III. A PRELIMINARY STATISTICAL ANALYSIS OF CHIPPED CRESCENTS FROM THE GREAT BASIN

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Tadlock (1966) compiled a useful study of "certain crescentic stone objects" which are found in the Great Basin and other portions of the Western United States. These artifacts, commonly called crescents, are typically found in collections of surface materials from late Pleistocene lakes and marshes in several western states (see Figure 1). Tadlock summarized reports of specimens from sites which have been dated through radiocarbon samples. He concluded that the crescents dated earlier than 7000 B.C., representing "an unidentified big-game hunting culture of the Paleo-Indian stage or has a possible range of dates between 7000 B.C. and 5000 B.C. and is associated with an unidentified combination big-game hunting and food-grinding culture of the ProtoArchaic stage " (Tadlock 1966: 672). However, Butler has suggested that these artifacts were used as scrapers, knives and gravers based on laboratory examination of wear patterns (Butler 1970: 39). Hester and Heizer (1973: 12) expressed doubt that Butler's evidence was conclusive and recommended that further testing of this hypothesis was desirable. They further reported that experiments with crescents hafted as projectile points were not wholly conclusive but did show that they could have served as projectile tips (ibid: 13).

This most recent controversy about the possible use of crescents (sometimes termed Great Basin Transverse points) suggests that more work must be done to determine the significant attributes of these objects and to relate these attributes to specific uses. This is particularly needed since these objects are considered to be a diagnostic of the Western Pluvial Lakes Tradition, an early lacustrine adaptation in the Great Basin. Crescents are found repeatedly in sites of this tradition and it has been postulated that they were used in hunting waterfowl. It is important to determine if there are significant differences in the attributes and functions of these crescent-shaped artifacts. A basic necessity in the study of functional differences is a stable typology which can be consistently applied (that is, replicated) on the basis of objective attributes.

<u>Typology</u>. Tadlock attempted to establish an objective classification system for crescents. He defined three types of crescents (see Figure 2) on the basis of what he called "attribute clusters" (Tadlock 1966: 663). His definitions of these types are as follows:

> "Type I. Quarter-moon crescent -- Crescents having concave edge and a convex edge. The convex edge is usually an uninterrupted arc; however, the body portion of the convex edge may be slightly convex to concave."

"Type II. Half-moon crescent -- Crescents having a straight edge and a convex edge. The straight edge may occur slightly convex. The convex edge is usually an uninterrupted arc; however, the body portion of the convex edge may be slightly convex to concave."

"Type III. Butterfly crescent -- Crescents having a concave edge and a convex edge with a prominent rounded notch in the center of the body portion of the concave edge. The body portion of the convex edge is slightly convex to concave." (Tadlock 1966: 663).

Tadlock clearly felt that his types were objective and easily used. However, there are some rather severe logical, practical, and statistical problems when these types are applied to other samples.

The logical problems are evident from a close rereading of Tadlock's definitions. He establishes a basic criterion of the type as a straight, convex, or concave edge and then goes on to state a condition where these can be anything between convex and concave. It seems logically inconsistent to specify an attribute as a straight edge and then grant that it may be slightly convex. Additionally, while the drawings of Type I and Type III are quite dissimilar, Tadlock's definition of these is basically the same: having a concave edge and a convex edge. The only difference is a "notch" in Type III which is lacking in Type I. Logically, Type III must be a subset of Type I or is a special variant of it.

Application of these types is difficult. Clewlow (1968: 9) observed that "the Type III specimens from NV-Hu-17 locality 1 do not display this notch", but did have a flat or concave back edge. Clewlow thus was led to interpret the strict definitions in a way which may well be inconsistent with Tadlock's original usage.

Clewlow also classed a number of crescent-shaped artifacts as scrapers and excluded them from his sample of Great Basin Transverse points. This was done on the basis of their not displaying "true symmetry bilaterally" and lack of bifacial pressure flaking and parallel flaking (Clewlow 1968: 10). Yet some of the scrapers he illustrates (op. cit., Plate 5) are more bilaterally symmetrical than the Great Basin Transverse points shown in his Plates 3 and 4 (op. cit.: 85-86). Additionally, Clewlow (1968: 12) excludes "two unusual bipointed objects" because they are thick and biconvex in cross section and were probably made by percussion rather than pressure flaking. Yet these objects have a very similar appearance to many crescents (Clewlow 1968: 84, Plate 1s, t), and one of these specimens is ground on its convex edge, as are many of the crescents. Thus, Clewlow appears to exclude many crescent-shaped artifacts from any comparisons, largely because of his subjective feeling that they are not Great Basin Transverse points. This type of subjective exclusion of artifacts from consideration because they do not fit a particular preconception of a possible usage prejudices any scientific attempt to discover true variations within discrete artifact classes.

Even Tadlock seemed to have difficulty in applying his own classification system for crescents. In the photographs of the Long Valley Lake crescents, his application of the types does not appear to be consistent (Tadlock 1966: 666-667). Morphologically, the specimens shown in Tadlock's Figure 3p and q, which are classed as Type I, more closely resemble the specimens shown as Figure 4c, d, and e, which are classed as Type II, than they do the other Type I specimens. Additionally, the specimens shown in Tadlock's Figure 3i has a concave upper edge and a concave body on the lower edge, much like the Type III specimens and yet it is included with Type I specimens, none of which appear to have a concave lower edge. All of this suggests that Tadlock's typing of specimens was, like Clewlow's, to some degree very subjective. Although he states that his types are based on objective attributes, it appears that Tadlock has used considerable latitude in applying his categories.

Additionally, using the sample of 27 crescents from Long Valley Lake, Tadlock has derived average characteristics for his three types (1966: 663-664). Statistically, this is an extremely small sample with which to validate a typology. Since only four specimens are shown as Type III, it is questionable if this limited sample can truly represent the universal population of all Type III crescents. Thus, when Tadlock concludes that the average weight for Type III crescents is 12.8 grams versus 6.4 grams for Types I and II, there is some question as to the applicability of this conclusion beyond this one sample. Since this is further compounded by the subjectivity of classifying specimens, as discussed earlier, we must conclude that there are some severe problems in accepting the validity of these types.

Statistical Comparison of Types of Crescents. To further check the validity of Tadlock's typology, data on an additional sample of crescents were obtained. This sample consisted of available specimens in the Lowie Museum of Anthropology, Berkeley, and includes some complete crescents from sites NV-Hu-17, NV-Hu-20, and NV-Hu-22 as well as data from specimens in the Mudge and the Durban private collections. All are from the Black Rock Desert area of Humboldt County, Nevada. This area and many of the specimens described here were described by Clewlow (1968). Of the 33 complete specimens recorded, 27 could be classified using Tadlock's typology. The remaining specimens in the Lowie Museum collections were too fragmentary or too irregular to be firmly classified.

