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Testing a Simple Hypothesis Concerning the Resilience of Dart Point Styles to Hafting Element Repair

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Experimental flintknappers have shown that it was possible for prehistoric hunters to repair basally damaged dart points by retouching the base to a different shape. Because dart points were highly curated tools and often manufactured of non-local, high utility toolstones, the lack of evidence in the archaeological record for basal retouch of one type into another is perplexing. We develop and test a hypothesis for the resistance of retouched bases to typological change, using a set of projectile point assemblages from northeastern Nevada. It is possible that the necessity of refitting repaired points to a limited supply of pre-prepared dart foreshafts constrained the retouch of broken points. If repair of a broken point required a hunter to modify its hafting element beyond limits feasible for reattaching it onto the foreshafts in hand, it was more economical for the hunter to simply replace the broken point. If so, such constraints to haft repair have implications for understanding why dart point base styles are spatially and temporally patterned.

Advocates of the "rejuvenation model" (Flenniken and Raymond 1986; Flenniken and Wilke 1989) challenge Great Basin dart point chronologies that track stylistic variability in haft element shape over time. They assume that the labor necessary to manufacture chipped stone projectile points made repair of broken points worthwhile. Replicative manufacture, damage, and repair of experimental dart points demonstrate that impact frequently shatters the bases of stone points, but damaged bases can occasionally be repaired by modifying the haft to a different form (Flenniken 1986; Flenniken and Raymond 1986; Titmus and Woods; Towner and Warburton 1990). Based on this observation, they propose a model of projectile point rejuvenation in which all Middle and Late Holocene dart point types in the Great Basin represent various stages in the use-life of any particular point. According to the model, each point began its career as either a Northern Side-notched or Elko Corner-notched prototype. Upon breakage, rejuvenation caused it to assume formal characteristics of Rosegate, Gypsum, Pinto, Gatecliff, and/or Humboldt types.

The implications of the rejuvenation model for Great Basin prehistory are profound. Great Basin archaeologists define point types based on "stylistic" variability among hafting elements, and use types to assess the relative age of archaeological assemblages (Heizer and Hester 1978; Thomas 1981; Holmer 1986). If the rejuvenation model is correct, repairing a broken base can change the point from one supposed temporal type to another. It follows, then, that all Middle and Late Holocene

Great Basin dart point types must be contemporary, and all dart point chronologies based on basal shape must be incorrect. Such a finding would call into question most models of Great Basin culture history and subsistence-settlement variability.

Yet the rejuvenation model claims little supporting evidence in the archaeological record. Although advocates point out that overlapping distributions of point types in stratified caves of the eastern and northern Great Basin are consistent with the rejuvenation model (Flenniken and Wilke 1989), their analyses of archaeological point repair assemblages have yet to demonstrate convincing evidence that points changed type because of repair (Flenniken 1991; Rondeau 1996). The strong stratigraphic patterning of point types at Gatecliff Shelter (26Ny301- Thomas 1983), James Creek Shelter (26Eu843 - Drews 1990), and Surprise Valley (O'Connell and Inoway 1994) directly contradicts the hypothesis. Analyses of the distribution of dart points by depositional context (O'Connell and Inoway 1994), dart point size (Bettinger et al. 1991), and obsidian hydration readings (Hockett 1995) also fail to support logical implications of the rejuvenation model.

IMPLICATIONS OF PROJECTILE-POINT DOMINATED ASSEMBLAGES

Projectile point assemblages from several recently investigated lithic scatters (Figure 1) lend further evidence contradicting the rejuvenation model. These assemblages originate from the Clover Valley (26Ek2789) and Town Creek (26Ek3783) sites (Petersen and Stearns 1992), the Santa Fe site (26Eu1595 - Zeanah 1993) and the Ander Wright site (26Ek6439 - Zeanah and Elston 1997). All are alike in that they contain notably large numbers of projectile points, accompanied by relatively few additional tools or debitage. Only a single point type dominates each assemblage, but a variety of other types may also occur in minor quantities (Table 1). Humboldt points dominate 26Ek2789, Elko Corner-notched points overwhelm the assemblage of 26Eu1595, and Gatecliff Split Stem points predominate in the assemblages of 26Ek3783 and 26Ek6439 (Figures 2 and 3). The preponderance of particular point types suggests that a single component, possibly a single occupation, produced the bulk of each assemblage.

There are functional differences among the four sites. Petersen and Stearns (1992) inferred that 26Ek2789 was a palimpsest of several prehistoric antelope drives, based on the ubiquity of impact fractures, the dominance of distal point fragments, and the topographic position of the site within antelope habitat. However, they found 26Ek3783 to be a specialized locus for the repair of broken projectile points, possibly associated with a particular communal hunting event, based on the preponderance of basal fragments, the frequency of reworking along blade edges, and spatial clustering of points.

Similarly, the frequency of impact snaps and fractures, basal hafting elements, and small retouch, notching, and alternate flakes in the 26Eu1595 assemblage, suggested that the site served for repair of broken points, probably after a single hunting event (Zeanah 1993). Evidence of both manufacture and repair of split-stem projectile points overwhelm the 26Ek6439 assemblage (Zeanah and Elston 1997). Step, burination, and fluting fractures of point fragments are evidence that points were used and broken nearby, and returned to 26Ek6439 for repair or discard. The margins of many points are retouched (Figure 2 f-g, Figure 3i) providing evidence for point repair. Numerous detached point barbs, ears and haft elements; as well as pressure, notching, and alternate flakes in the debitage assemblage are evidence of both point manufacture and repair. Late stage bifaces and point preforms (Figure 3a) of local material types are also evidence that new points were manufactured to replace irreparably damaged points.

Therefore, all four of the projectile point-dominated assemblages pertain to dart point manufacture, use, discard, or repair. At first glance, these sites appear to lend some support

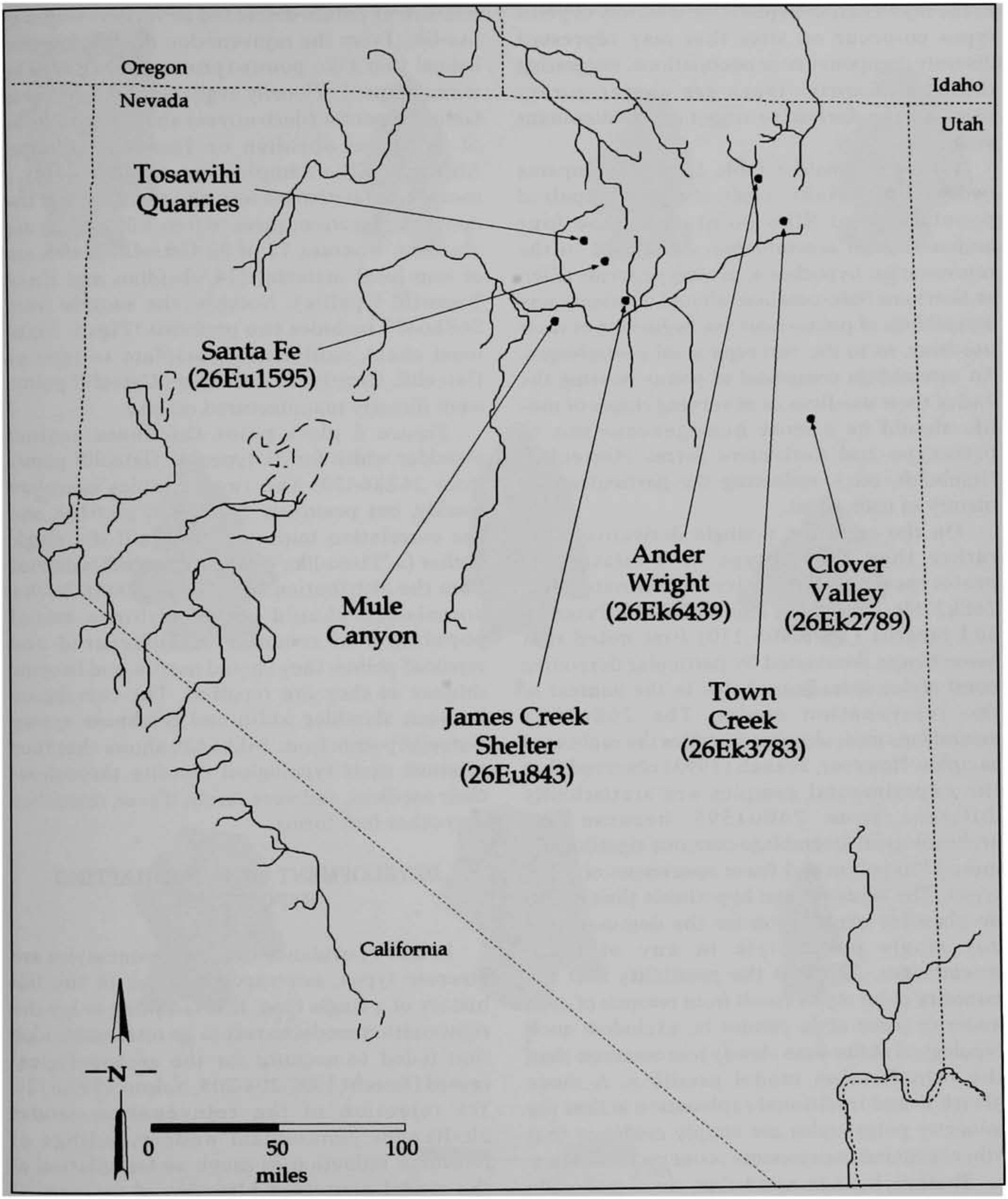

Figure 1. Map of Nevada Showing the Locations of Projectile Point Assemblages Mentioned in Text.

to the rejuvenation hypothesis; a variety of point types co-occur on sites that may represent discrete components or occupations, suggesting that the minority types are contemporary prototype or derivative stages of the dominant style.

