A STATISTICAL ANALYSIS OF GUNTHER SERIES PROJECTILE POINTS FROM TWO NORTHERN CALIFORNIA SITES

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ABSTRACT

This paper tests the validity of a subtype, called the Sutter Variant, of the Gunther Series projectile point type. To do so, it examines metric characters of Gunther Series points from two locations in northern California: the Miller Mound (COL-1) on the middle Sacramento River, and the Picnic Ground (ELD-728) and Arrowhead Campground (ELD-263) sites in the Sly Park locality of the central Sierras. The study first uses the t-test to compare the metrics of points intuitively typed as Gunther Contracting Stem at Miller Mound and Sly Park. The study next uses the t-test to compare the metrics of points typed intuitively as Sutter Variant from Sly Park with points typed as Gunther Contracting Stem from both sites combined. Finally, the study calculates the multivariate discriminant function, based on the metric characters, that best separates these two subtypes. The study shows that the Sutter Variant is a statistically significant subtype of the Gunther Series. It also concludes that the standard Thomas metrics for projectile points are sufficient for analyzing within-type variation in most cases and should be included as standard measures in site reports.

INTRODUCTION

Artifact typological studies have enormous potential for increasing our understanding of all dimensions of prehistoric lifeways and their changes. This is a somewhat surprising statement to be making in 1993. The fundamental artifact types have been worked out and codified and have changed little for 20 years. Interest has shifted to more direct dating methods and studies of subsistence economics. Nevertheless, with the availability of large artifact collections that are evenly distributed in their geographic origins due to public archaeology, and with an increased maturity in the understanding of mathematical classification techniques on the part of archaeologists, typology may be poised for some refinements and advances, if not for major breakthroughs. The advantages of typological refinement are obvious. The major classes of artifacts, such as projectile points, shell beads, and milling equipment, among others, are the most visible in any collection. The archaeologist's perception of their place in space and time is usually the most immediate touchstone

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available for inspiration in planning research strategies and forming interpretations.

Artifact typologies in the past have focused on the most practical strategies for discriminating among major artifact types, and follow-on studies continue to refine the chronological and spatial placement of these broad types. The next step in artifact typological studies is to examine spatial and temporal variation within broad artifact types and to determine whether further refinement is possible or useful. Doing so requires the application of mathematical methods to examine variability that lies beyond the grasp of intuition and to control for random and misleading variation.

Archaeologists in northern California have noted for decades that there is considerable typological variation within the class of projectile points that belong to the Gunther Series. Yet they are in general agreement about the temporal and spatial placement of these artifacts. The Gunther Series thus provides an excellent case study of variation within a generally recognized artifact type. Even within the subclass of Gunther Series that includes only contracting stem points, there is much variation in size and shape remarked upon and considered by archaeologists.

This study identifies a particular subclass of Gunther Series points and tests the hypothesis that they form an identifiable subtype, perhaps with spatial and temporal meaning. In doing so, it provides some insights as to the dimensions of projectile point variability, their measurement, and their uses in typology. This subtype is called the Sutter Variant.

The Sutter Variant of the Gunther Series is a small projectile point, generally made from a thin flake. In contrast to the classic Gunther Variant, which has straight edges, somewhat pronounced barbs, and a robust stem, the Sutter Variant has slightly concave edges, small barbs, and a small, sometimes tiny, stem. In general, the Sutter Variant has a gracile appearance, compared with the classic Gunther Contracting Stem point (Figure 1).

The Sutter Variant was first recognized as a potentially discrete subtype by Jerry Johnson and his students, working in the eastern Sacramento Valley and adjacent Sierran foothills. Several workers have noted the subtype in print. For example, Bethard (1988) separates small and large Gunther variants, without specifically naming them. Dougherty (1990) introduces the name Sutter Contracting Stem to designate points at SAC-29 that are smaller than classic Gunthers, and that have less pronounced barbs. Dougherty believes that the Sutter Variant is distributed mainly in the lower Sacramento Valley and adjacent foothills and that it remains the dominant form in this area through the protohistoric.

This study examines the differences between Gunther Contracting Stem and Sutter Variant at two closely related sites (ELD-263 and ELD-728) located at Sly Park in the Sierran mid-elevations. It compares these subtypes statistically to one another and to Gunther Contracting Stem points from the Miller Mound, COL-1, located in the middle Sacramento River Valley (Figure 2). The major steps in the analysis are as follows:

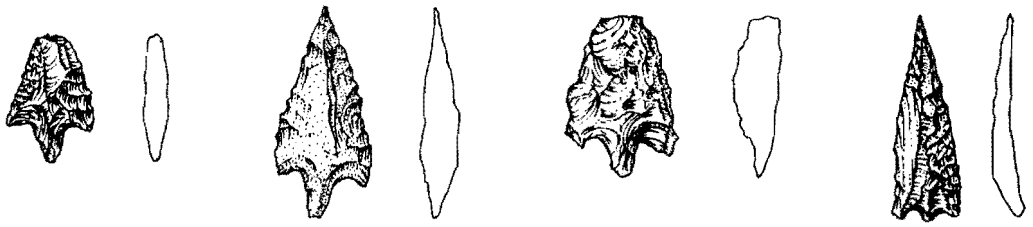
(1) Metrically compare points classed as Gunther Contracting Stem between sites to see whether there are significant differences.