Some differences in these specimens and those reported by Tadlock were immediately apparent. Tadlock (1966: 663-664) reported smoothing on all specimens and nipples on both edges for most of his specimens. Smoothing was present only on some of the new sample and nipples were not observed at all. On some specimens, smoothing was on one or two edges, some being smoothed on both edges, and some were not smoothed at all. This sharply contrasts with Tadlock's report where smoothing was reported on both edges of all specimens.

Thirteen of the specimens in this sample can be placed in Tadlock's Type I, 11 in Type II, and 3 in Type III. Average metric measurements of these specimens are given in Table 1 below. Following the practice of Clewlow (1968: 8), length is given as the measurement of the longest axis of the specimen and thus is what Tadlock gives as "width". The measurement shown as width in this study is what Tadlock reports as "length". All measurements except weight are given in millimeters; weight is in grams.

TABLE 1

Mean Data for Complete Black Rock Desert Crescents

Type	N	Length	Width	Thickness	Weight
I	13	47.0	17.3	5.24	5.89
II	11	53.36	18.05	5.409	6.8
III	3	52.0	20.0	4.2	5.9

It is obvious from these data that there are not the marked differences in weight and thickness which are reported in the specimens used in Tadlock's study. However, the best scientific way to make such judgments is through the application of appropriate statistical tests.

This is typically done by hypothesis testing. Normally, when comparing means, the null hypothesis is stated that there is no difference in average measurements for a given variable. By applying an appropriate statistical test, this null hypothesis can be accepted or rejected. In this particular case, we have a variety of attribute measurements and three postulated types. It is appropriate to compare each type against each other type on each variable. In this way, we ask the question: Is there enough difference in the average measurement (of length, width, etc.) so that we can say these are different types? If the difference is large enough (for a given sample size), then the null hypothesis can be rejected and we can be reasonably confident that the specimens do represent different types.

In such a comparison of independent means, the appropriate test of significance is a t-test:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\dfrac{\Sigma X_1^2 - \dfrac{(\Sigma X_1)^2}{N_1} + \Sigma X_2^2 - \dfrac{(\Sigma X_2)^2}{N_2}}{(N_1 + N_2 - 2)} \cdot \dfrac{1}{N_1} + \dfrac{1}{N_2}}$$

(Bruning and Kintz 1968: 10)

where: $\bar{X}$ = group means

ΣX^2 = sum of squared values

$(\Sigma X)^2$ = square of summed values

N = number of specimens in group

This test is basically a comparison between the difference in the means of two independent groups and the variations within each group corrected for sample size. If these two calculations are about the same, then the final t-value will approximate 1 or less and we will not be able to say that the groups are significantly different. To determine if a given level of significance is reached (.01 and .05 are normally accepted levels), reference is made to a table of t-values such as that of Ostle (1963: 528), for the level of significance at a given degree of freedom.

This type of test is greatly affected by sample size (N) and requires a very large difference to establish significant differences when the sample size is small.

Type I crescents were compared with Type II specimens on each of the four variables. Additionally, Type II was compared with Type III and Type I was compared with Type III. Resultant t-values are shown in Table 2.

Table 2

t-values Comparing Types I, II, and III

Comparison	Length	Width	Thickness	Weight	df*
I vs II	1.2634	1.0449	.2410	.6926	22
II vs III	.1628	1.433	1.118	.3834	12
I vs III	.7966	1.518	1.060	.0042	14

*df = degrees of freedom

None of these values is significant at the .05 level. The largest t-value was for the comparision of width between Types I and III, which resulted in a value of 1.518. However, a value of 1.761 is needed to establish that a significant difference exists with 14 df. Thus, in all of these comparisons, we are unable to reject the null hypothesis (i.e., that there is no difference).

This comparison is hindered by a number of factors. The most meaningful is the same problem which was mentioned earlier with Tadlock's study and small sample size. As the number of specimens increases, the differences in mean value is more readily established as a significant difference. Thus with two samples of 100 specimens each, if the mean values for length, width, or thickness were four or five millimeters, we could probably find that there was a real difference between the two groups. In the present case where there are only a few specimens, it is impossible to establish that any real difference exists. The visible difference in the means may just be a function of sampling.

An additional possibility is that there is no actual difference in these types; that is, that this particular classification scheme is not sufficiently discriminating to show any real differences. As indicated earlier, Tadlock's application of his typology was not consistent and some specimens he called Type I resembled his Type II specimens. Thus, there is a distinct possibility that differences which might exist are "hidden" by the way the specimens were grouped.

This leads us to two basic questions about crescents:

1. Do crescents have any significant variance?
2. Are there "types" of crescents which can be rigorously defined?

One natural approach to answering the first of these questions is to examine the variation in crescents between sites. Obviously, if there are functional, temporal, or even merely stylistic differences in crescents, this would probably be more visible between sites than within any given site.

Comparison Between Sites. The data published by Tadlock on 29 specimens from Long Valley Lake provides one source of data for between-site comparisons. Since he has included measurements for all specimens, it is possible to statistically compare these crescents with data developed from other sources (Tadlock 1966: 664, Table 1).

A second sample of crescents, in the collection of Jack Nicolarsen (Reno) from the Black Rock Desert area of Humboldt County, Nevada, provides another series for comparison. The specimens are from a site on the eastern edge of the Black Rock Desert which is situated between the Quinn River and a local landmark known as "MacFarland's Bathhouse". Clewlow (1968: Map 2) shows site NV-Hu-16 in this vicinity. However, the site from which these Nicolarsen crescents were collected lies to the west of NV-Hu-16, closer to the Quinn River (Hester 1976).

A comparison of the Long Valley crescents and the most complete specimens in the Nicolarsen collection is shown in Table 3. As noted earlier, the length and width measurements shown by Tadlock have been transposed to facilitate comparisons with other reports.

Table 3

Comparison of Crescents from Long Valley Lake and the Nicolarsen Collection

	N	Length	Width	Thickness	Weight
Long Valley	29	52.8620	19.6552	5.2931	7.0828
Nicolarsen	38	50.1315	19.5	5.4737	6.1895
t-value		1.326	.1945	.6455	1.1448

None of these t-values is significant at .05 with 65 df. Thus we cannot reject the null hypothesis and must assume that they represent the same population. Since these samples total 67 specimens, this comparison is rather surprising, particularly since the samples are from the opposite sides of the state of Nevada.

To check further, the Nicolarsen specimens were compared with the 20 complete crescents from NV-Hu-17. These latter specimens were included in the original 33 crescents used as the source of the earlier Between-Type comparison. They are used separately here since they represent the largest subset of that grouping, thus providing a large enough sample to make a statistical comparison worthwhile. The results of the comparison between the Nicolarsen crescents and those from NV-Hu-17 are given in Table 4.