However, consider Table 1, which compares two experimentally, replicated and repaired populations of Elko points with the four archaeological assemblages. According to the rejuvenation hypothesis, prototype forms (Elko or Northern Side-notched) should dominate any assemblage of points near the beginning of their use-lives, as in the two replicated assemblages. An assemblage composed of points nearing the end of their use-lives or at varying stages of use-life should be a more homogeneous mix of prototype and derivative forms (Gatecliff, Humboldt, etc.), reflecting the particular life-history of each point.

On the contrary, a single derivative type, rather than a prototype or a mixture of prototypes and derivatives, dominate sites 26Ek2789, 26Ek3783, and 26Ek6439. Petersen and Stearns (1992:105-110) first noted that assemblages dominated by particular derivative point styles seem improbable in the context of the rejuvenation model. The 26Eu1595 assemblage most closely resembles the replicated samples. However, Zeanah (1993) observed that the experimental samples are statistically different from 26Eu1595 because the archaeological assemblage contains significantly more Elko points and fewer specimens of other types. The rejuvenation hypothesis thus allows no plausible explanation for the dominance of any single point style in any of these assemblages. Although the possibility that the minority point styles result from retouch of each majority point style cannot be excluded; such typological shifts were clearly less common than the rejuvenation model predicts. A more plausible and traditional explanation is that the minority point styles are simply evidence that other temporal components occur on these sites.

Further, bear in mind that since projectile point manufacture and repair took place at 26Ek6439, its assemblage must contain a mixture of points discarded at various stages of use-life. From the rejuvenation model, it seems logical that Elko points (prototypes) should be manufactured of locally available chert, whereas Gatecliff points (derivatives) should tend to be of non-local obsidian or Tosawihi Opalite. Although Elko samples are too small for a meaningful statistical test, the trends are in the opposite direction; three of four Elko points are obsidian, whereas 17 of 32 Gatecliff points are of non-local material (14 obsidian and three Tosawihi Opalite). Notably, the sample from 26Ek6439 includes two preforms (Figure 3a) of local chert, sufficiently complete to type as Gatecliff. Clearly, at least some Gatecliff points were directly manufactured on-site.

Figure 4 plots point thickness against shoulder width for 21 typeable Gatecliff points from 26Ek6439. The two variables correlate weakly, but positively ($r2 = .269$, $p = .016$), and the correlation improves greatly if the single outlier (a "Pinto-like" split-stem point) is deleted from the distribution ($r2 = .52$, $p = .0004$). Such a correlation should occur within a mixed population of recently manufactured and repaired points: they should narrow and become thinner as they are repaired. The correlation between shoulder width and thickness among Gatecliff points from 26Ek6439 shows that they retained their typological identity throughout their use-lives, and were rarely, if ever, retouched into other haft forms.

DEVELOPMENT OF THE REHAFTING HYPOTHESIS

In face of evidence that dart point styles are discrete types, not varying stages in the life history of a single type, it is tempting to lay the rejuvenation model to rest as an interesting idea that failed to account for the archaeological record (Knecht 1997:204-205; Nelson 1997:372). Yet rejection of the rejuvenation model challenges economical understandings of toolstone reduction as much as formulation of the model contested histories of typological change. Projectile points were highly curated tools that were frequently manufactured of high

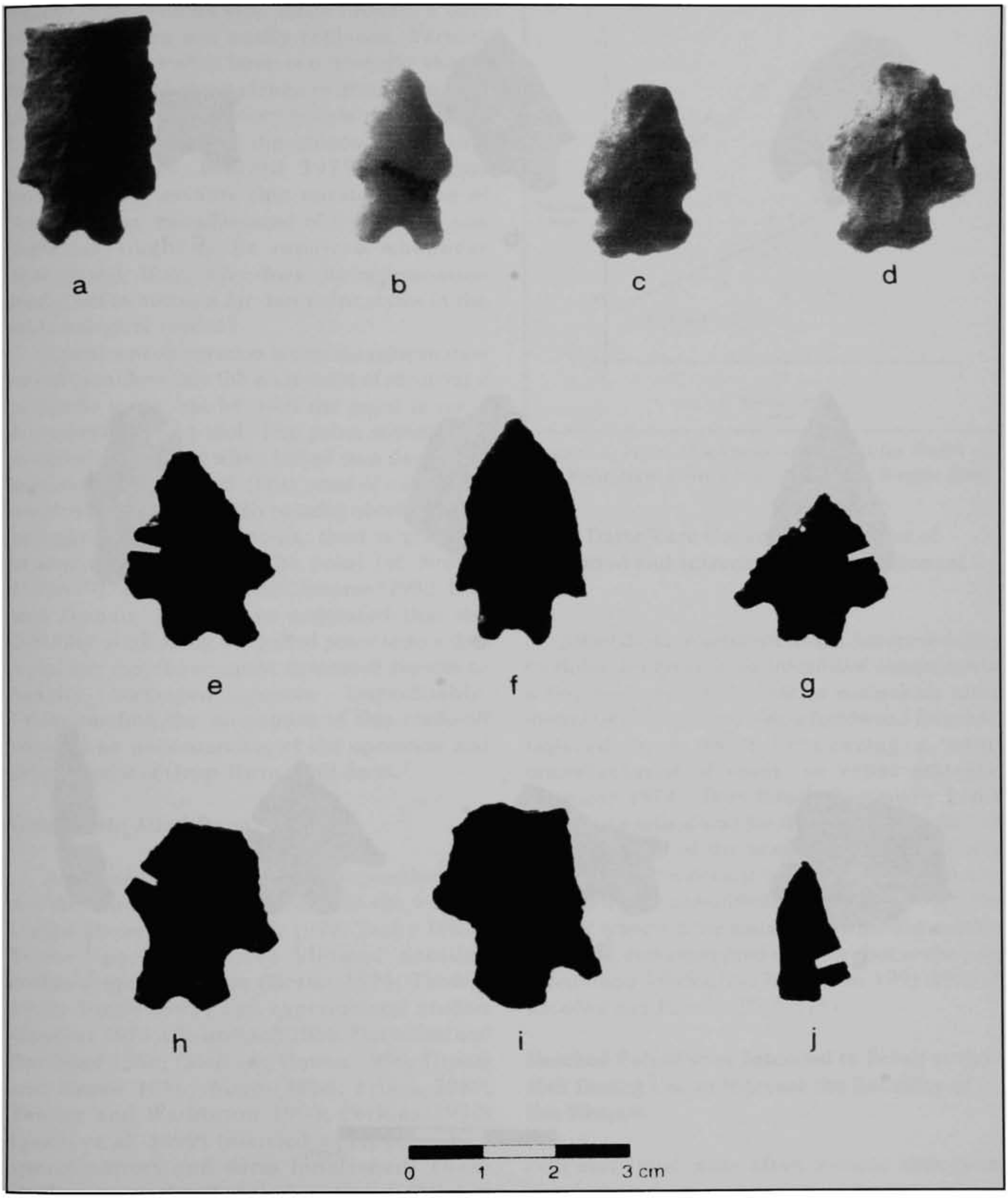

Figure 2. Projectile Points from site 26Ek6439; a-b, e-h. Gatecliff Split Stem; c. Large Side-notched; d. Elko Corner-notched; i. Gatecliff Contracting Stem; j. Rosegate.