(2) Metrically compare points classed as Sutter Variant from Sly Park with points classed as Gunther Contracting Stem from both sites to see whether Sutter differs significantly from classic Gunther.

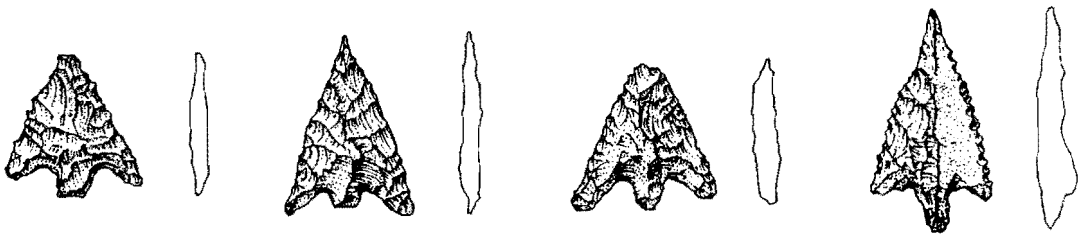
(3) Develop a discriminant function to mathematically define the difference between Sutter Variant and Gunther Contracting Stem.

The Gunther Series

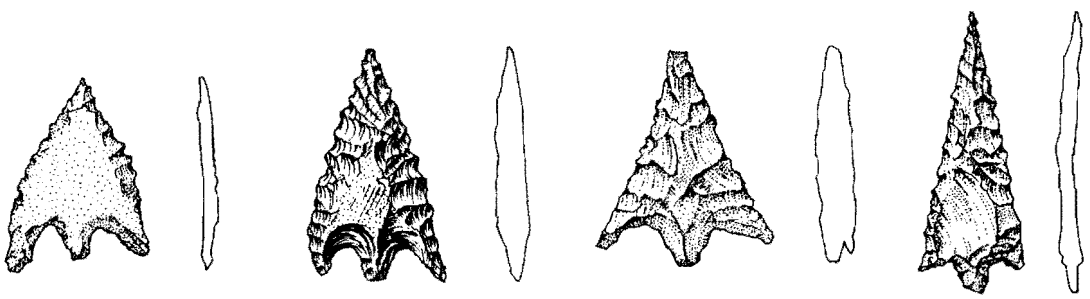
Treganza (1958) named and defined the Gunther Barbed projectile point type. The name Gunther comes from Gunther Island in Humboldt Bay. The term barbed refers to their distinctively long distal shoulders, sometimes extending below the stem resulting in a basal indention ratio (axial length divided by maximum length) of less than



SUTTER VARIANT



SLY PARK GUNTHER



COLUSA GUNTHER

FIGURE 1.