Table 4

Comparison of Nicolarsen and NV-Hu-17 Crescents

	N	Length	Width	Thickness	Weight
Nicolarsen	38	50.1315	19.5	5.4737	6.1895
NV-Hu-17	20	50.37	17.6	5.26	6.435
t-value		.0919	2.221*	.6956	.0325

*Significant at .05 with 56 df.

As can be seen from the data in Table 4, the measurements for length, thickness, and weight are very close between the sites. However, there is a significant difference in the width of specimens from the two sites. Since the mean width from the Long Valley specimens shown in Table 3 was greater than the mean width for the Nicolarsen crescents, we can readily see that the NV-Hu-17 specimens are also significantly different in average width from the Long Valley specimens reported by Tadlock.

This difference becomes more striking when we observe that the Nicolarsen specimens are from the same general area as are those from NV-Hu-17; in fact, the sites are less than three miles apart and are separated only by the Quinn River. It is interesting to find that specimens from sites so closely related geographically vary significantly from one another whereas in the earlier comparison, there was no significant differences between collections from two sites (Long Valley; Nicolarsen) at opposite sides of the state. These results strongly suggest that while there is a general similarity between crescents over a wide geographic area, there are differences in crescents within this specific area which merit close attention.

To examine this variance further, Table 5 summarizes measurement data for all of the complete Black Rock Desert crescents.

Table 5

Mean Measurements for Complete Black Rock Desert Crescents

Site/collection*	N	Length	Width	Thickness	Weight
Mudge Coll.	1	57.0	16.0	5.5	7.5
Durban Coll.	3	52.67	19.67	5.67	7.0
NV-Hu-17	20	50.37	17.6	5.26	6.4
Nicolarsen Coll.	38	50.1315	19.5	5.4737	6.1895
NV-Hu-20	4	38.5	13.0	3.87	3.0
NV-Hu-22	5	38.2	14.2	3.8	3.08

*All specimens listed here, except the 38 from the Nicolarsen Coll. are in the Lowie Museum of Anthropology.

The larger groups of these crescents have already been compared. The other groups are such small samples that a statistical test becomes difficult to use and tenuous to interpret. However, even direct visual comparison of these data suggests that there may be meaningful differences between these sites. Clearly, NV-Hu-20 and NV-Hu-22 crescents more closely resemble one another than they do NV-Hu-17 or the Nicolarsen crescents. Their mean length, width, thickness and weight are all consistently below those of the other specimens. If these mean values are indicative of what the values would be if larger samples were collected from these sites, then the NV-Hu-20 and NV-Hu-22 crescents would undoubtedly be significantly different from the other Black Rock Desert specimens and also different from those reported by Tadlock from the Long Valley Lake area. For the location of NV-Hu-20 and NV-Hu-22, see Clewlow (1968: Map 2).

Obviously, even from these limited data, we can see that some differences do do exist. Yet the data do not suggest whether these differences are the result of different uses for crescents at the various sites, or if they are only stylistic variation of different craftsmen. The variations could well be the result of differences in the raw materials available for crescent manufacture or in the age of the sites.

It is difficult to find correlated differences in other variables for these sites. The major difference in types of projectile point reported by Clewlow for these sites seems to be the presence of a Clovis point at NV-Hu-17, while Lind Coulee points were present at NV-Hu-22 (Clewlow 1968: 6-37). Other point types at these sites were much the same and are representative of a variety of different time periods.

The fact that there are substantial differences in the average measurements for crescents between the various Black Rock Desert sites does suggest the desirability of further analysis. As has been demonstrated earlier, Tadlock's types could not be cross validated with complete specimens available for study in Berkeley from the Black Rock Desert area. Yet some kind of typology is needed in order to show any patterns of types or systematic variation between these sites. Thus a more discriminating typology must be developed to facilitate further study of crescents.

A Revised Typology. Tadlock's basic idea of using the shape of the inner and outer edges of various crescents as the basis for a typology still appears to be a sound one. As has been previously noted, the major problem with his system was an overlapping of definitions and the judgmental broadening of his categories so that on occasion they contradicted the basic definitions.

An attempt is made here to revise and expand his typology to provide more categories or types, and to define these types in clearly objective terms. This suggested descriptive typology is illustrated in Figure 3. Definitions for these types are as follows:

Semi-biconvex: Two convex edges with one more convex than the other.
Planoconvex: Upper edge flat; lower (outer) edge convex.
Concavoconvex: Upper (inner) edge concave; lower (outer) edge convex.
Concavoplano: Upper (inner) edge concave; lower (outer) edge straight.
Biplano: Both edges straight.
Semi-biconcave: Both edges somewhat concave.
Biconcave: Both edges markedly concave.

These terms are normally used in optics to describe lenses. They are descriptive in their own right but have been adapted slightly here to fit this new use.

It is obvious that there is a wide spectrum of possibilities of shapes and certainly all of the possibilities have not been exhausted here. It is also obvious that these types can be defined mathematically in terms of planes, curves, and angles. Additionally, they could be described using midbody-width to tip-width ratios, and other measurable characteristics. We will still have difficulty classifying some specimens, particularly those which are crude, asymmetrical, or severely damaged. Nonetheless, this greater number of types we believe provides a better opportunity to demonstrate variation in crescents across time, geographic area, or because of differential usage.

These categories could be either expanded further or collapsed. For example, the Semi-biconcave and Biconcave types differ only in the degree of concavity. There is no line of separation between these types. They are postulated here only to demonstrate how extreme cases can be isolated for study. The Biconcave type does not occur in the Black Rock Desert area collections but has been seen in specimens collected from the Borax Lake region of northcentral California (Harrington 1948). This type should be continued until it is determined where these extreme specimens occur. If Tadlock's hypothesis of the California crescents being later in time than the Great Basin examples is correct, it may be possible to show that these extreme Biconcave specimens are a late elaboration of the basic crescent pattern.

It is also obvious that this list does not exhaust the list of possible types. Some additional possibilities are shown in Figure 4. Strong (1959:161) has observed that such biconvex pieces would be called points or knives and thus would not ordinarily be compared with objects classed as crescents.

The Convexplano and Planoconcave possibilities may also exist but again, these would not usually be compared with crescents. It will be interesting to see these classes of objects either verified or discarded sometime in future. Through the establishment, testing, and discarding of additional types, much can be learned about crescents -- and the other objects as well.

One additional kind of crescent, not considered here, is the "eccentric" form. Such specimens have a general "crescent" configuration, but are chipped into odd shapes, some perhaps being zoomorphic representations (Harrington 1948; Beck 1971).

Distribution of the Revised Types. Using this revised typology, the specimens reported by Tadlock and those available to us from Black Rock Desert sites were classified and the distribution of these revised types is shown in Table 6.