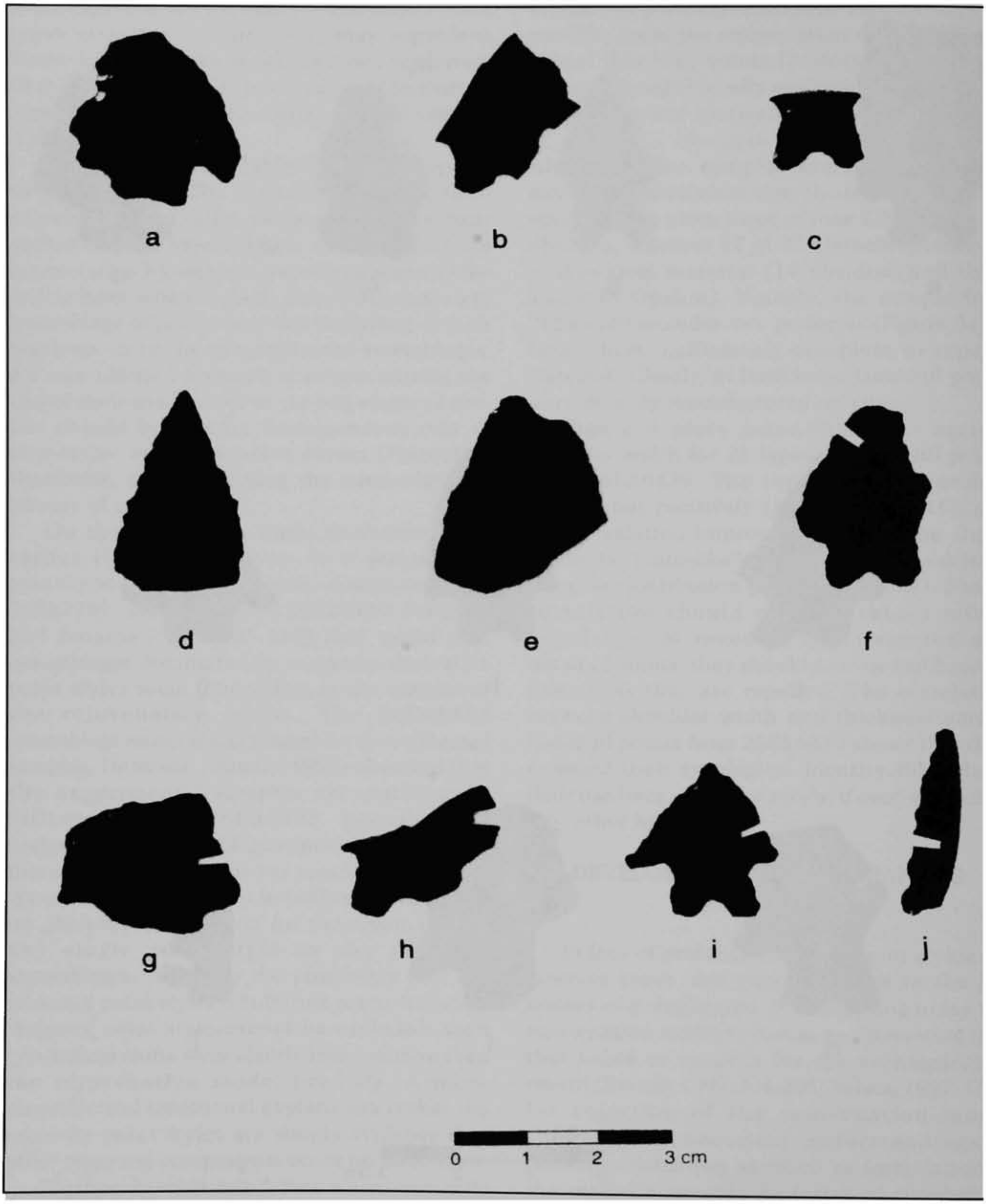

Figure 3. Projectile Points from site 26Ek6439; a. Gatecliff preform; b-c, f, h-i. Gatecliff Split Stem; d-e, g, j. untypeable fragments.

quality, exotic toolstones. Once broken, a dart point was often not easily replaced. Various flintknapping studies have convincingly shown that retouching hafting elements into alternative shapes could salvage many points with broken bases. Given models of the economics of lithic technology (cf. Binford 1979), it seems reasonable to assume that curated pieces of personal gear, manufactured of high utility raw material, ought to be repaired whenever economical. If so, why does the rejuvenation model fail to account for dart point styles in the archaeological record?

A pertinent observation is that the rejuvenation model considers only the economics of repairing a projectile point, but by itself the point is not a functional hunting tool. The point achieves its intended utility only when hafted on a dart, to be launched from an atlatl. If the costs of rehafting a point onto a dart outweigh benefits obtained from salvaging the broken point, then it must be uneconomical to repair the point (cf. Nelson 1996:119).[1] Both Petersen and Stearns (1992: 108) and Zeanah (1993) have suggested that the difficulty of rehafting a repaired point onto a dart foreshaft, may have made extensive repairs to basally damaged points unprofitable. Understanding the economics of this trade-off requires an understanding of the operation and maintenance of Great Basin atlatl darts.

Great Basin Atlatl Darts

Archaeologists have recovered spearthrowers and darts from various dry caves in the western United States (Hester et al. 1974; Tuohy 1982). These specimens have allowed detailed archaeological analyses (Hester 1974; Thomas 1978; Tuohy 1982) and experimental studies (Spencer 1974; Christenson 1986; Flenniken and Raymond 1986; Odell and Cowan 1986; Titmus and Woods 1986; Woods 1988; Frison 1989; Towner and Warburton 1990; Perkins 1992; Couch et al. 1999) intended to replicate how spearthrowers and darts functioned. These studies are the basis for the following observations about the maintenance and operation of atlatl darts in the Great Basin.

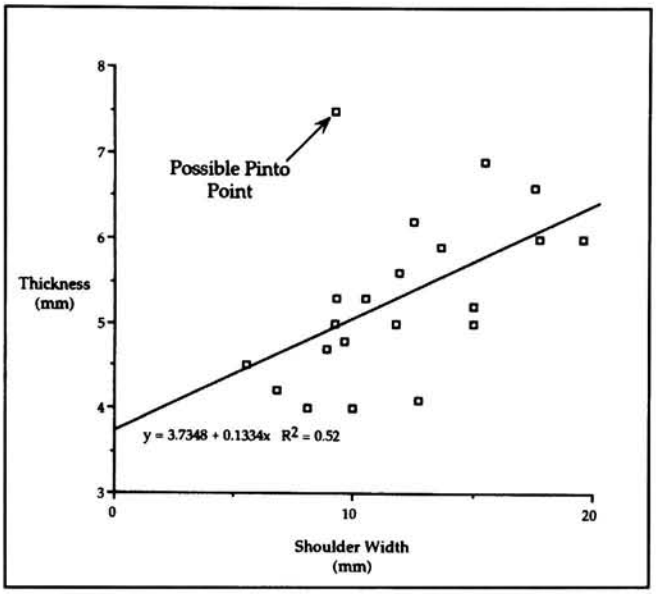

Figure 4. Point Thickness and Shoulder Width on 21 Split-stem Points from the Ander Wright Site.

Atlatl Darts Were Constructed as a Set of Interfitted and Interchangeable Component Parts.

Atlatl darts in western North America were a modular design of three interfitted components; a fletched proximal shaft, a mainshaft often manufactured of cane, and a hardwood foreshaft tapered to a point or bearing a point manufactured of stone, or other material (Spencer 1974). Dart foreshafts usually had a tapered proximal end for fitting into a socket on the distal end of the main shaft. This allowed the foreshaft to detach from the main shaft and remain firmly embedded in the animal, while the hunter retrieved the main shaft, inserted another foreshaft, and attempted another shot at the prey (Flenniken 1985:273-274; Frison 1991:293; cf. Kroeber and Barrett 1960:118).

Notched Points were Intended to Break at the Haft During Use to Increase the Lethality of the Weapon.

Point typologists often assume that point breakage and retouch occur most commonly on the exposed blade of stone points, while the basal hafting element is shielded from damage and repair (Thomas 1981; Hoffman 1985). However, experiments show that dart points frequently break at the base on impact, and flintknappers suggest that point notching may have been an intentional strategy for controlling where the point was likely to break, so as to leave point fragments in the wound of the animal (Van Buren 1974:31, 33; Flenniken 1985; Odell and Cowan 1986; Flenniken and Raymond 1986; Titmus and Woods 1986; Musil 1988; Towner and Warburton 1990). Hafting elements may also affect the lethality of the dart; contracting stemmed points may be intended to detach from the foreshaft and remain embedded in a wounded animal, whereas notched points are more likely to remain bound to the foreshaft (Christenson 1987: 145-148). Some ethnographic accounts suggest that points and point fragments work into the wounded animal, killing it while the hunter tracks it (Ellis 1997:51-52, 57). Thus, the use of stone points that are prone to impact breakage increases the effectiveness of the dart as a weapon.

Well-Equipped Hunters Probably Carried Only a Few Dart Foreshafts Hafted with Stone Points that were Intended to Host Multiple Points Over their Use-Lives.

As mentioned above, a socketed attachment between the foreshaft and main shaft of the dart, allowed the hunter to "reload" the mainshaft with spare foreshafts. Table 2 lists several dart foreshaft caches recovered from the Western United States. The composition of these caches suggests that individual hunters rarely carried more than ten spare dart foreshafts at a time. Possibly, it did not pay hunters to carry too many foreshafts at once because of their limited portability and the poor chance of ever launching more than a few darts at any single, mobile target (Frison 1991:293; Flenniken 1985:273).

Frequently, no more than one or two dart foreshafts from the caches have stone dart points attached to them. The remaining foreshafts were either intended to function without stone points, or are spare foreshafts that were pre-notched for attachment of a stone point whenever needed. The limited number of hafted foreshafts, the presence of pre-notched spare foreshafts without points and unattached points and preforms, and the breakability of stone points suggests that each hafted foreshaft was intended to host more than one stone point during its use-life.

Hunters Were Prepared to Repair or Replace Broken Dart Points in the Field.

The presence of flaking tools, and spare points and preforms with the foreshaft caches of Table 2 shows that hunters were prepared to repair or replace broken dart points in the field. Although probably arrow, rather than dart points, an animal skin pouch containing 110 unhafted Rosegate points and preforms was also recovered from 26Wa197 (Hester 1974), suggesting that well-equipped hunters carried an ample supply of spare points to replace broken points on-the-spot.[2] Clearly, sites 26Ek6439, 26Ek3783, and 26Eu1595 are additional evidence for in-field manufacture and repair of dart points. Table 3 lists several additional examples of projectile point dominated assemblages from elsewhere in the Great Basin, where hunters retooled and rehafted their dart supplies soon after expending them on a hunt.

