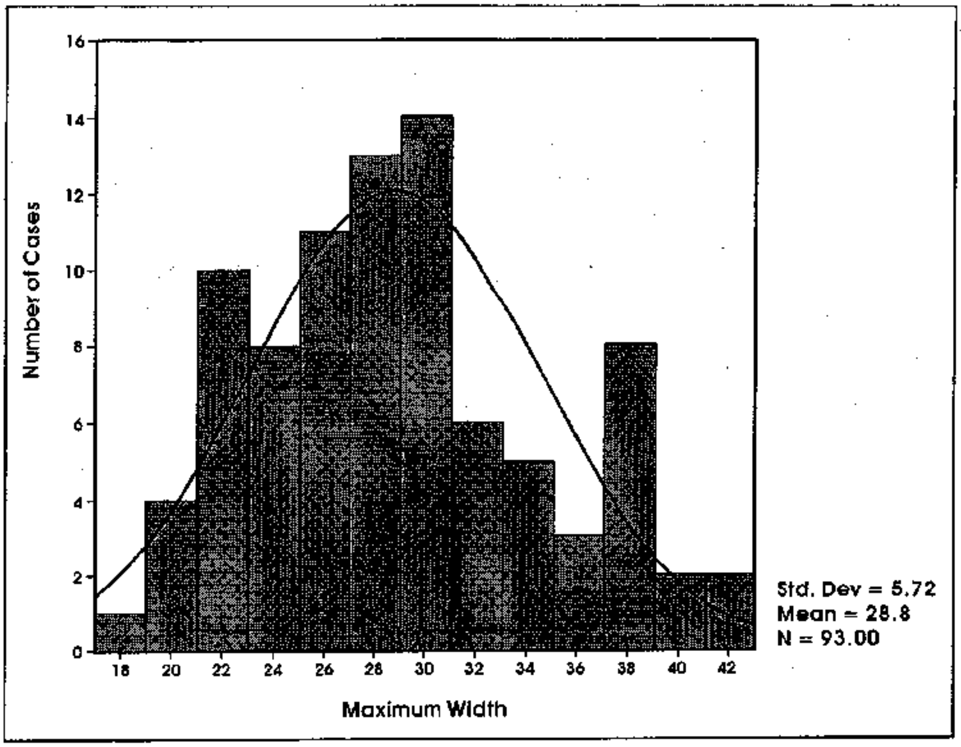


Figure 62. *Maximum widths of complete Tortugas points.*

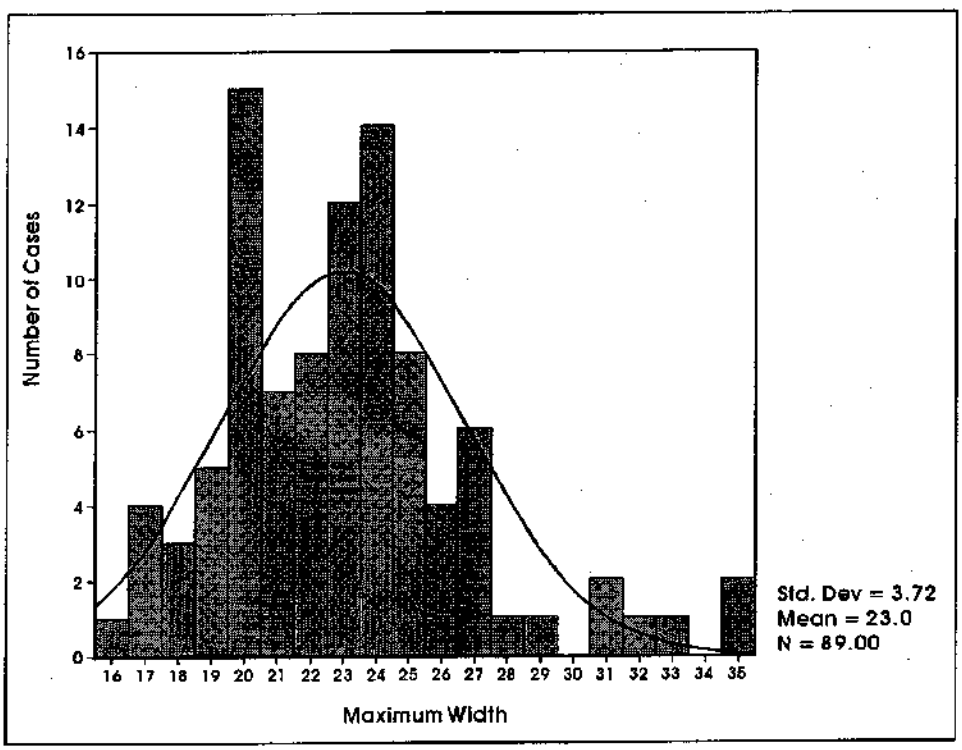


Figure 63. *Maximum widths of complete Matamoros points.*

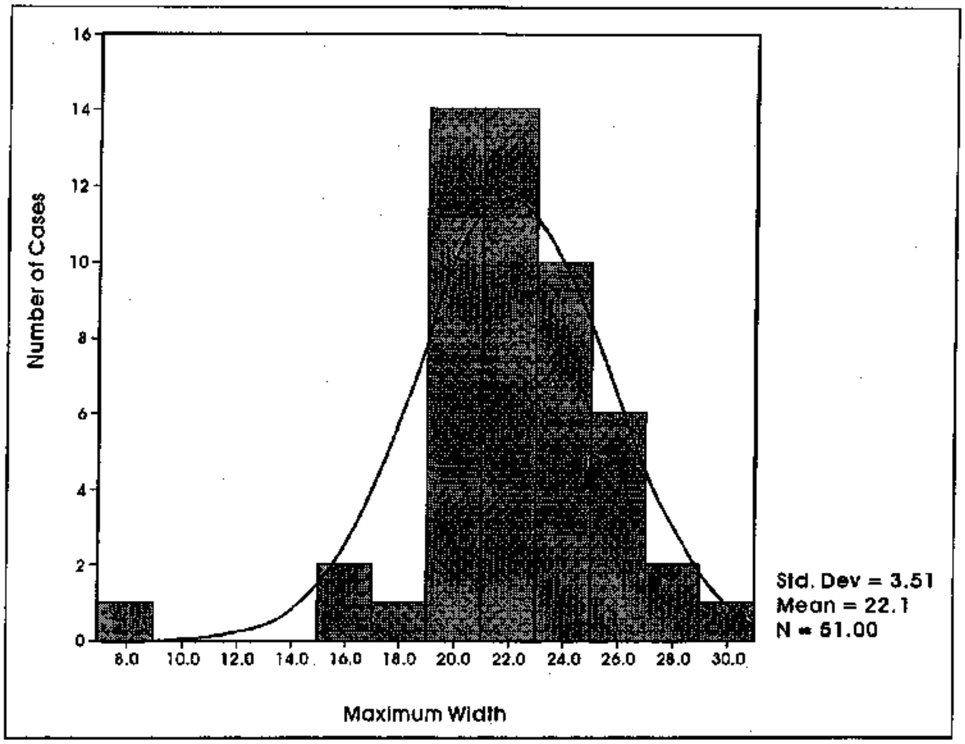


Figure 64. *Maximum widths of complete Refugio points.*

mentioned before, since resharpening affects the entire length of the point, it results in both a gradual narrowing as well as shortening of the projectile point with each resharpening episode. In addition, because some broken proximal fragments are rejuvenated into newly functional specimens through repointing, some relatively short but broad points are also introduced into the Tortugas-Matamoros and Abasolo-Catán groups. The combination of the two avenues of returning ineffective or failed points to a functional state appears to result in the normal distribution of maximum widths within both groups.

As described in the historical overview section, an additional aspect of the South Texas projectile point typology is the tendency on the part of some archeologists to define varieties within both the triangular and the round-base points. The next section considers the analytical utility of these projectile point varieties in light of the technological aspects and typological implications mentioned above. Although, for the sake of brevity, the discussion will focus only on varieties within the triangular types, the general trends and conclusion presented apply to both triangular and round-base point types.

To define variants within the Matamoros and Tortugas points recovered from Cueva de la Zona de Derrumbes, McClurkan (1966) used differences in width/length ratios within and between types and variants. The width/length ratio (referred to as length/width ratio in McClurkan 1966) employed by McClurkan was derived by dividing the mean maximum width by mean maximum length and presenting the product as a whole number. The resultant width/length ratios and their relationships to types and variants are described in the historical section discussing the origins of the common South Texas types and will be referred to in this section as appropriate.