Also included are four specimens from the Borax Lake site in California, two or which have been noted earlier as extreme cases. These four specimens are now in the Southwest Museum in Los Angeles and metric measurements were not readily available. These Borax Lake crescents led Tadlock (1966: 673) to hypothesize an early "ProtoArchaic" stage which antedates the Windmiller Culture (formerly Central California Early Horizon). Meighan and Haynes (1968, 1970) have reassessed the geology of the Borax Lake site and carried out obsidian hydration analyses of a number of artifacts, concluding that the site may be as old as 12,000 years.

Table 6

Distribution of Crescents by Type

Type Name	Long Valley* Lake Site	Nicolarsen Coll.	Humboldt** County	Mudge Coll.	Durban Coll.	Borax Lake	Total
Semi-biconvex	1	1	2	0	0	0	4
Planoconvex	7	9	11	3	1	1	32
Concavoconvex	13	25	45	33	12	1	129
Concavoplano	2	21	14	6	4	0	47
Biplano	2	6	6	2	0	0	16
Semi-biconcave	4	5	4	1	0	0	14
Biconcave	0	0	0	0	0	2	2
Total	29	67	82	45	17	4	244

* Judged from photographs in Tadlock 1966: 666-667.
** Includes sites NV-Hu-17, NV-Hu-20, NV-Hu-22. These and the samples from the Mudge and Durban collections are in the Lowie Museum.

The specimens shown in this distribution include many which are not complete and thus any comparison of attribute measurements is not possible. For this reason, and because of the very small sample size of some types, no further statistical tests of significance were performed. Such tests must await a further sampling of complete specimens and should be included with a more rigorously controlled classification of crescents to be used for a complete analysis of variance.

It is noteworthy that the Concavoconvex specimens, from which this whole class of objects takes its name, make up 53% of the total sample of 244 crescents. The proportion of Concavoconvex specimens to total sample for each site varies from 37% with the Nicolarsen collection to 73% in the Mudge collection (Borax Lake is excluded since only four of the eleven crescents Tadlock mentions from that site are available for study). The appearance of other types also varies markedly from site to site but this may well be a function of the interest of the collector or sampling error rather than any real difference in occurrence. Only when a sufficient number of sites producing crescents have been excavated or control-collected and studied can a realistic estimate of between-site occurrences of types of crescents be established.

It is important to note, however, that the Planoconvex and Concavoplano types do occur at all the Black Rock Desert sites in fairly sizable numbers. Their frequency of occurrence gives credence to their existence as separate types. The other types do not occur in all locations and do not have any consistent proportion across the samples.

While there can be no statistical test of within-site difference because of the small number of complete specimens, it is worthwhile to examine the mean values to see possible sources of variance. This can help to determine if future studies of within- and between-site variation of crescents would be worthwhile.

A summary of measurements by type for the Nicolarsen specimens is given in Table 7. In order to examine another source of variation, percentage of smoothing is also shown. This is derived from notes on these specimens where length of smoothing on the edges was recorded. Comparison of the measurements of smoothing does not appear fruitful here, since the length of smoothing is often not measurable due to the broken condition of some specimens. However, it does appear worthwhile to examine the relative occurrence of the smoothing trait across specimens since this can be determined even when the crescent is not complete. It is interesting that smoothing does not occur in all specimens, as would be suggested by Tadlock's study where length of smoothing is shown for all examples (Tadlock 1966: 664, Table 1). Rather, in the present sample, some specimens are smoothed on only one edge, some are smoothed on both edges, and some are not smoothed at all.

Table 7

Mean Data for the Nicolarsen Crescents

Type	N	Length	Width	Thick.	Weight	Smoothing			
						% upper	% lower	% both	% none
Semi-biconvex	1	43.0	19.0	5.0	4.8	0	0	0	100
Planoconvex	9	57.0	18.66	5.44	5.48	22	0	0	78
Concavoconvex	25	50.08	19.64	5.78	6.77	48	0	0	52
Concavoplano	21	51.33	20.14	5.33	5.40	33	0	19	48
Biplano	6	47.10	19.80	5.0	5.62	33	0	17	50
Semi-biconcave	5	58.0	18.80	5.6	6.32	40	0	20	40
Biconcave	0	0	0	0	0	0	0	0	0

Several very interesting trends emerge from these data. While a comparison of length and weight is unrealistic since partial specimens are included, the measurement for width and thickness should be relatively accurate. These measurements show very little variance. However, the differences which are visible are not necessarily in the direction expected. For example, we might expect the Planoconvex and Semi-biconvex pieces to be wider than other types, especially so for the Concavoconvex, which appears to be the basic type. However, this does not appear to be the case in this sample. Rather, it would appear that the Semi-biconvex and Planoconvex types are actually less wide and less thick on the average than the Concavoconvex type. Additionally, smoothing is present in less than half the specimens in most of the types. Of those which are smoothed, most are smoothed only on the upper surface and, in the case of the Concavoconvex type and Planoconvex type, no cases were observed where the crescent was smoothed on both edges.

Interestingly enough, the smoothing characteristics of the Concavoplano, Biplano, and Semi-biconcave types appear to be remarkably similar even though there are differences in the mean attribute measurements of these types. This clustering of the smoothing characteristics for these three types could be taken to indicate that this is a type cluster, rather than three distinct types. If this relationship is encountered consistently across sites, this may indicate that these three categories are subtypes within a more generic class (as would be the Biconcave, which is not present in this sample). While length of smoothing measurements are not available for all collections, it was possible to study these data with the Nicolarsen crescents. Mean length of smoothing on the upper edge for 29 specimens was 9.53 mm with a range of 6 mm to 19 mm. For 6 specimens with smoothing on the lower edge, mean length of smoothing was 9.33 mm with a range of 8 mm to 12 mm. The smoothed portion of the edge was normally in the middle of the edge, as would be expected if these artifacts were hafted. Occasionally, the smoothing is slightly off center.

Differential weights between these three types suggests that the Semi-biconcave type is considerably heavier than the other two types. Since these data are based on some partial specimens, no firm conclusion can be drawn. But the pattern of attribute variation within a generic class for a specific site warrants further attention as large samples become available for study.

Table 8 presents summary data on materials in Lowie Museum from the Humboldt County sites (NV-Hu-17/20/22). Since it represents a fairly large sample size, it deserves special attention. As noted earlier, only 33 of these pieces are complete.