The Labor Required to Produce and Repair a Broken Dart Point was Less than the Labor Required to Produce or Repair a Dart Foreshaft.

The manufacturing of atlatl darts was time consuming. Although a broken point can be repaired in as little as three minutes (Flenniken and Raymond 1986: 608), complete reduction of corner-notched projectile points can take from 20 to 40 minutes (Flenniken and Raymond 1986:608; Spencer 1974:51; Keely 1982), supporting the assumption that hunters should salvage broken points whenever possible. However, production of the foreshaft can take longer than an hour and the entire dart at least several hours to assemble (Spencer 1974: 57; Keely 1982). Particular time and attention must be paid to achieving a proper attachment between the dart foreshaft and main shaft to ensure that the mainshaft will not splinter on impact (Frison 1989; Knecht 1997:197). Too, a damaged foreshaft, main shaft, or fletching element must be replaced rather than repaired (but see Couch et al. 1999:32). Therefore, foreshafts required greater labor and time investment to construct and repair than stone points (Keely 1982; Fischer 1985:29).

Attachment of a Dart Point to a Foreshaft was Difficult and Time Consuming.

Flintknappers frequently complain that it is difficult to properly bind a point to a foreshaft because a good fit requires a straight alignment between the dart point, and the notch in the foreshaft. Given that every foreshaft was intended to bear multiple points over its use-life, and required a higher labor investment to produce or modify than a stone projectile point, it is more sensible to adjust the point to achieve a proper fit than it is to modify the foreshaft. Attachment of the projectile point to the foreshaft often requires thinning of the base of the point (Spencer 1974:49; Flenniken and Raymond 1986:605-606; Towner and Warburton 1990:313; cf. Binford 1986:550), insertion of a hide or bark pad between the point and foreshaft (Van Buren 1974:32; Frison 1989) or abrasion of the hafting element of the point (Christenson 1987:148; Tankersley 1994:120-122). Altogether, attachment of a chipped stone point to a foreshaft can take over 20 minutes (Spencer 1974:49).

Different Haft Element Styles Probably Favored a Specialized Hafting Technique.

Rehafting a repaired point is complicated in that different haft styles are best suited for particular binding strategies (Van Buren 1974:19, 66; Knecht 1997: 196, 201-202). Dart points are attached to foreshafts using a mastic adhesive made from pine pitch and/or sinew bindings that wrap the point to the foreshaft. The foreshaft may be notched or socketed (Holmer 1986:112). Although archaeological specimens show that both pitch and sinew bindings and notched and socketed foreshafts were used for hafting a variety of point styles, different hafting element styles probably favor particular hafting strategies. For example, notched point styles are more appropriate for notched split-shaft foreshaft attachments (Musil 1988), while stemmed and contracting stem points are better suited for socketed foreshaft attachments (cf. Frison 1991; Musil 1988). Too, corner and side-notched points are best attached to the foreshaft with sinew bindings (Holmer 1986:112), while mastic adhesive is more useful with stemmed and lanceloate points (Holmer 1986:112; cf. Woods 1988:6; Flenniken and Wilke 1989:152). Therefore, rehafting a repaired point with a new haft element shape may require altering the binding and foreshaft of the point.

The Rehafting Hypothesis

These observations suggest why the necessity of rehafting a point to a foreshaft often made it uneconomical to salvage a point with a broken hafting element. Given that foreshafts (which probably were intended to host more than one point during their use-lives) required more labor to manufacture than points (which probably were intended to shatter or remain embedded in the animal on use), the primary concern of a hunter wishing to repair a damaged atlatl dart should have been the foreshaft, not the projectile point (cf. Keely 1982). The limited supply of spare foreshafts at hand, the difficulty of attaching points to foreshafts, and the need to repair broken darts in the field encouraged hunters to maintain a set of interchangeable stone points, all with consistent basal shape. This constraint limited the variability acceptable among haft elements of replacement points and restricted the amount of retouch feasible for repairing a broken base in the field. If so, hunters must have found it more economical to simply discard and replace broken points rather than repair them. When hunters did repair basally damaged points, they struggled to reproduce the haft element shape of the original point, discarding points that could not be repaired and rehafted without modifying the foreshaft and hafting technique. These constraints discouraged retouch of one point type to another.

The rehafting hypothesis implies that the variability of foreshafts should closely correspond to the variability of stone dart points, inviting comparison of hafted archaeological specimens. In an analysis of 142 ethnographic and archaeological arrows, Thomas (1978) found that projectile point length, width, thickness, weight, and neck width significantly co-varied with arrow length, mainshaft diameter, and foreshaft diameter. However, among a sample of ten atlatl foreshafts tipped with stone points, Thomas failed to find any significant correlations between projectile point length, width, thickness, weight, or neck width with foreshaft length or diameter at all. Thomas concluded that dart point size bore little relationship to foreshaft size, contrary to the rehafting hypothesis, but noted that a larger sample could easily change conclusions.

In a more recent study, Shott (1997) expanded Thomas' sample to 39 hafted dart points. Shott compared point length, shoulder width, thickness, and neck width with foreshaft diameter, and found significant positive correlations in all comparisons, but correlation coefficients ranged only from .38 to .45. Shott concluded that dart point attributes were only moderately correlated with foreshaft diameter. However, Shotts' analysis may be challenged since his sample included specimens from as far afield as Peru, Alaska, and Australia. It seems reasonable that regional differences in weapons systems technology could distort the expected relationship between point and foreshaft attributes.

Independently, we have reviewed various archaeological reports from the western United States to obtain a sample of 46 hafted dart points. The sample includes the 10 darts considered by Thomas and six of the points reported by Shott, using dimensions reported by the two authors. The remaining 30 specimens were gleaned from various reports (Hough 1914; Loud and Harrington 1929; Woodward 1937; Martin et al. 1952; Harrington 1960; Lindsay et al. 1968; Gunnerson 1969; Hester 1974; Hattori 1982; Tuohy 1982; Pendleton 1985; Frison 1991). However, dimensions usually had to be estimated from scale drawings and photographs in which bindings obscured point neck widths. Too, point weights and thickness were rarely reported. Consequently, only dart point length and width could be consistently recorded and compared to foreshaft length and diameter. Table 4 presents data from the 46 specimens.

The sample includes a variety of haft element styles. Be aware that analysts interpreted specimens from Hidden Cave (Pendleton 1985) and 26Wa197 (Hester 1974) as hafted bifacial knives rather than projectiles. However, all the bifaces were hafted onto tapered foreshafts that were clearly intended to be inserted into socketed mainshafts of darts, thrusting spears, or harpoons. Too, the specimens from 26Wa197 were recovered together in a cache, which is more suggestive of a bandoleer of spare darts than of knives (Shott 1997:88). Therefore, although some specimens may have been used as knives, this function must have supplemented their service as projectiles (see Ellis 1997: 51-54 for ethnographic examples).

Table 5 shows the results of linear regressions between point and foreshaft attributes. Neither point length nor point width correlates with foreshaft length. However, point length and width do significantly correlate with foreshaft diameter; foreshaft diameter variability accounts for 30% of variability among point lengths and 50% variability of point widths. Figure 5 plots the distribution of point width versus foreshaft diameter. The analysis supports Shott's finding that stone point attributes correlate with foreshaft diameters, but suggests that the correlations may be very strong. Clearly, there is a relationship between hafted dart foreshafts and stone points, consistent with the rehafting hypothesis.

TESTING THE REHAFTING HYPOTHESIS

If the interpretation that the four projectile point dominated assemblages were produced over a few brief occasions is correct, then the points recovered from each assemblage must have belonged to only a few hunters faced with rehafting repaired or spare points on the limited supply of foreshafts at hand. If ease of rehafting these points was a critical concern, then each hunter should have found a narrower range of variability in hafting element attributes acceptable for usable points than archaeologists recognize as defining that particular point type. This should contrast with the range of variability expressed in assemblages of the same point type, but recovered from various strata or loci of palimpsest sites. Logic suggests that such palimpsest assemblages must represent discard and loss of points by many hunters over prolonged periods. Each point probably originates from a different foreshaft belonging to a different hunter. Therefore, the range of variability among hafting element attributes in palimpsest assemblages should be greater than the variability of projectile point dominated assemblages.

To test this expectation, metric attributes of Humboldt, Gatecliff and Elko points from the four projectile point dominated assemblages were compared with those retrieved from various contexts (sites, strata, loci, etc.) of three palimpsest assemblages: 26Eu843 (James Creek Shelter -Drews 1990; Zerga and Elston 1990), Tosawihi Quarry (Leach and Botkin 1991; Ataman and Drews 1992; Ataman and Bullock 1995), and Mule Canyon (Ataman and Ingbar 1994). Table 6 summarizes the representation of the three point styles in the seven assemblages. Five metric variables from the Monitor Valley key (Thomas 1981) were compared (where applicable) in the seven assemblages: Distal Shoulder Angle (DSA), Proximal Shoulder Angle (PSA), Notch Opening Index (NOI), Basal Width (BW) and Neck Width (NW). Tables 7 and 8 summarize mean and variance values for these attributes in the assemblages.