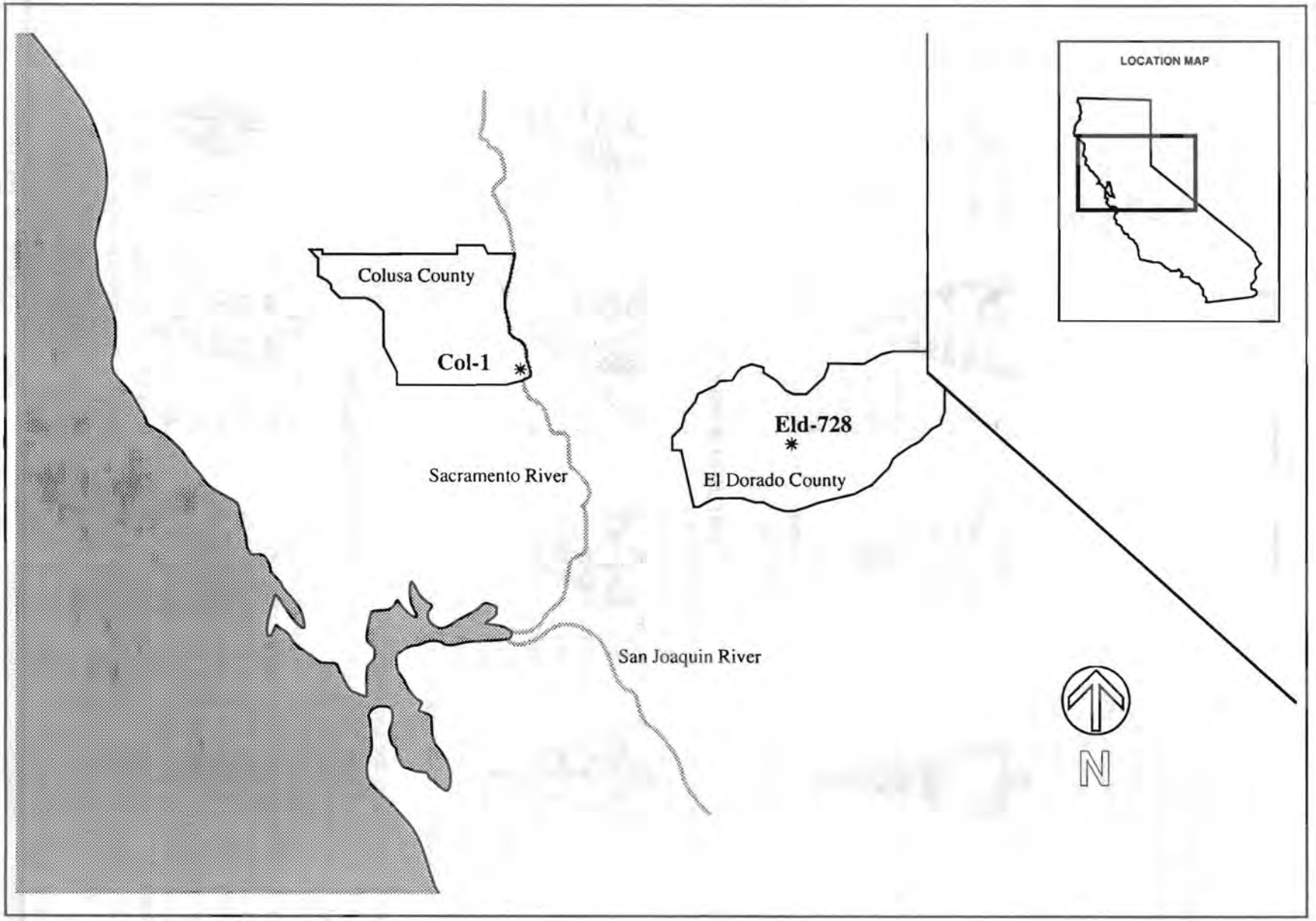


Figure 2. Locations of Col-1 and Eld-728.

one. Jackson and Schulz (1975) have described these in general terms as "medium to small stone projectile points characterized by trianguloid blades, contracting or parallel stems, pronounced shoulders with angle of less (usually considerably less) than 75 degrees, and with base profiles (the proximal border of the blade from shoulder to shoulder exclusive of the stem) concave or indented." Recently, however, the type Gunther has become a catch-all for small- to medium-sized triangular late period projectile points from northern California. It is not difficult to find in the literature points classified as Gunther which deviate substantially from the type originally described.

Gunther series projectile points range throughout the northern Central Valley from Sacramento and Calaveras Counties in the south to Modoc and Siskiyou Counties in the North. They are restricted in the west by the coastal ranges but have been found in Humboldt, Mendocino, and Sonoma counties. Jackson and Schulz (1975) published a distribution index of Gunther points.

It is widely accepted that the Gunther series projectile points belong to the Late period although the date of their first appearance remains uncertain. The Gunther points at the Miller Site were found in association with artifacts diagnostic of the post-A.D. 1300 period. Baumhoff (1985) has proposed a beginning date for the type at A.D. 600. Jobson (1991) is in agreement here, claiming the contracting stem variant dates to post A.D. 600, and after A.D. 1300 temporally overlaps with the expanding stem variant. In the Sacramento Canyon north of the valley, Basgall and Hildebrandt (1989) have radiocarbon and dendrochronological dates on material in association with Gunther Series points at A.D. 770, 1767, and 1665. This type is also seems to appear after A.D. 1100 at New Melones Reservoir, near the southern end of its range (Moratto 1984).

The Miller Mound

The Miller Site (COL-1) is located 17 miles north of Knights Landing on the west bank of the Sacramento River in southern Colusa County. Heizer (1936) excavated the site and described it as "one of the largest undisturbed mounds in the North Central Sacramento Valley." The site measures 350 feet from north to south, 300 feet from east to west and is elevated roughly nine feet above the surrounding valley terrain. With the deepest deposit approximately three feet lower than the valley floor, the total depth of the site is roughly 12 feet. The mound is circular in shape with steep sloping sides and a somewhat level top surface. Heizer concluded the mound to be a late River Patwin site with historic components.

The projectile points used in this analysis came from additional excavations conducted by the University of California at Davis in the summers of 1962-63. A complete analysis and report of the Miller Mound Site is currently being prepared by Henry Schulz at the University of California at Davis.

Sly Park Sites

Sly Park is a flat surface located on a tributary to the Cosumnes River at around 3,500 feet in elevation in the central Sierras (Figure 2). It was historically a wet meadow and is now covered by Jenkinson Lake, a facility of the Bureau of Reclamation's Central Valley Project, and a source of water supply for El Dorado County.

The shores of Jenkinson Lake are home to two large prehistoric sites, called the Picnic Ground Site and Arrowhead Campground Site. These sites are located less than one mile apart, and both are on well-drained flanks of the Sly Park meadow with a southern aspect (Figure 3). Arrowhead Campground Site (ELD-263) covers approximately 34,000 square meters and may contain 300 or more bedrock mortar cups. The Picnic Ground Site (ELD-728) contains more than 100 bedrock mortars and is approximately 31,000 square meters in size. Both sites have produced temporal artifacts clearly indicating occupation over a span of at least 4,000 years. A wide-stemmed point recovered at the Picnic Ground site probably indicates an earlier occupation.