Table 8

Mean Data for NV-Hu-17/20/22 Crescents

Type	N	Length	Width	Thick.	Weight	Smoothing			
						% upper	% lower	% both	% none
Semi-biconvex	2	36.0	22.0	8.50	4.20	50	0	0	50
Planoconvex	11	41.13	20.90	4.86	5.15	0	27	27	46
Concavoconvex	45	41.47	17.0	5.26	5.12	22	4	40	44
Concavoplano	14	44.78	17.75	4.68	5.22	7	22	57	14
Biplano	6	42.08	18.08	4.83	4.30	0	33	50	17
Semi-biconcave	4	43.25	20.25	4.12	5.20	0	25	50	25
Biconcave	0	0	0	0	0	0	0	0	0

Here the Planoconvex specimens are wider than the Concavoconvex ones which contradicts the trend in the Nicolarsen collection specimens presented in Table 7. As was the case with the Nicolarsen Planoconvex crescents, the thickness is less than for the Concavoconvex, but this may or may not be a significant difference. Smoothing is present more often in all types than was the case with the Nicolarsen collection. Another difference in smoothing is that while the Nicolarsen specimens were seldom smoothed on both edges, in this sample, smoothing, when it is present, occurs most often on both the upper and lower edges. While there were no cases of smoothing only on the lower edge in the Nicolarsen specimens, this is apparently a fairly common characteristic in this sample.

Since we believe that smoothing on the edges would most probably be a function of the hafting process, it is quite possible that many of the NV-Hu-17/20/22 crescents were hafted differently than those in the Nicolarsen collection. This could well represent differential ages of occupation of these sites or it might be accountable for as variation in use of these artifacts at the different locations.

As was the case in the Nicolarsen collection data, the smoothing characteristics of the Concavoplano, Biplano, and Semi-biconcave specimens seem to cluster, although they do not have the same pattern as was observed earlier. Again, this suggests subtypes within a generic class, but makes the problem more complex since the smoothing is different (no smoothing on upper edge where this was frequent in the Nicolarsen specimens). Again, this may represent differences which are the result of different hafting practices.

As noted earlier, since the majority of these specimens are broken, it is very deceptive to look at mean length and weight for this entire collection. However, the marked difference in length in the sample and for the Nicolarsen specimens shown in Table 7, deserves comment. Mean length for the NV-Hu-17/20/22 specimens clusters in the lower 40 mm range whereas most of the mean lengths for Nicolarsen specimens are around 50 mm. Yet by reference to Table 5, we can see that within the NV-Hu-17/20/22 specimens, there are marked site differences. While these sites have been grouped together in Table 8 to present a larger sample size, the differences in Table 5 strongly suggest that each of these sites should be considered separately. The differences between these three sites in terms of types, measurements, and smoothing may help to clarify the real characteristics. However, such a study should be detailed enough to highlight all sources of variance within the crescent population. Such an exhaustive examination is beyond the scope of the present study and must await a further refinement of attributes and other variables to be considered.

Data for the Mudge collection in Lowie Museum are summarized in Table 9.

Table 9

Mean Data for the Mudge Collection Crescents

Type	N	Length	Width	Thick.	Weight	Smoothing			
						% upper	% lower	% both	% none
Semi-biconvex	0	0	0	0	0	0	0	0	0
Planoconvex	3	27.66	13.66	4.66	2.03	0	0	33	67
Concavoconvex	33	33.70	16.91	5.21	4.10	18	0	48	34
Concavoplano	6	34.50	15.0	5.75	3.61	33	0	33	34
Biplano	2	26.0	20.0	5.25	3.20	50	0	50	0
Semi-biconcave	1	27.0	19.0	4.0	2.50	0	0	100	0
Biconcave	0	0	0	0	0	0	0	0	0

The majority of the Mudge crescents are fragmentary so that the mean weight and length, which are markedly less than for other samples, are not an accurate estimate of any true variation. The one complete specimen from the Mudge collection had a length of 57 mm and weighed 7.5 grams, which was quite comparable to the complete specimens from other sites.

While most specimens are fragmentary, the data for width and thickness should still be relatively accurate. The previously noted phenomenon of the Planoconvex crescents in the Nicolarsen collection being less wide than the Concavoconvex crescents and thinner, also appears to be true in the Mudge collection. This pattern tends to suggest that the Planoconvex crescents in some collections are indeed smaller, thinner, and probably lighter than most crescents. If this is so, it may reflect a different use for this type of crescent at these sites. However, the variation in edge smoothing among these specimens precludes a firm designation of these crescents as scrapers (as Clewlow has done) until a more sophisticated study determines their most probable usage. But we do have enough of a pattern of systematic variation to raise some questions about different uses of a specific type at different sites.

The smoothing characteristics of the Mudge crescents do not cluster in the same way as was noted in the Nicolarsen collection and sites NV-Hu-17/20/22 specimens. This may be due to the very small sample of the Concavoplano, Biplano, and Semi-biconcave crescents. It is noteworthy, however, that the absence of any specimen with smoothing only on the lower edge mirrors the data from the Nicolarsen specimens. Thus, in smoothing, the Mudge collection has greater similarity to the Nicolarsen collection crescents and is quite different from the NV-Hu-17/20/22 specimens.

The Durban collection materials in Lowie Museum from the Black Rock Desert area are summarized in Table 10.

Table 10

Mean Data for the Durban Crescents

Type	N	Length	Width	Thick.	Weight	Smoothing			
						% upper	% lower	% both	% none
Semi-biconvex	0	0	0	0	0	0	0	0	0
Planoconvex	1	55.0	21.0	6.0	7.7	100	0	0	0
Concavoconvex	12	35.25	17.16	5.37	4.49	8	8	58	26
Concavoplano	4	46.2	17.2	5.38	5.8	25	0	75	0
Biplano	0	0	0	0	0	0	0	0	0
Semi-biconcave	0	0	0	0	0	0	0	0	0
Biconcave	0	0	0	0	0	0	0	0	0

Again, the pattern seen in the Nicolarsen and Mudge collection crescents where Planoconvex crescents are less wide and thinner than Concavoconvex crescents does not appear in the Durban collection. Thus, out of four samples, two vary in one direction and two vary in the opposite way. From present data and from such small samples, nothing conclusive can be determined. However, this does establish a question which needs to be answered in future research.

The Durban collection is such a small sample that it is also very difficult to establish any definitive pattern of smoothing, since any pattern would most likely reflect an error of sampling. The presence of some specimens with smoothing on only the lower edge suggests that this sample may be more similar to the NV-Hu-17/20/22 specimens. As noted earlier, differences in the patterns of smoothing may suggest variations in hafting methods or could be merely stylistic variations. The available data suggest that each site is somewhat different in percentage of smoothed pieces, which hints at great variability between sites.

To examine the variation in sites further, a study of breakage patterns of crescents was undertaken.

Breakage Patterns. To study breakage patterns, we must be somewhat concerned with the possible methods of hafting crescents. Clewlow has presented two possibilities for hafting as shown here in Figure 5. The basic premise to be examined here is that if the crescents were hafted with the pointed tips forward (Fig. 5a) then we could reasonably expect that most breakage should be in the tips of the specimens. If hafting was done with the tips back, as postulated in Figure 5b, then breakage should be in the body of the crescents.