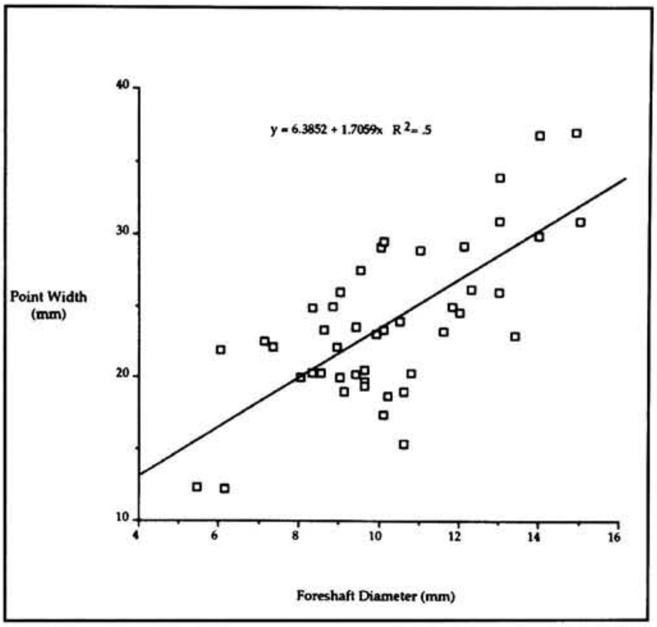

Figure 5. Foreshaft Diameters and Point Widths Among 46 Hafted Darts from the Western U.S.

The relationships expected between these variables and foreshaft hafting merit consideration. Frequent comment by flintknappers that attachment of the projectile point to the foreshaft often requires retouch to the base of the point (Spencer 1974:49; Van Buren 1974:20; Flenniken and Raymond 1986:605-606; Towner and Warburton 1990:313) suggests that basal thickness and basal indentation ratios (BIR) should most closely reflect hafting constraints, but these two variables were too inconsistently recorded to be compared in this analysis. Clearly, neck width should be strongly correlated with foreshaft width: a point with too wide or narrow a neck could not be effectively mounted in a foreshaft (Christenson 1987:147). Strong correlations between neck width and foreshaft diameters inferred from archaeological point collections (Corliss 1972; Fawcett and Kornfield 1980), and demonstrated in hafted arrows (Thomas 1978) and darts (Shott 1997), support this relationship. Logic suggests that the minimum point basal width feasible for mounting in a foreshaft is constrained by the foreshaft width simply because a too narrow a point base could not be effectively mounted in a wide foreshaft (Van Buren 1974:34; Christenson 1987:145). The correlations between point width and foreshaft width demonstrated above, and by Thomas (1978) and Shott (1997) in hafted specimens supports this inference. The relationships between proximal and distal shoulder angles and notch openings with foreshaft hafts are less clear-cut. Proximal shoulder angle and, to a lesser extent, notch openings should correlate strongly with neck width and base width so there should be an indirect relationship between foreshaft width and these two variables. It also seems reasonable that notch openings and shoulder angles are strongly related to hafting constraints when sinew serves to bind the point to the haft. Retouch of the proximal or distal shoulders to create an overly wide notch opening may limit the effectiveness of the haft by allowing the sinew attachment more room to shift and loosen.

If the hypothesis that rehafting points onto pre-existing foreshafts constrains the repairs that can be made to damaged point bases is true, then it follows that the variance of metric attributes of projectile dominated assemblages should be lower than variances of palimpsest assemblages. Thus:

$$H1: s^2pda < s^2pa$$
$$H0: s^2pda \geq s^2pa$$

where:
pda = projectile point dominated assemblages
pa = palimpsest assemblage

In contrast, there should be no significant differences among the variances of palimpsest assemblages, or among the variances of projectile point dominated assemblages.

A one tailed F-test served to test for significant differences in variance. Tables 9, 10, and 11 summarize F Test results for significant differences in variance of Humboldt, Gatecliff, and Elko points respectively.

For Humboldt points, basal width is the only applicable variable. As Table 9 shows, the variance among basal widths at 26Ek2789 is significantly less than the variance among Humboldt points from Tosawihi Quarry and Mule Canyon. However, the variances of the two palimpsest assemblages do not significantly differ from each other. All three results thus accord with expectations.

Considering Gatecliff points (Table 10), significant differences in variance are common between palimpsest and projectile point dominated assemblages. Proximal shoulder angles differ significantly between 26Ek6439 and Tosawihi Quarry, 26Ek6439 and Mule Canyon, 26Ek3783 and Mule Canyon, and 26Ek3783 and Tosawihi Quarry. Significant differences also occur between the variances of basal widths of 26Ek3783 and Mule Canyon, whereas the difference in variability between 26Ek6439 and Mule Canyon basal widths falls short of the criteria for rejecting the null hypothesis ($F = 1.91$, $F_{.05[28,24]} = 1.96$, $p > .05$). Neck widths from both 26Ek6439 and 26Ek3783 differ significantly from Mule Canyon. In contrast, no significant differences occur between 26Ek6439 and 26Ek3783, or between Tosawihi Quarry and Mule Canyon. All significant differences in variance are consistent with expectations.

The variances among 26Eu1595 Elko points are significantly less than those from Mule Canyon and Tosawihi Quarry (Table 11) in distal shoulder angle, proximal shoulder angle, notch opening, basal width, and neck width. In comparing 26Eu1595 Elkos with 26Eu843 Elkos, only the variance of neck width significantly differs. All significant differences between projectile point dominated assemblages and palimpsest assemblages are consistent with expectations.

As expected, no significant differences in variance obtain between Elko points from palimpsest assemblages from Mule Canyon and Tosawihi Quarry. However, the 26Eu843 collection exhibits significantly less variance in distal shoulder angle, proximal shoulder angle, and notch opening than Mule Canyon Elko points, and significantly less variance in distal shoulder angle and notch opening than Tosawihi Quarry Elko points. These significant differences between 26Eu843 and the other two palimpsest assemblages are contrary to expectations.

Table 12 tabulates all significant testing results for F tests. Of 37 comparisons of variance between palimpsest and projectile point dominated assemblages, 20 were significant, consistent with expectations. Elko points had a higher significance rate (73%) than Gatecliff points (35%) in comparisons between palimpsest and projectile point dominated assemblages. Only five comparisons were made between projectile point dominated assemblage (26Ek6439 and 26Ek3783), with no significant differences between the two samples. Of 21 comparisons between palimpsest assemblages, five expressed significant differences in variance, contrary to expectations. All five pertain to 26Eu843.

Significant differences in variances might be a misleading measure of differences in dispersion because variances frequently correlate with means (Bettinger and Eerkins 1997; Shennan 1998:43-44). Therefore, the significant differences obtained between variances projectile point dominated and palimpsest assemblages might simply reflect differences in the mean values of attributes rather than the relative dispersion of the attributes. One way to correct for this effect is to compare coefficients of variation (the standard deviation divided by the mean) in the samples. A nonparametric sign test can serve to compare differences in the coefficients of variation of projectile point dominated and palimpsest assemblages. The hypothesis is phrased so that for any comparison between assemblages, the probability that the coefficient of variation of a projectile point dominated assemblage is lower than that of the palimpsest assemblage is greater than the probability that the variance of the projectile point dominated assemblage is greater than or equal to the palimpsest assemblage.

Thus:

$$H_1: p < q$$
$$H_0: p \geq q$$

where:

p = the probability that the coefficient of variation of any the projectile point dominated assemblage is less than any palimpsest assemblage.

q = the probability that the variance of any projectile point dominated assemblage is greater than or equal to any palimpsest assemblage.

Table 13 presents coefficients of variation for the assemblages, and Table 14 summarizes results of the sign test. The table shows that in 37 comparisons all but six trend in the direction expected, with the variance of projectile point dominated assemblages being smaller than palimpsest assemblages. The six exceptions concern notch opening, distal shoulder angle, and basal width: three pertain to the 26Ek6439 site and four pertain to Gatecliff points. All comparisons of proximal shoulder angle and neck width trend in the direction expected. The binomial probability that such results could be drawn from a population where variances of projectile dominated assemblages are greater than or equal to palimpsest assemblages is 0.004 for basal width and 0.08 for neck width and proximal shoulder angle. In contrast, for distal shoulder angle comparisons, five of seven results conform to expectations, with a probability of 0.2. For notch opening, only four of seven results conform to expectations, with a probability of 0.5. In all, there are 31 results for 37 comparisons, with a probability less than .0001 that the results obtain from populations where variances of palimpsest assemblages equals or exceeds variances of projectile point dominated assemblages.

Discussion

The preceding tests show that dart points from projectile point dominated assemblages exhibit less variance in metric attributes than palimpsest assemblages, consistent with the rehafting hypothesis. Clearly, at projectile point dominated assemblages broken points were discarded long before hafting elements were retouched sufficiently to express the full range of variability possible within a single type, much less retouched into different types. This finding disputes the rejuvenation model, but is consistent with the hypothesis that constraints imposed by the foreshaft limited the amount of retouch that was feasible for repairing broken bases.