The plot of the width/length ratios for all complete Tortugas points (Figure 67) indicates that the mean ratio is 56, that is, the maximum width of the specimen represents 56 percent of the maximum length of the point. Interestingly, only four specimens have ratios equal to or higher than 75, meaning that in the case of these specimens, the width represents at least 75 percent of the length. The four specimens (5%) have a mean length of 46.8 mm and a mean width of 36.3 mm. These specimens are relatively broad compared to their length

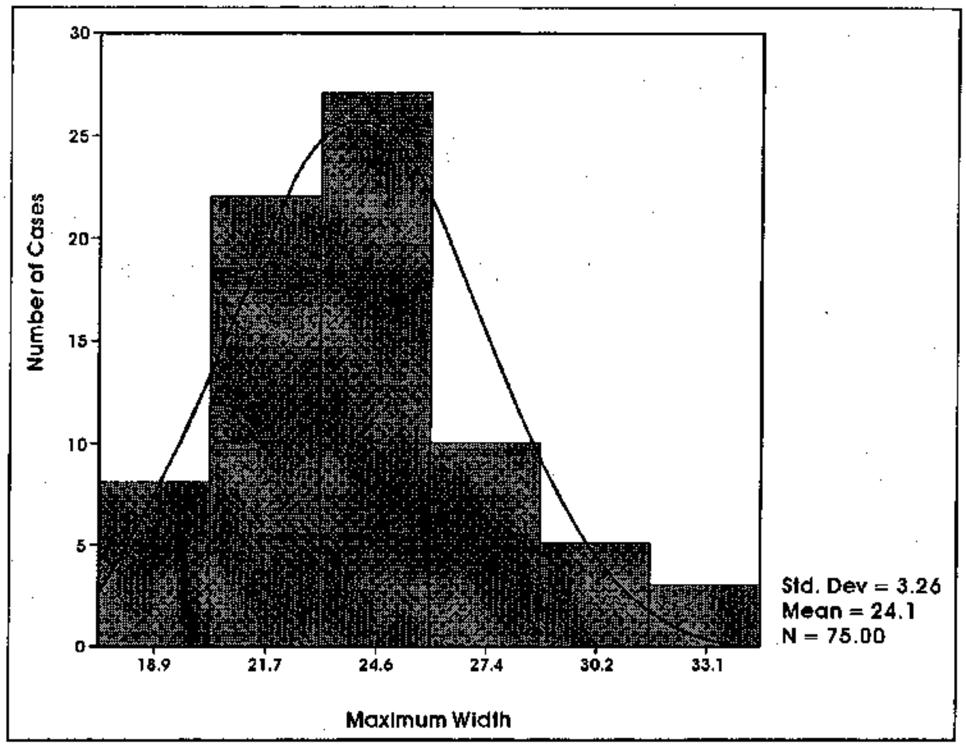


Figure 65. *Maximum widths of complete Abasolo points.*

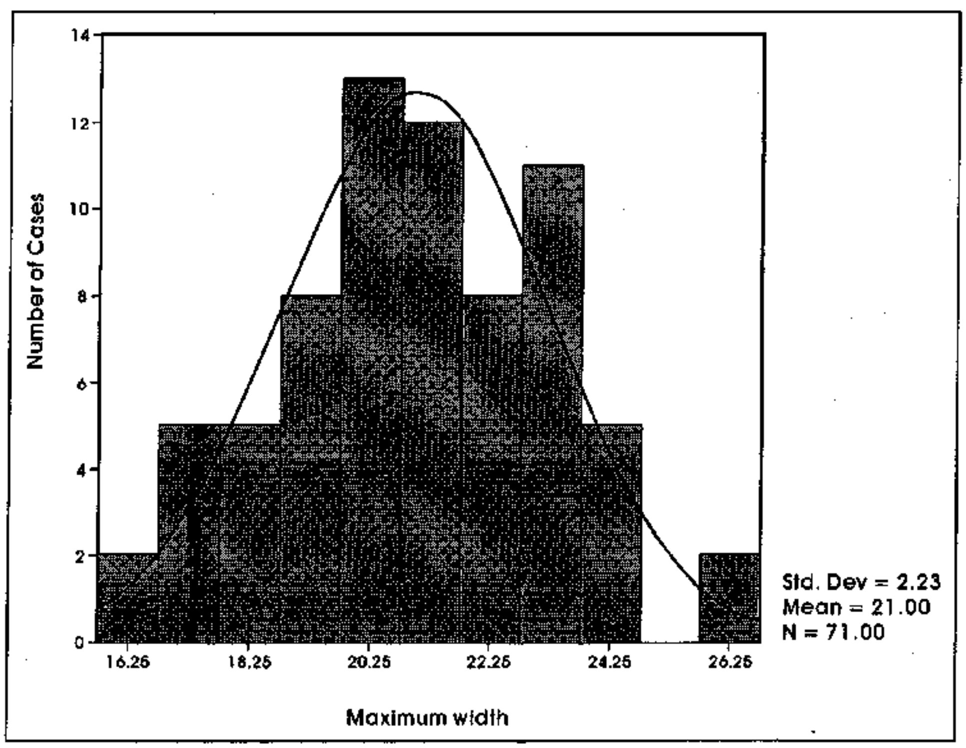


Figure 66. *Maximum widths of complete Catán points.*

and approximate the characteristics of the Tortugas Variety II specimens defined by McClurkan (1966). At the opposite end of the ratio distribution, there are 28 specimens (32%) that have ratios of 50 or less, indicating that the width of the points constitutes 50 percent or less of the length. These 28 specimens have a mean length of 53.8 mm and a mean width of 24.6 mm. These specimens are somewhat longer and more than 10 mm narrower than those in the earlier group. Sixty-eight percent (n=59) of all of the Tortugas points have maximum widths that are greater than 50 percent of their lengths. These 59 specimens have a mean length of 50.7 mm and a mean width of 30.7 mm.