Terminology of the parts of the crescents is provided in Figure 6. Using this illustration as a guide, all specimens were grouped into categories of breakage patterns and percentages were calculated. A summary of the resulting data are presented in Table 11.

Table 11

Comparison of Breakage of Black Rock Desert Area Crescents

Site	N	Tip	Wing	Body	Whole	Uncertain
NV-Hu-17/20/22	81	20%	30%	11%	36%	3%
Nicolarsen Coll.	67	41%	11%	0%	46%	2%
Mudge Coll.	45	22%	48%	28%	2%	0
Durban Coll.	17	25%	35%	15%	25%	0

While there is considerable variation between sites, the overall pattern suggests that few specimens are broken in the body of the crescent. This implies that the "tips-back" hafting method suggested by Rogers (1929) and Clewlow (1968), (Figure 5b, this paper), is highly unlikely. The higher percentage of tip breaks in the Nicolarsen specimens may be a result of sampling or may suggest that more of these crescents may have been hafted tip-forward, as alternatively suggested by Rogers and Clewlow (Figure 5a, this paper). However, none of the percentages reflect a clear majority of breakage types. While all of this may be taken as evidence of variation in hafting practices, actual proof would have to be shown through experimental evidence based on a large number of test examples. This could be done by observing the types of breakage occurring when crescents are hafted in various ways and actually impacted while attached to a dart thrown with an atlatl.

While the data on breakage are not clearcut, there are differences between the Nicolarsen specimens breakage patterns and breakage in pieces from the other sites. This may indicate that some significant variation in hafting or usage of crescents exists between the Nicolarsen collection pieces and the other specimens. As shown earlier, the Nicolarsen crescents also show differences in smoothing patterns, no instances of examples noted as having been smoothed only on the lower edge. If crescents were hafted as shown in Figure 5a, the upper or inner edge would need to be smoothed in some way to protect the lashings. Since almost half of the Nicolarsen crescents were smoothed only on the upper edge, and since slightly less than half of the Nicolarsen collection pieces are broken on the tips, it is very tempting to conclude that the specimens were hafted in this mode and were used as projectile points. However, that conclusion cannot be firmly drawn at this time. It must wait experimental demonstration of what breakage patterns occur when crescents are hafted in the different modes, and actually put to use.

Conclusions. The evidence seen in this study does not establish that there is any single function or style of crescents. Rather, the variation in attributes between sites, and in some cases between types, suggests that there may well have been a number of ways in which crescents were used. If, like fluted points, these objects were made with only one use in mind or with only one basic hafting method, then we could expect much more consistent patterns to emerge from the data. The very mixed result of the tabulations and comparisons presented here strongly suggests the possibility of multiple uses for crescents as well as variable hafting methods (i.e., for those which were hafted). It may well be that research on crescents has not yet examined those variables or attributes which would clearly indicate what the various functions of these artifacts actually were. For example, in studying the Nicolarsen collection crescents, it was observed that most of the specimens were thicker along the lower edge and were mostly planoconvex in cross section. The evidence of a thicker lower edge, when associated with the smoothing patterns and breakage patterns of the Nicolarsen specimens, may be further evidence of tips-forward hafting and their use as projectile points to stun waterfowl. The observation that most of the specimens are planoconvex in cross section may hint at other uses of these objects or may simply reflect flaking techniques.

There is enough systematic variation in the data to suggest a need to study other possible uses for crescents. A number of alternate hypotheses need to be formulated and tested before probable uses can be verified. For example, it is possible that some crescents were hafted as a long-handled knife for use in close hunting or in self defense. Such a weapon would be extremely useful to its owner and, if hafted tips-forward, this could also explain the breakage patterns seen on some specimens. Some crescents may have been knives, as suggested by Butler (1970), or scrapers, as suggested by Clewlow (1968). Certainly, these alternatives would help to explain the variance seen in the specimens examined in this study. Only through experimental testing and further data analysis on larger numbers of specimens and sites will we be able to discern which of these possibilities are the most probable.

These various possibilities do raise the question of proper terminology. Since no direct evidence has clearly established the use of crescents, the use of the name "Great Basin Transverse Points" is perhaps premature. Since there are other uses which would account for much of the indirect evidence, final adoption of the name should await a more definitive study or at least the discovery of some direct evidence. Thus, for the present, the name "crescent" is preferable.

This study has not resulted in answers to many of the basic questions about crescents. Rather, there appear to be more questions to be answered than previously, due to the demonstration of inter-site and possibly inter-type variation. It is clear, however, that a more descriptive system of classification and a more complete recording of attributes is necessary if future research is to examine the true variation in patterns. Since the descriptive typology developed here is based largely on objective data, it is recommended that sufficient data be recorded to clearly establish the type of crescent. This is much to be preferred over the continued use of the very subjective classification of crescents which has been employed in the past. Data needed for this purpose are shown in Figure 7.

Only when a large number of crescents from a variety of sites have been studied and typed will it be possible to validate the descriptive typology presented in this study and determine systematic variation in types between sites. Hopefully, meaningful variations can then be fully substantiated. Likewise, a substantial sample from a series of firmly dated sites is needed if temporal variations in types and uses of crescents are to be determined. While Tadlock (1966) has demonstrated the possible range of dates for crescents in the western United States, he could not say with confidence whether crescents were late Paleo-Indian or ProtoArchaic; Hester (1973) places them in the Western Pluvial Lakes Tradition dating from 6000 to 9000 B.C. With a sufficient number of specimens from stratified and dated sites, it should be possible to properly demonstrate variations in crescents over the apparently long span of time during which they were used.

Acknowledgments. The senior author wishes to acknowledge the crucial role of Paula Rosa and Stanley Castagnetto for their collection of data for this report while undergraduate students at the University of California, Berkeley, in the Spring of 1973. However, they should not be held responsible for the inferences drawn in the final report. These inferences and conclusions are the responsibility of the senior author, who prepared this paper during the Fall of 1973 while enrolled in Anthropology 533 at The University of Texas at San Antonio, under Dr. T.R. Hester. Dr. Hester provided the data, the references, the encouragement, and the editing required to make this study a reality.