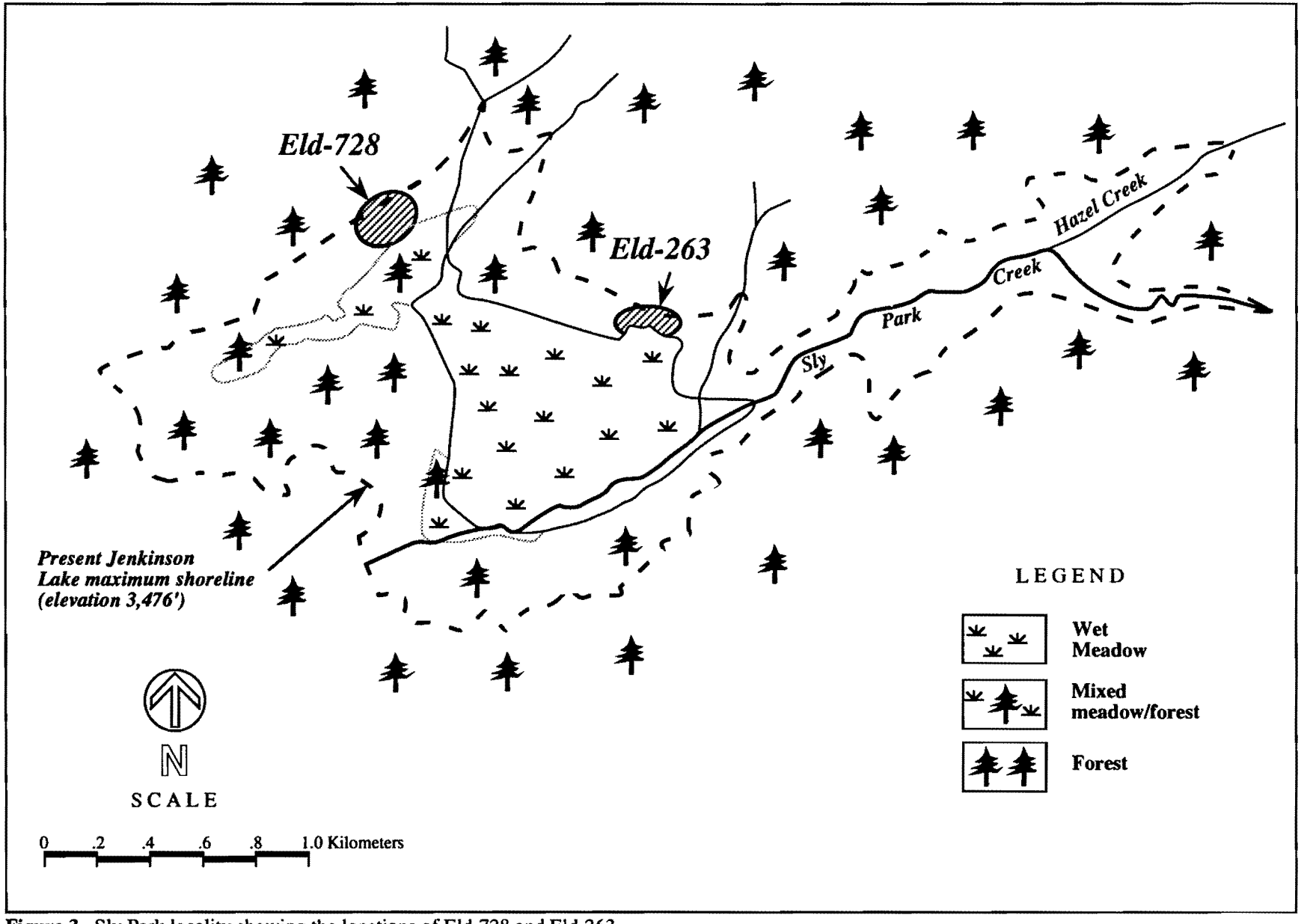


Figure 3. Sly Park locality showing the locations of Eld-728 and Eld-263.

In 1991, Ebasco Environmental conducted National Register site evaluations for these two sites (Ebasco Environmental 1989). The purpose of the project was to assess the effects on these sites of raising the level of Jenkinson Lake. E-basco's site evaluation techniques included controlled surface collection of beach deposits, augering with soil phosphate analysis of soil samples, bank profile excavation, and analysis of a private collection that was donated to the El Dorado Irrigation District. The collection was made by the wife of the park caretaker, who frequently walked the beach, and collected only from the two sites under evaluation. She stated that nearly all of her finds came from the Picnic Ground Site. Artifact collections from all sources yielded 58 Gunther Series points, including 35 classic Gunther Contracting Stem points and 23 contracting stem points classed as Sutter Variant. All but two of these points are from ELD-728.

METHODS

This study involves comparing individual measures, and linear combinations of individual measures, of projectile points. These methods are deployed in relation to a three-step research design. The methods included methods of measurement, statistical methods of comparison, and statistical methods of discrimination.

Research Design

The research design involves testing a series of linked hypotheses by stages. The first task is to determine whether samples of Gunther Contracting Stem projectile points from the two locations (Miller Mound and Sly Park) are from the same statistical population. The purpose of this test is to validate the classification of Gunther Contracting Stem points at Sly Park by comparison with those at Miller Mound.

The second task is to determine whether points classed as Sutter Variant (which are all from Sly Park), are from the same statistical population as those classed as Gunther Contracting Stem from the two locations combined.

The final step is to calculate the discrimin-ant function for distinguishing Sutter Variant from Gunther Contracting stem, to determine the degree of incorrect classification, and to calculate the formula for weighting measures and a discriminant criterion for distinguishing between Sutter Variant and Gunther Contracting Stem.