To begin to understand how projectile point design may be related to tool use it would be ideal to know the dimensions and/or ratios of new points (those that have not been resharpened). There are three Tortugas points that do not exhibit resharpening scars in the sample. Their mean width/length ratio is 65.8, the mean length of the points is 54.7 while their mean width is 36. On the other hand, the mean width/length ratio of four preforms from 41WB314 (PTs 2, 5, 6, and 8 in Miller et al. 2000:Table 7.31) is 47.3, with the mean length being 71.4 mm and the mean width 33.8 mm. These figures are somewhat more similar to the width/length ratio of the 12 longest Tortugas specimens in this sample. Their mean ratio is 52.2, with the mean length of the specimens being 66.6 mm and their mean width being 34.8 mm. Although not clear-cut, perhaps these samples indicate that Tortugas points are made relatively long and broad. The length assures that the tool has an efficient cutting edge, and when the blade finally fails, it still leaves a relatively long portion of the point available for rejuvenation. A broad blade ensures relatively long use-life through repeated resharpenings. Although some newly made points may start out relatively long compared to their width (i.e., with low width/length ratios), once the tips break and the points are rejuvenated they may quickly be transformed into specimens with high width/length ratios, that is, into specimens with widths greatly exceeding their lengths.

The plot of the width/length ratios for all complete Matamoros points (Figure 68) indicates that the mean ratio is 67.4, that is, the maximum width of the specimen