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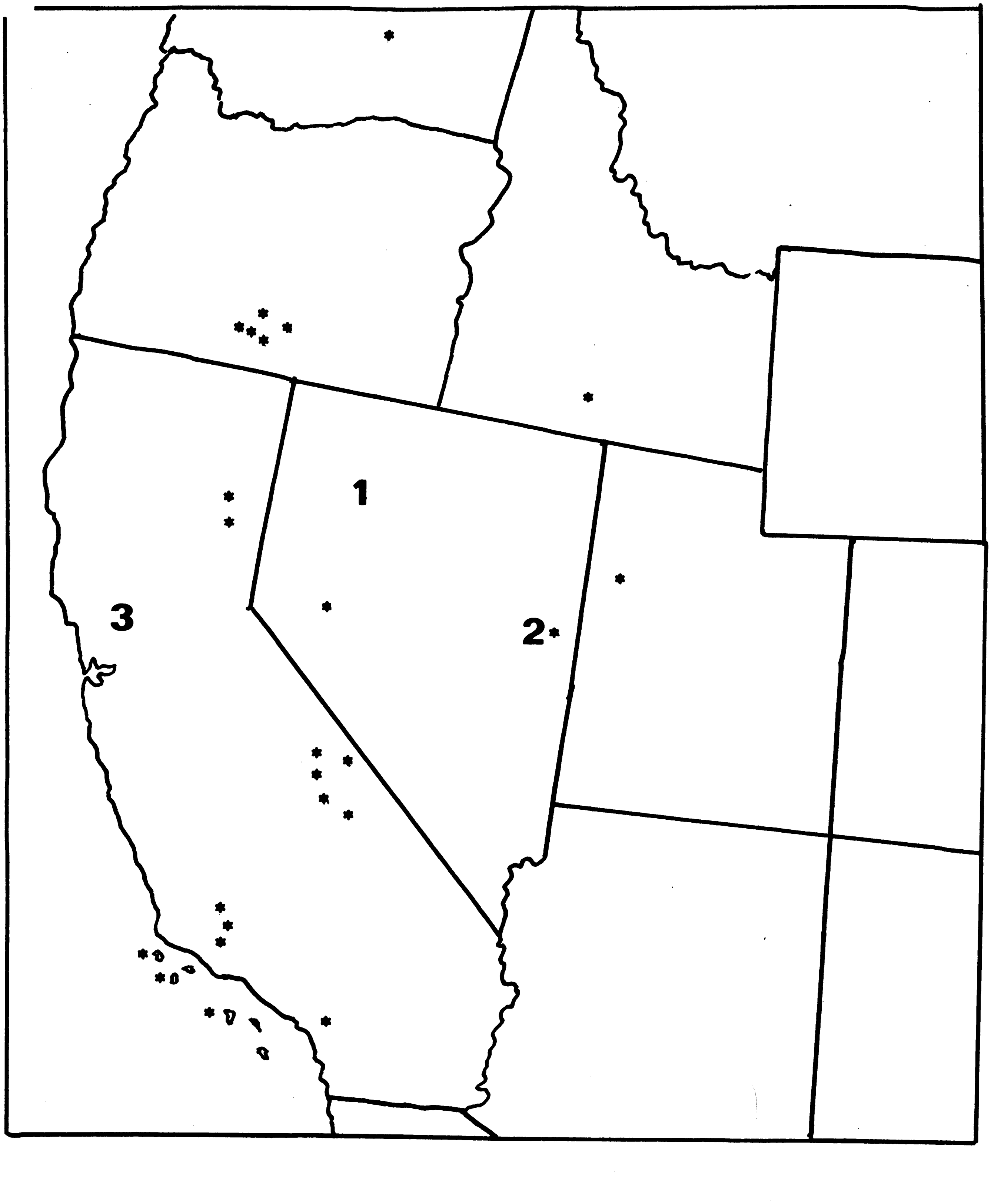

Figure 1. Western United States showing sites discussed in the present paper. 1, Black Rock Desert, Humboldt County, Nevada; 2, Long Valley site, Nevada; 3, Borax Lake site, Lake County, California. Stars indicate other sites where crescents have been reported. Adapted from Tadlock 1966: 665.

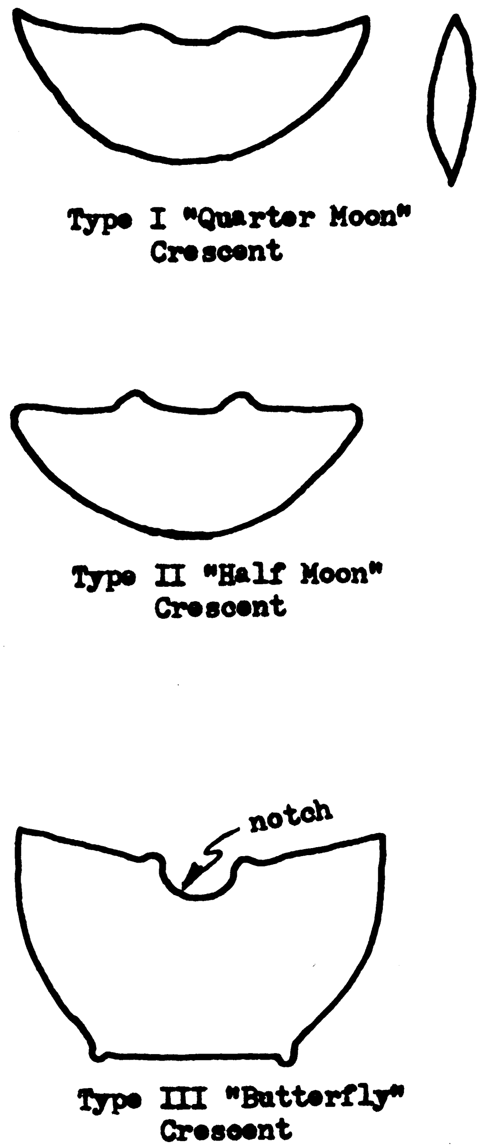

Figure 2. Tadlock's typology for crescents (Tadlock 1966: 663).

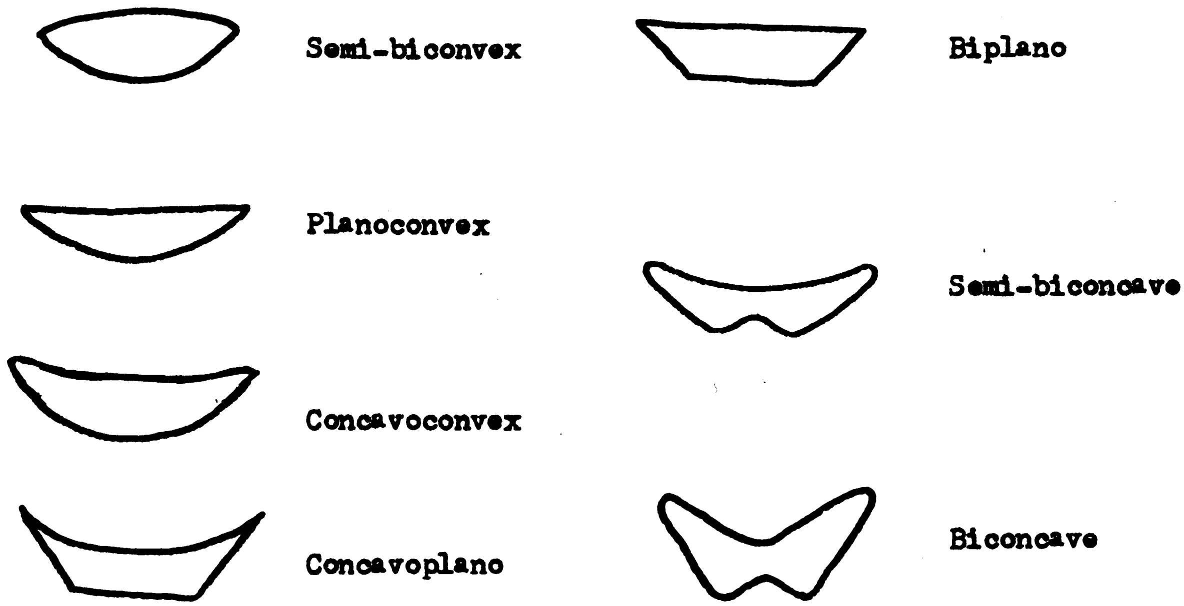

Figure 3. Descriptive typology for crescents based on Black Rock Desert and Borax Lake specimens.