Measurement Methods

Metrics -- Metric measurements of the projectile points were obtained following the procedures put forth by Thomas (1981). The measurements include maximum length, maximum width, maximum thickness, weight, notch width, neck width, proximal shoulder angle, distal shoulder angle, and notch opening angle.

In an effort to find additional distinguishing variables, a series of supplementary measurements which differ from Thomas's were taken. These include stem length, distal stem width, distal stem width-to-neck width ratio, neck width-to-stem length ratio. All linear measurements were taken to the nearest tenth of a millimeter, all weights to the nearest 1/100 of a gram, and all angular measurements to the nearest 5 degrees. When an angular measurement was taken on an asymmetrical point the larger of the two angles was recorded. Distal shoulder angle and proximal shoulder angle when possible were measured on the same side.

Missing Values -- If a measurement could not be taken on a specimen due to breakage, the missing value was estimated through reconstruction of the point. For example, in a case where a barb was missing due to breakage, the projectile point was assumed to be symmetrical with the complete barb being representative of the missing one, and the analyst took appropriate measurements on the reconstructed form. In such a case, the proximal and distal shoulder angles as well as the notch opening angle were taken on the unbroken side. This method was limited to the linear and angular measurements.

Missing values were determined by substituting the variable's mean value. Though the use

of a mean to represent a missing value does not provide the resolution of a regression analysis, particularly in cases where the variables are highly correlated, substituting the mean has proven a simple and effective measure. In a similar treatment of Gunther projectile points, Jobson (1991) examined the practicality of regression analysis to derive variables and concluded that unless the variables are highly correlated, replacing missing values with means is sufficient and more practical than regression analysis.

Classification Methods

Prior to the statistical analysis, the two point types were segregated intuitively based on several general morphological characteristics. In contrast to the Gunther Series, the Sutter sub-type is a smaller point with less pronounced barbs. When barbs are present on the Sutter Variant they are reduced and unlike the classic drooping barbs of the Gunther Series. Many of the Sutter points were made on thin flakes and are more gracile, in particular the elements comprising the base and stem.

Comparison Methods

The method chosen for testing the significance of differences between the projectile point groups in terms of individual characters was the t-test for independent samples. This test determines the estimated probability that the means of two independent samples are the same and are, therefore, drawn from the same underlying population. The result of the analysis is a number representing the probability that the two sample populations are from the same sampling universe. The study assumes that a probability of 0.05 indicates that a significant difference between sample means is likely and that the two sample populations are from different sampling universes.

The test assumes that the distribution of the measures in both samples is normal, and that the variances of the two sample populations are equal, though it is relatively insensitive to violations of these assumptions. Visual analysis of histograms determined that the frequency distribution of the projectile point measures is normal for each of the measures.

Discrimination Methods

The method chosen for discriminating between Gunther Series subtypes is discriminant analysis. Discriminant analysis is a multivariate taxonomic method by which individual measures are weighted to maximize the probability of correctly identifying unknown specimens from overlapping or closely related taxa. It creates the linear combination of correlated variables that best discriminates between types that the analyst has classified prior to the discriminant analysis. It can be used to create variable weightings and decision criteria by which an analyst can classify new cases (Sneath and Sokal 1973).

Discriminant analysis is an appropriate method for testing the statistical reality of intuitive classifications because it depends on the analyst designating the taxonomic units prior to statistical analysis and because it can produce a table showing the percentage of correct and incorrect classifications for a given data set. Since it is designed specifically to resolve borderline cases where taxa overlap, it is an appropriate method for examining archaeological taxonomic problems that involve variation within established types.

RESULTS

The research design called for a series of linked hypothesis tests designed to: (1) validate the classification of Gunther Contracting Stem points at Sly Park by comparison with Miller Mound, (2) determine the statistical validity of the intuitive Sutter Variant classification, and (3) calculate the discriminant function and a discriminating criterion.

Classification of Gunther Contracting Stem

The first step in the research design involved testing the hypothesis that points classed as Gunther Contracting Stem (not Sutter Variant) at Sly Park are part of the same statistical population as those classed as Gunther Contracting Stem at Miller Mound. This test was designed to validate

the classification of Gunther Contracting Stems at Sly Park. The test was implemented by running t-tests for significant differences between the within-site means on individual metric characters. Sample size varied by measure because of missing values resulting from broken pieces. The analysis included 34 points from Miller Mound and 35 points from Sly Park.

The results of the tests show that, for 12 out of 18 characters, there is no significant difference between the mean values of point measures from the two sites (Table 1). The mean values for most of these characters are very similar, and the probabilities of no significant difference are very high. Characters showing significant differences between the sites include thickness, and the related measures of neck width, notch width, distal stem width-to-neck width ratio, neck width-to-stem length ratio, and neck width-to-total width ratio.

Sly Park points are significantly thicker. This is probably a result, however, of the fact that many of these points are made of chert and quartz, which frequently contains inclusions that force a thicker point. The Miller Mound points, by contrast, are mostly made of obsidian and a fine-grained basalt. This is not a character, in other words, which has to do with aspects of intentional point shaping.