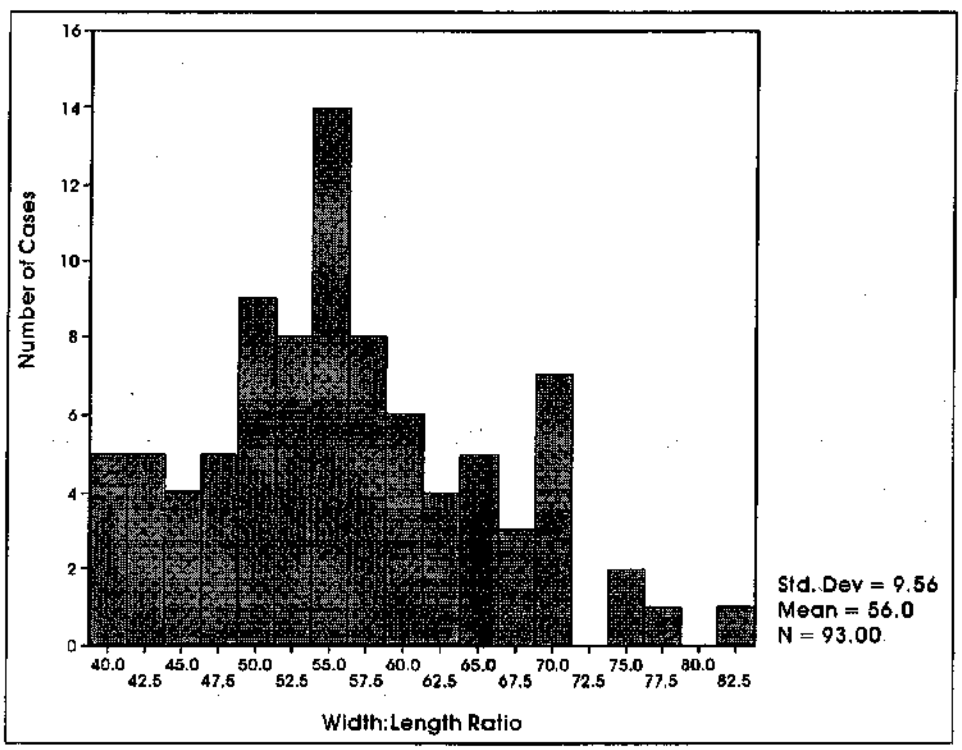


Figure 67. *Width/Length ratios for Tortugas points.*

represents 67 percent of the maximum length of the point. These points tend to be relatively broad compared to their length. Nineteen specimens (20%) have ratios equal to or higher than 75, meaning that their widths represent at least 75 percent of their lengths. The nineteen specimens have a mean length of 31.1 mm and a mean width of 26 mm. These points closely approximate the metric characteristics of Tortugas Variety II points defined by McClurkan (1966). At the opposite end of the ratio distribution, there are only two specimens that have ratios of 50 or less, indicating that the width of the points constitutes 50 percent or less of the length. The two specimens have a mean length of 36 mm and a mean width of 18.8 mm. These two specimens are somewhat longer and narrower than those in the earlier group. Overall, ninety-eight percent (n=93) of the Matamoros points have maximum widths that are greater than 50 percent of their lengths. These specimens have a mean length of 34.4 mm and a mean width of 23 mm. As a group, the Matamoros points are in general much broader with respect to their length than the Tortugas points.

Whether one views these smaller points as Matamoros or heavily resharpened Tortugas, it is more significant to note what aspects remain functional and what may have led to the discard of these specimens. As projectile points, although the thickness of the points may reduce blade failure rates, the thickness of the distal ends, particularly near the tip, also may reduce penetration. This reduction in penetration may be countermanded by the narrowness of the smaller forms versus the larger Tortugas type. The broad widths of the points, relative to their blade lengths, indicates that they may continue to have remnant use-life and may allow for further use. Nonetheless, the short length of the cutting edge may severely limit the effectiveness of the tool as a cutting instrument. Given that these smaller forms may have functioned as projectile points with reasonable effectiveness, and with reduced failure rates, it is likely that their high rate of discard may be due to their decreased effectiveness as elements of compound cutting instruments (i.e., short blade length).