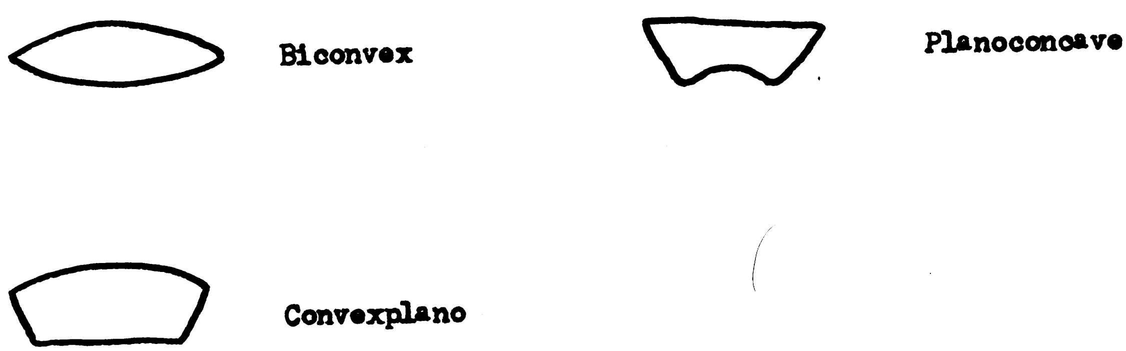

Figure 4. Additional possible types of crescents, not reported as having been found.

Figure 5. Possible hafting methods for crescents, (after Clewlow 1968 who adapted this from Rogers 1929: Fig. 2).

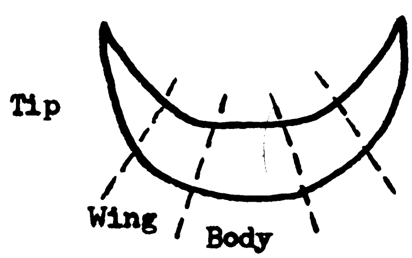

Figure 6. Terminology used in breakage analysis.

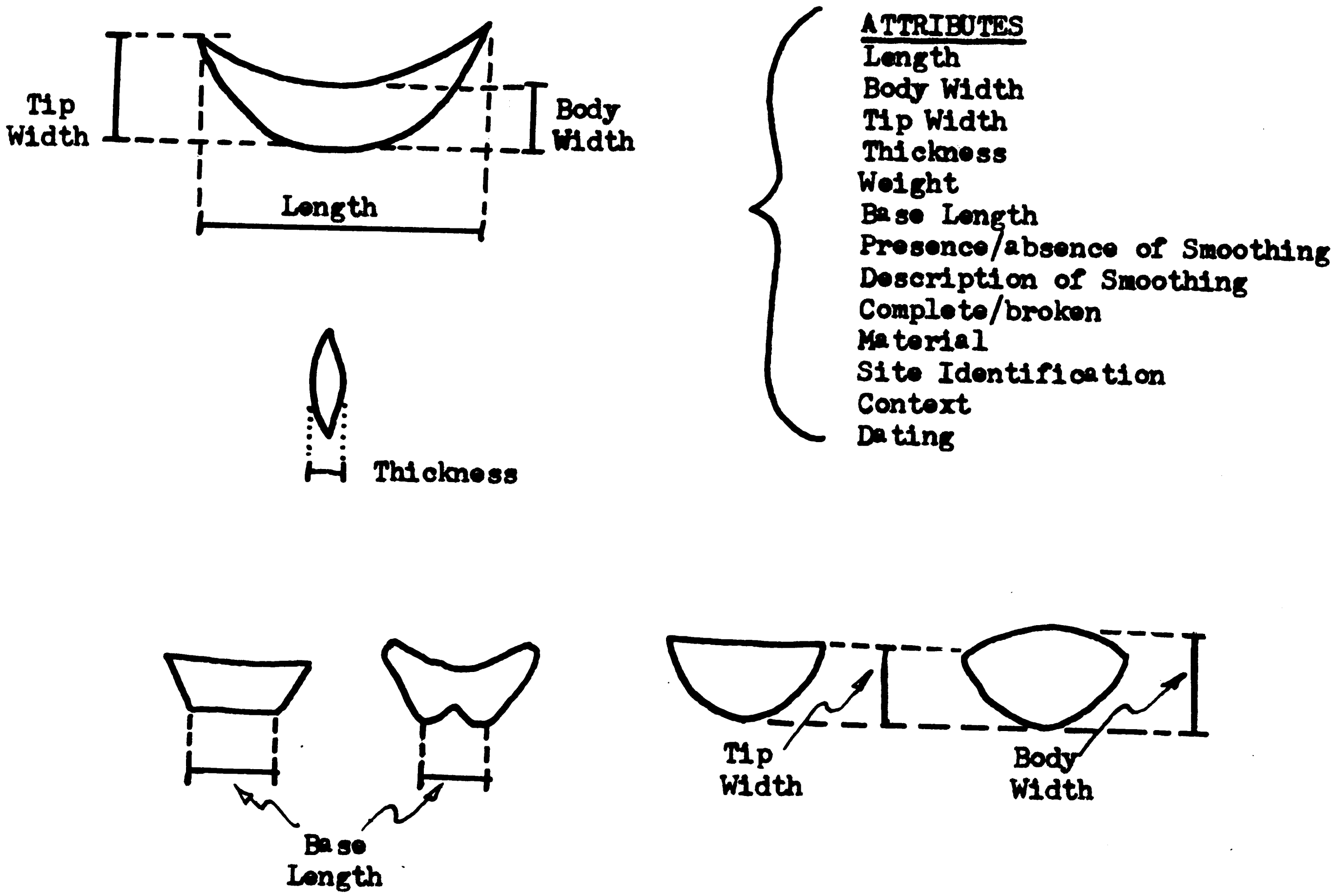

Figure 7. Data needed for further study of crescents.