The principal exception to this finding concerned Elko points from 26Eu843, which more often than not failed to differ significantly from projectile point dominated assemblages, but were significantly less variable than other palimpsest assemblages. It is not clear why the 26Eu843 collection should be like a projectile point dominated assemblage. Elko points from 26Eu843 show less evidence of retouch and less variability in reduction strategies than do Elko points from Mule Canyon or Tosawihi Quarry (Drews 1990; Zerga and Elston 1990; Ataman and Ingbar 1994:106). The typological similarity of 26Eu843 Elko points led analysts to speculate that a single individual manufactured many of the points (Drews 1990: 82; Zerga and Elston 1990: 215)[3]. If so, the Elko points from 26Eu843 actually represent a projectile point dominated assemblage, but the points are too widely dispersed in various strata of the shelter to make that a plausible explanation.

Also of note in the tests was the tendency for 26Eu1595 Elko points to significantly differ from palimpsest assemblage Elko points in all five variables, but 26Ek6439 and 26Ek3783 Gatecliff points significantly differed from palimpsest assemblage Gatecliff points only in proximal shoulder angle, neck width and basal width. It is interesting that proximal shoulder angle and basal width conform well with expectations for both Elko and Gatecliff points, since these attributes distinguish the two point styles (Thomas 1981). Too, notch openings and distal shoulder angles are attributes that should have less effect on the articulation of the point with the foreshaft than neck width or basal width. The tendency for these variables to differ significantly among Elko but not Gatecliff points suggests that they influence hafting more strongly in Elko points than Gatecliff points. Perhaps, this reflects differences in the importance of sinew bindings for hafting corner-notched Elko points and mastic adhesive for hafting stemmed Gatecliff points.

CONCLUSION

The preceding analysis allows an opportunity to comment on the proper role that replicative studies can play in scientific inquiry about the archaeological record. The rejuvenation model derives from actualistic replications of point manufacture, use, and repair that demonstrate that it was often possible to repair broken points by retouching the hafting element to a different form. Such repairs would surely cross typological boundaries (Flenniken and Wilke 1989). Yet demonstrating that something could be done by replication falls short of showing that it was actually done in prehistory (Thomas 1986:621-623).

Except for a post hoc claim to explain the long chronology of the eastern Great Basin, proponents of the rejuvenation model have yet to test hypotheses derived from the model against the archaeological record. The appropriate testing strategy is to cast hypotheses derived from the model against new sources of data that are independent of those used in model construction. Since the rejuvenation model derives from replicative analyses and was intended to explain the long chronology, additional replications or appeals to the stratigraphic distribution of point types in the eastern and northern Great Basin are simply inappropriate archaeological tests of the model. Critics of the rejuvenation model have undertaken serious attempts to test the model against new data and found that empirical evidence fails to support logical implications of the model (Bettinger et al. 1991; O'Connell and Inoway 1994).

Yet, does the lack of empirical support for the rejuvenation model warrant its dismissal from further inquiry about projectile point variability in the archaeological record? The value of the model is that it replicates aspects of projectile point manufacture and repair, previously unappreciated by projectile point typologists. If modern flintknappers are able to repair a broken point by changing the haft style, prehistoric flintknappers must have been able to do the same thing. If the archaeological record fails to support the rejuvenation model, then prehistoric flintknappers, more often than not, must have chosen not to mend broken points if repaired points crossed typological boundaries. Questioning why they made this decision offers an opportunity to learn something new about dart point variability.

In this paper, we have tried to take advantage of this opportunity, by turning the rejuvenation model around, and testing a hypothesis that may explain why prehistoric point types were resilient to typological change on repair. We find that significant differences between the variances of metrical attributes of point types from palimpsest and projectile point dominated assemblages are consistent with the hypothesis that rehafting constraints limited the amount or repair that was economical to undertake on broken point bases. While the rehafting hypothesis cannot explain why prehistoric hunters preferred one point type to another, it does suggest that they had powerful economic reasons for preferring to produce and maintain a single type. Such economic constraints contribute to understanding why dart point styles are spatially and temporally patterned in the archaeological record. Even if the rehafting hypothesis fails to stand up to further testing, we have documented interassemblage variability in point attributes that was not anticipated by traditional point typologies or by the rejuvenation model.

This analysis joins a growing set that suggests that much of the temporal and spatial variability among projectile point types, long assumed to be "stylistic," can be explained from an economic perspective. Recent research in the Great Basin suggests that various aspects of spatial and temporal variability in dart point styles may be attributable to regional variations in occupational history (O'Connell and Inoway 1994; Beck 1995), changes in weapons technology and hafting techniques (Musil 1988; Hughes 1998), the need to control breakage and resharpen points (Flenniken and Wilke 1989; Beck 1995), and cultural transmission (Bettinger and Eerkens 1997, 1999). This does not deny that some point variability may be stylistic (cf. Weisner 1983), but it is premature to be reassured that old, untested notions of mental templates and cultural norms account for the archaeological record (Nelson 1997:372). Clearly, the continent-wide distribution of many dart point styles (for example compare Heizer and Hester 1978: Figures 1, 2, 3, and 6 with Cambron and Hulse 1964: 23, 28, 125- 126, 21, 77, 118, 15, 17, 65- 66, 73, 83, 101, 14, 76, and 89-90 respectively) argues persuasively that all point variability cannot be simply explained as stylistic variability demarking regional ethnic or cultural boundaries.

No one model will explain everything there is to know about dart points, but pieces of the puzzle can be fitted together by addressing smaller testable questions about point variability. Much of this research might never have been conducted if not for the rejuvenation model. It all goes to show that a provocative idea does not always have to be right to inspire productive research.

NOTES

1- Weight imposes another obvious constraint for economically retouching broken points that is not considered in this analysis. A point fragment repaired into a functional projectile tip may lose enough mass to impair the accuracy, stability, penetrating power, range, and velocity of the dart (Christenson 1986; Perkins 1992; Hughes 1998). However, experimental studies indicate that points weighing less than 4 grams serve as effective dart tips (Fenenga 1953; Couch et al. 1999). Therefore, projectile aerodynamics alone is insufficient to explain why salvageable prehistoric dart points were discarded without repair (Couch et al. 1999: 32).

2- See Broadbent (1994) for an example of a cache of 39 dart points in the Intermountain West. Similarly, Dalton points found in caches and burials of the Southeastern United States also suggest that atlatl equipped hunters carried multiple replacement points as personal gear (Morse 1997; Walthall and Holly 1997: 158-159).

3- Some readers might object that idiosyncratic variation in skill and preference among individual flintknappers accounts for the differences in variance between projectile point dominated assemblages and palimpsest assemblages. However, such an explanation merely assumes that individual flintknappers will always manufacture similar projectile points while begging the question of why they should do so. Clearly, individuals may either be innovative or conservative regarding the range of artifacts they manufacture, and the archaeologists' task is to understand why either strategy was taken. The original rejuvenation hypothesis proposed an economic scenario that expected prehistoric flintknappers to prefer variability in projectile point haft shape, whereas the rehafting hypothesis nominates economic constraints that would cause prehistoric flintknappers to avoid variability in haft shape.

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Table 1

COMPARISON OF TWO EXPERIMENTAL ASSEMBLAGES OF REPAIRED ELKO POINTS WITH PROJECTILE POINT-DOMINATED ASSEMBLAGES

Sample	Humboldt Series	Gatecliff Series	Elko Series	Rosegate Series	Cottonwood Series	Out of Key	Total
Flenniken and Raymond (1986) Experiment	0	4	20	3	0	1	28
Towner & Warburton (1990) Experiment	0	0	19	4	0	5	28
Clover Valley Site (26Ek2789) (Petersen and Stearns 1990)	72	1	7	5	0	0	85
Town Creek Site (26Ek3783) (Petersen and Stearns 1990)	0	94	1	0	0	0	95
Santa Fe Site (26Eu1595) (Zeanah 1993)	0	2	75	1	1	4	84
Ander Wright Site (26Ek6439) (Zeanah and Elston 1997)	0	32	4	1	0	2	39

Table 2

DART FORESHAFT CACHES RECOVERED FROM THE WESTERN UNITED STATES

Site	Total Foreshafts	Hafted Foreshafts	Notched Foreshafts	Tapered/ Bunted Foreshafts	Spare Points/ Preforms	Flaking Tools	Reference
Sand Dune Cave	6	6	0	0	18	P	Lindsay et al. 1968:41
Cave 2, Cornfield Creek	8	8	0	0	0	?	Woodward 1937:46-47; Shott 1997:87
NV-WA-197	8	6	2	0	5	P	Hester 1974
Cowbone Cave	7	0	0	7	?	?	Elston 1986:140
NC Site	6	1	0	5	1		Tuohy 1982
Winnemucca Cave	14	0	0	14	?	?	Tuohy 1982
Hogup Cave	7	0	2	5			Aikens 1970:159-162

Table 3
ADDITIONAL POINT REPAIR AND REPLACEMENT ASSEMBLAGES FROM THE GREAT BASIN

Site Name	Dominant Point Styles	Reference
26La1985	Humboldt	Hanes and McGonagle 1985
Diamond Lil, OR	Rosegate, Elko	Flenniken 1991
CA-Alp-152	Elko	Rondeau 1996