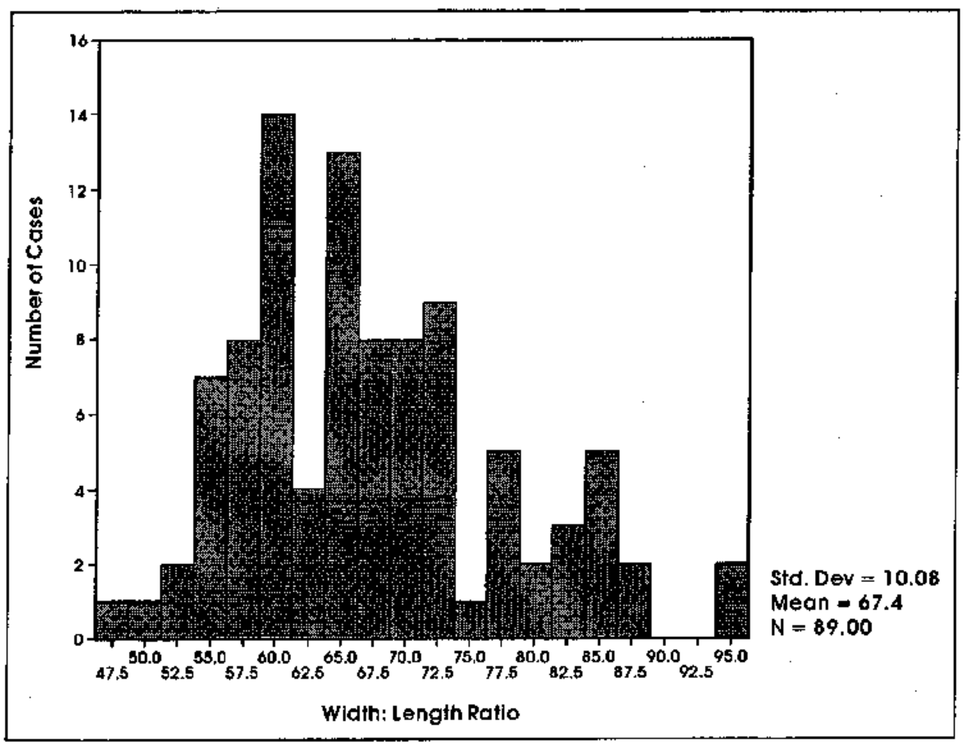


Figure 68. *Width/Length ratios for Matamoros points.*

Summary and Theoretical Considerations

Overall, the historical review of the round-based (Abasolo, Catán, and Refugio) and triangular (Tortugas and Matamoros) projectile points indicates that, for typological purposes, each form has been divided into larger and smaller types (i.e., Abasolo and Catán; Tortugas and Matamoros). Based on MacNeish's original work, it appeared that the larger types exceeded 40 mm in maximum length while the smaller types were less than 40 mm in maximum length. In addition, MacNeish's (1958) excavations have suggested that the larger of the forms preceded the smaller forms, at least in Tamaulipas. Based on a handful of sites where the four point types have been recovered *in situ* (i.e., Loma Sandia; 41LK31/32; 41ZP364; 41WB314), it has been assumed that the general temporal affiliation of the larger and smaller forms of these triangular and subtriangular forms also applies to South Texas.

Projectile point types are analytical constructs defined by archeologists. Therefore, there is nothing inherently wrong with arbitrarily defining types based on size. The difficulty arises when the larger and smaller forms are employed as index markers indicative of the chronological position of one or another archeological manifestations. The technological and simple statistical analyses conducted here indicate that, at least in technological terms, there is a strong connection between the larger and smaller forms of morphologically similar types. In fact, the connections seem to be so strong that they suggest that many of the smaller points that are consistently typed as Catán and Matamoros based on the size criteria are simply heavily resharpened and rejuvenated versions of the larger forms (i.e., Abasolo and Tortugas). The implications of this statement for the continued use of the two smaller types as chronological markers is that they can no longer be employed as Late Archaic index markers with any degree of confidence. That is, assuming that small projectile points named by archeologists as Catán and Matamoros were really made during the Late Archaic, the rejuvenation and resharpening of Abasolo and Tortugas points, that were presumably made much earlier in time, results in the manufacture of small forms that would be consistently assigned to the Late Archaic.

High rates of projectile point resharpening may be encouraged by high hunter-gatherer mobility within a context of low lithic raw material predictability (see Paleoindian lithic technology). The triangular and subtriangular morphology of these forms may also decrease projectile point failure rates and encourage high rates of projectile point rejuvenation. That is, as Tortugas points are resharpened and rejuvenated their maximum thickness tends to move closer to their tip therefore reducing blade failure rates as well as shortening the segment of the blade that may fail. These aspects of projectile point design result in increased use-life and shorter projectile points at the time they are finally discarded. This pattern of resharpening and rejuvenation would account for the high frequencies of small complete triangular and subtriangular projectile points encountered on South Texas sites.