The Sly Park points have significantly wider notches and necks than Miller Mound, and this is reflected in ratios including these measures. This means that, though the points are the same in terms of all other shape and size characters, Miller Mound Gunther Contracting Stem points tend to have straighter, or less v-shaped stems than those from Sly Park.

Though there is significant variation between the two sites in terms of stem shape, in general, it is reasonable to conclude Gunther Contacting Stem points from the two locations belong to the same population in terms of all other size and shape characters.

Validity of the Sutter Variant

The second step in the research design is the test to determine whether the points intuitively classified as Sutter Variant at Sly Park are significantly different from Gunther Contracting Stem points at Miller Mound and Sly Park combined. The test was implemented by running t-tests for significant differences between the within-type means on individual metric characters. Sample size varied by measure because of missing values resulting from broken pieces. The analysis included 69 Gunther Contracting Stem points and 23 Sutter Variant points.

The results of the tests show that, for 11 out of 18 the characters measured, there is a significant difference between the Sutter Variant and Gunther Contracting Stem (Table 2). The Gunther points are significantly longer, wider, and heavier, than Sutter Variants. The Gunther stems and notches are wider and longer. The Sutter points, on the other hand, have a significantly larger length-to-width ratio. They are somewhat longer/narrower in shape. Sutter points also have a significantly shorter stem in relation to length and a larger ratio of neck to maximum width. The stem is also narrower at its end, in relation both to maximum length and to neck width, than the Gunther point stem.

In general, the intuitive impression of the Sutter Variant as a gracile Gunther Contracting stem, slightly narrower, and with a smaller, more tapering stem, is confirmed by these results. The most obvious difference, however, is one of scale. Most of the scale measurements (weight, length, width) show a significant difference, and some shape measurements do not (such as proximal shoulder angle, distal shoulder angle, and notch angle). In sum, the Sutters are smaller than Gunthers, and have clear, but subtle shape differences involving the shape of the stem and the overall length-width proportions.

Discriminant Analysis

The purpose of the discriminant analysis is to calculate a discriminant function that is a linear combination of individual measures and which provides the maximum possible separation be-

Table 1. T-Test results, comparing Gunther Contracting Stem points from Miller Mound and Sly Park.

Measure	Miller Mean	Sly Park Mean	prob.	Significant diff.	Remarks
Maximum length	26.83	26.97	0.91		
Maximum width	17.08	17.31	0.73		
Thickness	**3.92**	**4.37**	**0.02**	•	**Sly Park thicker**
Weight	1.09	1.16	0.52		
Notch width	**5.59**	**6.98**	**0.00**	•	**Sly Park notch wider**
Neck width	**4.67**	**6.03**	**0.00**	•	**Sly Park neck wider**
Base width	3.81	3.63	0.47		
Stem length	4.93	4.70	0.35		
Distal shoulder	5.76	5.40	0.28		
Base width/neck width	**0.82**	**0.59**	**0.00**	•	**Miller stem less tapering**
Neck width/stem length	**1.85**	**1.37**	**0.02**	•	**Miller stem squatter**
Base width/max. width	0.22	0.22	0.74		
Length/width	1.63	1.58	0.61		
Neck width/max width	**0.27**	**0.36**	**0.00**	•	**Sly Park neck wider**
Stem length/max length	0.19	0.19	0.80		
Proximal shoulder angle	72.17	73.57	0.55		
Distal shoulder angle	144.56	144.77	0.96		
Notch opening angle	74.24	71.20	0.50		

Table 2. T-test results, comparing Gunther Contracting Stem and Sutter Variant projectile points.

Measure	Gunther Mean	Sutter Mean	prob.	Significant diff.	Remarks
Maximum length	**26.90**	**22.84**	**0.00**	•	**Gunther bigger**
Maximum width	**17.20**	**12.81**	**0.00**	•	**Gunther bigger**
Thickness	4.15	3.76	0.11		
Weight	**1.13**	**0.79**	**0.00**	•	**Gunther heavier**
Notch width	**6.30**	**5.43**	**0.00**	•	**Gunther notch wider**
Neck width	5.36	4.93	0.07		
Base width	**3.72**	**2.57**	**0.00**	•	**Gunther stem wider**
Stem length	**4.81**	**3.42**	**0.00**	•	**Gunther stem longer**
Distal shoulder	**5.58**	**3.51**	**0.00**	•	**Gunther barb longer**
Base width/neck width	**0.71**	**0.51**	**0.00**	•	**Gunther stem straighter**
Neck width/stem length	1.60	1.64	0.87		
Base width/max. width	0.22	0.20	0.11		
Length/width	**1.61**	**1.82**	**0.04**	•	**Sutter longer/narrower**
Neck width/max width	**0.32**	**0.38**	**0.00**	•	**Sutter neck wider**
Stem length/max length	**0.19**	**0.16**	**0.02**	•	**Gunther longer stem**
Proximal shoulder angle	72.17	72.09	0.97		
Distal shoulder angle	144.67	142.35	0.42		
Notch opening angle	72.70	72.52	0.96		

tween the groups of cases labelled Gunther Contracting Stem and Sutter Variant. This is a more complicated, and more powerful, method of testing the significance and the degree of separation between these subtypes. It also provides an indication of which measures contribute significantly to discriminating the groups. The technique is appropriate for examining the taxonomic closeness of known distinct groups whose characteristics are overlapping.