Table 4
HAFTED STONE POINTS AND DART FORESHAFTS FROM VARIOUS SITES IN THE WESTERN UNITED STATES

Site	Haft Element Form	Point Length (mm)	Point Width (mm)	Foreshaft Length (mm)	Foreshaft Diameter (mm)	Reference
Broken Roof Cave,	corner notch	49	23	99.1	13.4	Thomas 1978: Table 3; Guernsey 1931: Fig AZ 48c
Broken Roof Cave,	corner notch	57.3	29.2	97.9	10	Thomas 1978: Table 3; Guernsey 1931: Fig AZ 48c
Broken Roof Cave,	corner notch	65.4	29.6	99.4	10.1	Thomas 1978: Table 3; Guernsey 1931: Fig AZ 48c
Bushwhack Cave, AK	corner notch	32.9	23.3	197.8	11.6	Harrington 1960: Plate 25c
Cave 2, Cornfield Creek, UT	corner or side notch	54.1	20.3	189.4	10.8	Shott 1997: Table 1; Woodward 1937:46-47
Cave 2, Cornfield Creek, UT	corner or side notch	55.8	22.6	212.6	7.1	Shott 1997: Table 1; Woodward 1937:46-47
Cave 2, Cornfield Creek,UT	corner or side notch	60.4	20.5	181.2	9.6	Shott 1997: Table 1; Woodward 1937:46-47
Cave 2, Cornfield Creek, UT	corner or side notch	60.4	20.2	165.1	9.4	Shott 1997: Table i; Woodward 1937:46-47
Cave 2, Cornfield Creek, UT	corner or side notch	60.7	24.9	155.1	8.3	Shott 1997: Table 1; Woodward 1937:46-47
Cave 2, Cornfield Creek, UT	corner or side notch	70.4	20	189.5	8.0	Shott 1997: Table 1; Woodward 1937:46-47
Ceremonial Cave, TX	corner notch	39	19	105.9	9.1	Thomas 1978: Table 3; Cosgrove 1947: Fig 69d
Ceremonial Cave, TX	corner notch	50.6	26.2	56.9	12.3	Thomas 1978: Table 3; Cosgrove 1947: Fig 69b
Ceremonial Cave, TX	corner notch	54	19	60	10.6	Thomas 1978: Table 3; Cosgrove 1947: Fig 69d
Falcon Hill Cave, NV	split stem	59	29	446	11	Hattori 1982
Hidden Cave, NV	basal notch	39.3	23.6	135	9.4	Pendleton 1985: Figures 61 and 62
Hidden Cave, NV	basal notch	53.4	23.6	179	9.4	Pendleton 1985: Figures 61 and 62
Lava Caves, NM	stemmed or lanceolate	95.3	22.2	85.7	7.3	Hough 1914: 19-20
Lovelock Cave, NV	lanceolate?	49.3	18.7	149.6	10.2	Loud and Harrington 1929: Plate 45d
Lovelock Cave, NV	stemmed?	89.28	37.2	119	14.9	Loud and Harrington 1929: Plate 45b
Lovelock Cave, NV	corner notch		22.2	151	8.9	Loud and Harrington 1929: Plate 45c

Table 4 cont.

Site	Haft Element Form	Point Length (mm)	Point Width (mm)	Foreshaft Length (mm)	Foreshaft Diameter (mm)	Reference
NC Cave, NV	corner notch	42	22	197	6	Tuohy 1982
NV-Wa-197, NV	stemmed or lanceolate	62	26	141	13	Hester 1974: Table 1
NV-Wa-197, NV	stemmed or lanceolate	85	31	140	15	Hester 1974: Table 1
NV-Wa-197, NV	stemmed or lanceolate	87	30	122	14	Hester 1974: Table 1
NV-Wa-197, NV	stemmed or lanceolate	93	31	126	13	Hester 1974: Table 1
NV-Wa-197, NV	stemmed or lanceolate	100	37	135	14	Hester 1974: Table 1
NV-Wa-197, NV	stemmed or lanceolate	117	34	130	13	Hester 1974: Table 1
Potter Creek Cave, CA	unknown	34	20.3	171.5	8.5	Thomas 1978: Table 3
Rasmussen Cave, UT	corner notch	42	26	127.5	9	Gunnerson 1969:101, Figure 41
Rasmussen Cave, UT	corner notch	60	20	132	9	Gunnerson 1969:101, Figure 41
Sand Dune Cave, UT	corner or side notch	44.1	24	142	10.5	Lindsay et al 1968: Figure 42
Sand Dune Cave, UT	corner or side notch	48.5	17.4	148	10.1	Lindsay et al 1968: Figure 42
Sand Dune Cave, UT	corner or side notch	49.2	24.6	142.2	12	Lindsay et al 1968: Figure 42
Sand Dune Cave, UT	corner or side notch	54.6	27.5	133.7	9.5	Lindsay et al 1968: Figure 42
Sand Dune Cave, UT	corner or side notch	57.4	23.4	130	10.1	Lindsay et al 1968: Figure 42
Sand Dune Cave, UT	corner or side notch	63	23.1	132.9	9.9	Lindsay et al 1968: Figure 42
Spring Creek Cave, WY	corner notch	33.3	20.3	146.4	8.3	Frison 1991: Figure 2.62a
Steamboat Cave, NM	corner notch	42.4	25	129.7	8.8	Thomas 1978: Table 3; Cosgrove 1947: Fig 70a
Steamboat Cave, NM	corner notch	43.7	23.4	119	8.6	Thomas 1978: Table 3; Cosgrove 1947: Fig 70a
Steamboat Cave, NM	corner notch		29.3	129.5	12.1	Thomas 1978: Table 3; Cosgrove 1947: Fig 70a
Tularosa Cave, NM	corner notch	25.4	12.3		5.4	Martin et al 1952: Figure 136 d,e
Tularosa Cave, NM	corner notch	34.8	12.2	69.8	6.1	Martin et al 1952: Figure 136 d,e
White Dog Cave, AZ	corner or side notch	38.3	19.7	105	9.6	Thomas 1978: Table 3; Guernsey and Kidder 1921: Plate 34
White Dog Cave, AZ	corner or side notch	39.1	19.4	84.5	9.6	Thomas 1978: Table 3; Guernsey and Kidder 1921: Plate 34
White Dog Cave, AZ	corner or side notch	39.9	15.4	118.4	10.6	Thomas 1978: Table 3; Guernsey and Kidder 1921: Plate 34
White Dog Cave, AZ	corner or side notch	56.4	25	126	11.8	Thomas 1978: Table 3; Guernsey and Kidder 1921: Plate 34

Table 5
LINEAR REGRESSION ANALYSIS FOR HAFTED DART ATTRIBUTES

Test	**r**	**r2**	**p**
Point Length vs. Foreshaft Length	0.023	0.0005	0.883
Point Width vs. Foreshaft Length	0.087	0.007	0.5694
Point Length vs. Foreshaft Diameter	0.56	0.31	0.0001
Point Width vs. Foreshaft Diameter	0.705	0.5	0.0001

Table 6
ELKO, GATECLIFF, AND HUMBOLDT POINT COUNTS IN SEVEN NORTHEASTERN NEVADA ASSEMBLAGES

	Assemblage Name	**Elko Series**	**Gatecliff Series**	**Humboldt Series**
Projectile Point-dominated Assemblages				
	Clover Valley (26Ek2789)	7*	1	72
	Ander Wright (26Ek6439)	4	32	0
	Town Creek (26Ek3783)	1	94	0
	Santa Fe (26Eu1595)	75	2	0
Palimpsest Assemblages				
	Mule Canyon	109	35	29
	Tosawihi Quarries	40	24	15
	James Creek Shelter (26Eu843)	23	2	0

* Emboldened counts not considered further

Table 7
MEAN VALUES FOR PROJECTILE POINT DOMINATED AND PALIMPSEST ASSEMBLAGES

		PSA	DSA	NOI	BW	NW
Humboldts	Clover Valley (26Ek2789)	NA	NA	NA	13.2	NA
	Mule Canyon	NA	NA	NA	12.7	NA
	Tosawihi Quarries	NA	NA	NA	13.3	NA
Gatecliffs	Ander Wright (26Ek6439)	93.9	177.4	83.8	11.9	10.9
	Town Creek (26Ek3783)	93.7	188.8	97.6	13	11.6
	Mule Canyon	84.2	164.8	79.1	12.4	11.2
	Tosawihi Quarries	90.4	166.9	75.4	12.5	12.3
Elkos	Santa Fe (26Eu1595)	118.4	143.6	25	11.9	9.7
	Mule Canyon	123	167.2	44.3	15	11.5
	Tosawihi Quarries	121.8	161.9	40	14.8	11.4
	James Creek Shelter (26Eu843)	127.1	153.7	26.5	15.5	10.1

Table 8
VARIANCE VALUES FOR PROJECTILE POINT DOMINATED AND PALIMPSEST ASSEMBLAGES

		PSA	DSA	NOI	BW	NW
Humboldts	Clover Valley (26Ek2789)	NA	NA	NA	5.4	NA
	Mule Canyon	NA	NA	NA	14.1	NA
	Tosawihi Quarries	NA	NA	NA	10.1	NA
Gatecliffs	Ander Wright (26Ek6439)	56	974.7	804.9	3.2	3
	Town Creek (26Ek3783)	65.4	742.7	573.3	3.8	3.2
	Mule Canyon	176.8	908.6	578.1	6.1	8
	Tosawihi Quarries	124.8	499.6	584.6	4.8	4.5
Elkos	Santa Fe (26Eu1595)	40.4	210.1	206	3.3	1.6
	Mule Canyon	129.6	742.1	702.9	7.3	5
	Tosawihi Quarries	73.9	625.5	672.2	6.1	3.6
	James Creek Shelter (26Eu843)	54.1	255	194.2	4.4	2.9