The prehistoric recycling of artifacts could further complicate site formation processes and typological assignments. Depositional settings throughout large portions of South Texas are not amenable to the formation of deeply stratified sites due to the lack of major streams. Many archeological assemblages remain exposed on surface for extended periods on relatively stable land surfaces. The high mobility of hunter-gatherers combined with the potentially unpredictable distribution of lithic resources may encourage the recycling of projectile points from exposed living surfaces and their continued use and rejuvenation and eventual incorporation into Late Prehistoric components where they would appear to have served as arrow points.

Another interesting and important outcome of this study relates to the nature of the distally beveled tool forms (Nueces tools and Olmos bifaces) and their technological and likely temporal relationship to other tools. This study indicates that at least the bifacially flaked Nueces tools may be manufactured from recycled bifacial artifact failures. Some of these artifacts may be bifaces that failed during the early to middle stages of reduction or projectile points that failed during use. Olmos bifaces seem to represent the apex of this strategy to recycle failed tools. The fact that a large proportion of these tools are made on failed alternately beveled dart point fragments is interesting since it suggests that either aspects of prehistoric land use, resource structure, or technological organization, have favored high rates of recycling of failed tools. The recycling of manufacture-failed bifaces into bifacial Nueces tools represents the extension of this strategy. In addition, the use of heavily beveled Tortugas failures as blanks for the manufacture of Olmos bifaces also allows archeologists to link the two tools into a single broadly contemporaneous tool kit. This is not to say that wherever one finds a Tortugas point there should also be an Olmos biface. It simply suggests that the makers of Tortugas projectile points also made and utilized Olmos bifaces. The high rates of artifact recycling exemplified by the Nueces tools and Olmos bifaces have not been documented in other parts of the state. The fact that it occurs in South Texas (and probably also northern Tamaulipas) may be influenced by, and telling of, cultural and technological responses to low-density broadly distributed resources, the overall lack of year-round water sources, and high hunter-gatherer mobility. The high incidence of what appear to be multi-functional tool forms in the Middle and Late Archaic tool assemblages of South Texas and northern Tamaulipas also bespeaks of, and has broader relationships with, edible and lithic resource distributions and mobility patterns. It is likely that the same factors that led to high incidences of tool recycling may also favor the use of versatile multi-functional tools.

Finally, the fact that triangular and related subtriangular forms dominated the projectile point technology in South Texas and northern Tamaulipas throughout the Middle and Late Archaic is remarkable and does not occur in any other part of Texas. The fact that this pattern may extend as far back as the late Paleoindian period (i.e., Lerma points) is even more astounding. A traditional normative perspective on this lack of change in projectile point types would suggest that the region was inhabited by only a few major cultural groups possessing a very conservative, non-changing technological repertoire. The seeming marginality of the region south of the riverine portion of South Texas, in combination with possibly low population densities, may support such an interpretation. While such an explanation may or may not be accurate, from the perspective of cultural adaptation it begs the question of why did the material culture and specifically the projectile point forms change so little over such a long time span? If the technological sphere is one aspect of cultural adaptation to its natural environment, the lack of identifiable change in projectile forms seems to suggest that perhaps the resource base and the structure of the resources changed very little over time. Although little is available to reconstruct the paleoenvironmental conditions in South Texas and northern Mexico, what is available (i.e., Gustavson and Collins 1998, Nordt 1998; Quigg and Cordova 2000; Turpin et al. 1994) suggests that some changes in paleoenvironmental conditions did take place, even during the past 3,000 to 4,000 years. If this was the case, one would have to assume either that the magnitude and impact of the changes was not sufficient to alter the resource base and structure or that the technological responses to those changes did not involve changes in projectile point morphology but took place in other aspects of technological organization (i.e., changes in mobility and land use, richness and diversity of tool kits, etc.). Unfortunately, the investigation of this latter scenario can be pursued only in temporally anchored large assemblages where one can define overall behaviorally related tool kits and compare and contrast the composition of the tool kits, observe changes in raw material procurement strategies, and monitor aspects of tool reliability in response to different degrees of risk and costs of risk experienced by hunter-gatherers. This does not mean, however, that research in lithic technology should be limited to such assemblages. It has been shown here that a great deal can be learned even from individual artifact categories if sufficiently large collections are available for study and well-circumscribed research questions guide the analysis.