Of the 18 measures entered into the discriminant analysis, seven failed the univariate F-test of significance. These are thickness, neck width, neck width-to-stem length ratio, base width-to-maximum width ratio, proximal shoulder angle, distal shoulder angle, and notch angle. These are not significant measures for discriminating Gunther Contracting Stem and Sutter Variant.

The multivariate test statistics calculated included Wilks' lambda, Pillai trace, and Hotelling-Lawley trace. These were all highly significant, indicating a valid separation of the two classes by the discriminant function. The canonical correlation of subtype membership and the measures is 0.756. The canonical loadings, or the correlation between the individual measures and the discriminant function, indicate the relative contribution of each measure to the discriminant function. Table 3 shows these, in rank order.

Table 3

Correlations Between the Individual Measures and the Discriminant Function

Measure	Correlation (canonical coefficient)
Maximum width	0.648
Distal shoulder length	0.642
Stem length	0.517
Base width	0.447
Base width-to-neck width ratio	0.437
Weight	0.352
Neck width-to-maximum width ratio	- 0.319
Maximum length	0.314
Notch width	0.247
Stem length-to-maximum length ratio	0.235
Length-to-width ratio	- 0.208

It is interesting to note that measures of scale, such as maximum width, weight, and maximum length, figure prominently in the discriminant function. After width, however, the next four strongest discriminators involve shoulder and base (stem) width characters. This bears out the intuitive discrimination of Sutter Variant from Gunther Contracting Stem based partly on size, and partly on gracile stem and shoulder characteristics. It also appears contrary to the t-test results, which seemed to emphasize the importance of the major scale characters.

The discriminant function classified 92% of the cases from Miller Mound and Sly Park correctly. The Gunthers are correctly classified 94% of the time. The Sutter are correctly classified 87% of the time. This is an very good classification success rate for overlapping types. Table 4 correlates the intuitive and the automated classifications.

Figure 4 is a histogram showing Sutter Variant and Gunther Contracting Stem scores on the discriminant function.

The discriminant weights can be used to classify new cases known to be either Sutter Variant or Gunther Contracting Stem. This can be done by multiplying the discriminant character weights by the values of the corresponding measures on the new case to be classified. The discriminant weights for the five best discriminating measures are listed in Table 5 for that purpose.

Table 4

Discriminant Function Classification of Points Typed as Gunther Barbed or Sutter Variant

	Gunther	Sutter	Total	Pct. correct
Gunther	65	4	69	94.2%
Sutter	3	20	23	87.0%
Total	68	24		92.0%