Table 9
F TEST RESULTS FOR HUMBOLDT ASSEMBLAGES

Test Results	Clover Valley (26Ek2789) vs. Tosawihi Quarry	Clover Valley (26Ek2789) vs. Mule Canyon	Tosawihi Quarry vs. MuleCanyon
One Tailed F test			
BW	$F=2.57, F_{.05[14,71]}=1.84, p=.005$	$F=1.85, F_{.05[28,71]}=1.65, p<.025$	-

- not significant at .05 level

Table 10
F TEST RESULTS FOR GATECLIFF ASSEMBLAGES

Test Results	Ander Wright (26Ek6439) vs. Tosawihi Quarry	Ander Wright (26Ek6439) vs. Mule Canyon	Ander Wright (26Ek6439) vs. Town Creek (26Ek3783)	Town Creek (26Ek3783) vs. Mule Canyon	Town Creek (26Ek3783) vs. Tosawihi Quarry	Tosawihi Quarry vs. Mule Canyon
One Tailed F test						
DSA	-	-	-	-	-	-
PSA	$F=2.16, F_{.05[22,30]}=1.91, p=.025$	$F=3.06, F_{.05[32,30]}=1.84, p<.005$	- -	$F=2.7, F_{.05[32,85]}=1.6, p<.001$	$F=1.91, F_{.05[22,85]}=1.71, p<.025$	
NOI	-	-	-	-	-	-
BW	-	-	-	$F=1.62, F_{.05[28,91]}=1.6, p<.05$	-	-
NW	-	$F=2.57, F_{.05[26,27]}=1.91, p<.01$	-	$F=2.53, F_{.05[26,78]}=1.65, p<.005$	-	-

- not significant at .05 level

Table 11
F TEST RESULTS FOR ELKO ASSEMBLAGES

Test Results	Santa Fe (26Eu1595) vs. Mule Canyon	Santa Fe (26Eu1595) vs. Tosawihi Quarry	Santa Fe (26Eu1595) vs. James Creek Shelter (26Eu843)	Mule Canyon vs. Tosawihi Quarry	Mule Canyon vs. James Creek Shelter (26Eu843)	Tosawihi Quarry vs. James Creek Shelter (26Eu843)
One Tailed F test						
DSA	$F=3.53$, $F_{.05[92,51]}=1.54$, $p<.001$	$F=2.98$, $F_{.05[37,51]}=1.7$, $p<.005$	- -	- -	$F=2.91$, $F_{.05[92,22]}=1.87$, $p<.005$	$F=2.45$, $F_{.05[36,22]}=1.96$, $p<.01$
PSA	$F=3.21$, $F_{.05[104,73]}=1.47$, $p<.001$	$F=1.83$, $F_{.05[36,73]}=1.62$, $p<.01$	- -	- -	$F=2.39$, $F_{.05[104,23]}=1.83$, $p<.01$	- -
NOI	$F=3.41$, $F_{.05[88,50]}=1.59$, $p<.001$	$F=3.26$, $F_{.05[36,50]}=1.7$, $p<.001$	- -	- -	$F=3.62$, $F_{.05[88,22]}=1.89$, $p<.001$	$F=3.46$, $F_{.05[36,22]}=1.96$, $p<.005$
BW	$F=2.2$, $F_{.05[87,73]}=1.5$, $p<.001$	$F=1.84$, $F_{.05[38,73]}=1.59$, $p<.025$	-	-	-	-
NW	$F=3.11$, $F_{.05[86,48]}=1.59$, $p<.001$	$F=2.26$, $F_{.05[37,48]}=1.7$, $p<.01$	$F=1.84$, $F_{.05[22,48]}=1.8$, $p<.05$	-	-	-

- not significant at .05 level

Table 12
SUMMARY OF SIGNIFICANT DIFFERENCES IN VARIANCES AMONG PDA AND PA HUMBOLDTS, ELKOS AND GATECLIFFS

Projectile Point Dominated vs. Palimpsest Assemblages	**Palimpsest Assemblages vs. Palimpsest Assemblages**
PSA- Ander Wright (26Ek6439) vs. Tosawihi Quarry	DSA- Mule Canyon vs. James Creek Shelter(26Eu843)
PSA- Ander Wright (26Ek6439) vs. Mule Canyon	PSA- Mule Canyon vs. James Creek Shelter(26Eu843)
NW - Ander Wright (26Ek6439) vs. Mule Canyon	NOI- Mule Canyon vs. James Creek Shelter(26Eu843)
PSA- Town Creek (26Ek3783) vs. Tosawihi Quarry	DSA- Tosawihi Quarry vs. James Creek Shelter(26Eu843)
PSA - Town Creek (26Ek3783) vs. Mule Canyon	NOI- Tosawihi Quarry vs. James Creek Shelter(26Eu843)
BW- Town Creek (26Ek3783) vs. Mule Canyon	
NW - Town Creek (26Ek3783) vs. Mule Canyon	
DSA - Santa Fe (26Eu1595) vs. Mule Canyon	
DSA - Santa Fe (26Eu1595) vs. Tosawihi Quarry	
PSA - Santa Fe (26Eu1595) vs. Mule Canyon	
PSA - Santa Fe (26Eu1595) vs. Tosawihi Quarry	
NOI - Santa Fe (26Eu1595) vs. Mule Canyon	
NOI - Santa Fe (26Eu1595) vs. Tosawihi Quarry	
BW - Santa Fe (26Eu1595) vs. Mule Canyon	
BW - Santa Fe (26Eu1595) vs. Tosawihi Quarry	
NW - Santa Fe (26Eu1595) vs. Mule Canyon	
NW - Santa Fe (26Eu1595) vs. Tosawihi Quarry	
NW - Santa Fe (26Eu1595) vs. James Creek Shelter(26Eu843)	
BW - Clover Valley (26Ek2789) vs. Mule Canyon	
BW - Clover Valley (26Ek2789) vs. Tosawihi Quarry	

Table 13
COEFFICIENTS OF VARIATION FOR PROJECTILE POINT DOMINATED AND PALIMPSEST ASSEMBLAGES

		PSA	DSA	NOI	BW	NW
Humboldts	Clover Valley (26Ek2789)	NA	NA	NA	0.1760	NA
	Mule Canyon	NA	NA	NA	0.2957	NA
	Tosawihi Quarries	NA	NA	NA	0.2390	NA
Gatecliffs	Ander Wright (26Ek6439)	0.0797	0.1760	0.3386	0.1503	0.1589
	Town Creek (26Ek3783)	0.0863	0.1443	0.2453	0.1500	0.1542
	Mule Canyon	0.1579	0.1829	0.3040	0.1992	0.2525
	Tosawihi Quarries	0.1236	0.1339	0.3207	0.1753	0.1725
Elkos	Santa Fe (26Eu1595)	0.0537	0.1009	0.5741	0.1527	0.1304
	Mule Canyon	0.0926	0.1629	0.5985	0.1801	0.1944
	Tosawihi Quarries	0.0706	0.1545	0.6482	0.1669	0.1664
	James Creek Shelter (26Eu843)	0.0579	0.1039	0.5259	0.1353	0.1686

Table 14

SIGN TEST RESULTS FOR PROJECTILE POINT DOMINATED VERSUS PALIMPSEST ASSEMBLAGES COEFFICIENTS OF VARIATION COMPARISONS FOR ALL POINT STYLES

PDA vs. PA	PSA	DSA	NOI	BW	NW	Total
Ander Wright (26Ek6439) vs. Tosawihi Quarry (Gatecliffs)	-	+	+	-	-	
Ander Wright (26Ek6439) vs. Mule Canyon (Gatecliffs)	-	-	+	-	-	
Town Creek (26Ek3783) vs. Mule Canyon (Gatecliffs)	-	-	-	-	-	
Town Creek (26Ek3783) vs. Tosawihi Quarry (Gatecliffs)	-	+	-	-	-	
Santa Fe (26Eu1595) vs. Mule Canyon (Elkos)	-	-	-	-	-	
Santa Fe (26Eu1595) vs. Tosawihi Quarry (Elkos)	-	-	-	-	-	
Santa Fe (26Eu1595) vs. James Creek Shelter (26Eu843) (Elkos)	-	-	+	+	-	
Clover Valley (26Ek2789) vs. Tosawihi Quarry (Humboldts)	NA	NA	NA	-	NA	
Clover Valley (26Ek2789) vs. Mule Canyon (Humboldts)	NA	NA	NA	-	NA	
incorrect predictions/ total comparisons	0/7	2/7	3/7	1/9	0/7	6/37
p (one tailed)	0.08	0.2	0.5	0.004	0.08	0.001

- Projectile Point Dominated Assemblage Coefficient of Variation less than Palimpsest Assemblage Coefficient of Variation

+ Projectile Point Dominated Assemblage Coefficient of Variation greater than Palimpsest Assemblage Coefficient of Variation