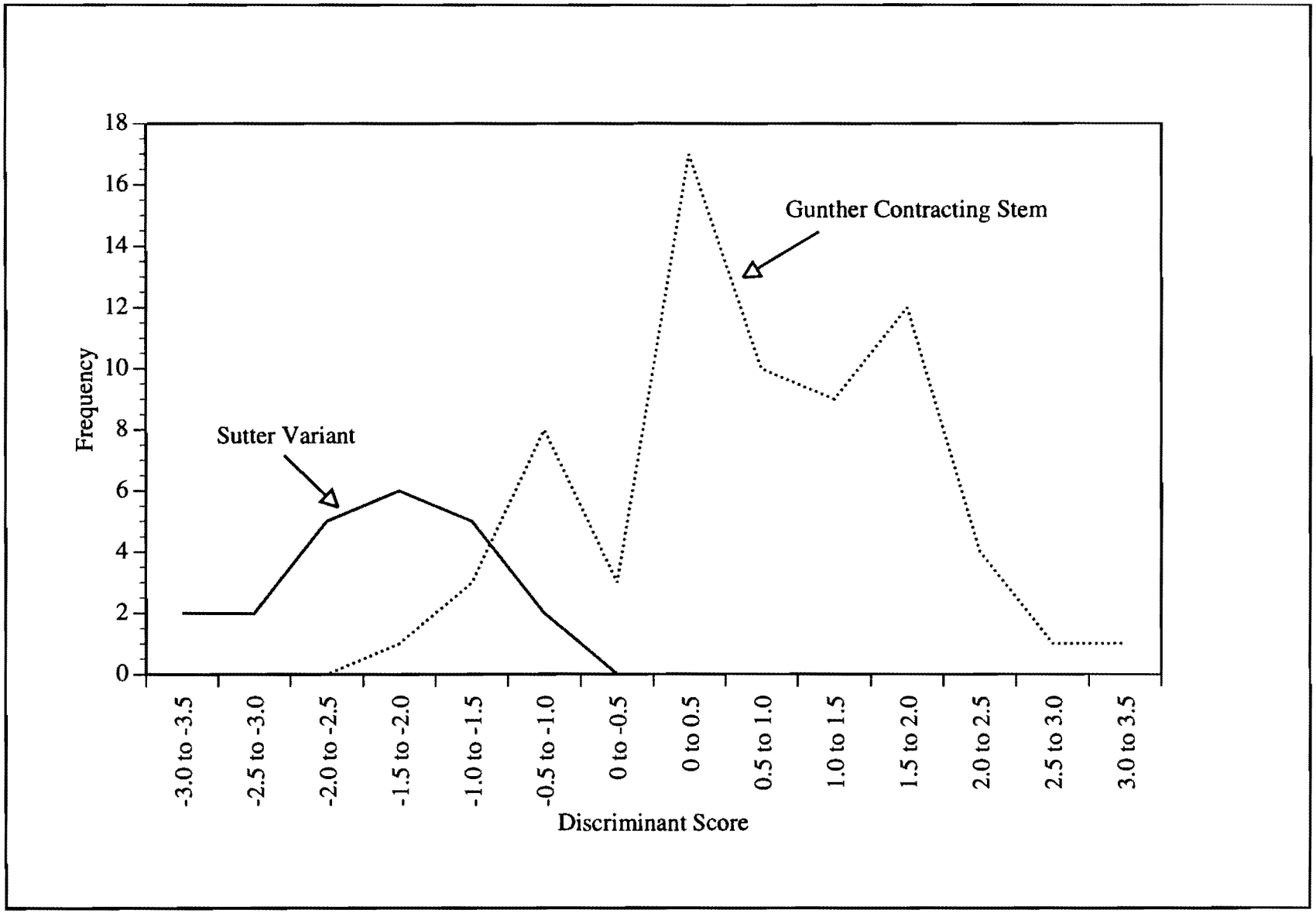


Figure 4. Discriminant score frequency distribution.

Table 5

Weights for the Five Best Measures for Discriminating Sutter Variant and Gunther Contracting Stem Projectile Points

Variable	Gunther wt.	Sutter wt.
Maximum width	18.687	18.461
Distal shoulder length	6.272	5.277
Stem length	-12.882	-14.452
Base width	-24.564	-24.465
Base width-to-neck width ratio	174.498	169.544
Constant	-409.921	-388.223

To classify a particular point, calculate two discriminant scores, one assuming each of the two potential classifications. Calculate the discriminant scores by multiplying the individual measures by the discriminant weights, sum these products, and add the constant. Classify the point as Gunther Contracting Stem if the discriminant score for Gunther Contracting Stem is larger, and Sutter Variant if the score for Sutter Variant is larger.

Classifying individual projectile points by calculating the discriminant scores, however, is a cumbersome method, and raises the need for a simple set of discriminating break points based on individual metric characters. Two of the characters in this study provide unambiguous break points that an archaeologist can use as a general guide in classifying new points using simple measures (Table 6). The break point for these measures was calculated by splitting the metrical difference between the values located one standard deviation from each mean.

Table 6

Classification Break-points for Distinguishing Sutter Variant from Gunther Contracting Stem Based on Visual Observation

Character	Break Point	Remarks
Maximum width	14.49 mm	Sutter narrower
Distal shoulder length	4.21 mm	Sutter shoulder smaller

CONCLUSIONS

This study shows that the Sutter Variant of the Gunther Series of projectile points is a distinct entity, not a figment of typological imagination. This immediately begs the question of its temporal and spatial placement. While the Miller Mound and Sly Park data have served admirably to examine the dimensions of formal variability of these two subtypes, they are silent regarding the temporal placement of these two subtypes. The Sly Park data is mostly from surface context, and many of the early excavation records from Miller Mound are lost. It seems likely, however, that there are distinct temporal and spatial implications of these types. While the authors have not completed an exhaustive study of the matter, it is apparent from perusal of reports and discussions with Jerry Johnson and John Dougherty that the Sutter Variant may be most common on the east side of the lower Sacramento Valley and adjacent Sierran foothills, generally north of the Mokelumne River.

This study shows that the variation within Gunther Contracting Stem that archaeologists have noted for many years is patterned, and not random variation. Additional studies should attempt to understand the dimensions of variation within the type, both spatially and temporally. A brief examination of one large published collection of Gunther Contracting Stem points illustrates this fact well. The collection from SHA-1176, -1175, -1169, and -476, sites in Sacramento Canyon (Basgall and Hildebrandt 1989) includes 191 points. A superficial examination of metric data for these points shows some striking differences as compared with the Gunther Series points from Miller Mound and Sly Park. For example, the Sacramento Canyon points are shorter, thinner, and lighter, are intermediate in width and base width, and have wider stems, on average, as compared with the points from Miller Mound and Sly Park. Proximal shoulder angle is smaller, while distal shoulder angle and notch angle are much larger. In other words, the Sacramento Canyon points tend to be small in size, even smaller than Sutter Variant, but unlike the Sutter

Variant points, are of moderate width, and have tapering stems with broad necks and v-shaped notches.

Do the results of this study warrant the definition of an entirely new type called Sutter Contracting Stem? Because of the difficulty of keying out the Sutter Variant and the fact that it overlaps with the classic Gunther subtype, it is preferable to call this a variant in the Gunther Series, of Gunther Contracting Stem.

The study also shows that the classic Thomas point metrics have considerable value as a standard set of measures, in accounting even for variations at the subtype level. While the authors added additional measures in order to include as many as possible of the dimensions of subtype variability with the Gunther Series, parallel tests showed that little was lost in the discriminant analysis by using only the Thomas metrics. On the other hand, a non-Thomas metric, distal shoulder length, turned out to be the second best discriminator in the tests including all the metrics. In general, additional measures will be useful for specialized studies such as this one, but the Thomas metrics should be standard in excavation reports.

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