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Morphological and Temporal Variation in Bifurcate-Stemmed Dart Points of the Western Great Basin

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There continues to be controversy regarding the typological affinities and temporal placement of bifurcate-stemmed dart points across much of the Great Basin. Morphological analysis of 688 projectile points from eight localities suggests that much of this variation conforms to two formal expressions, gracile artifacts equating to the Gatecliff Split-stem series in more northern areas and robust artifacts consistent with historical descriptions of the Pinto series in the southwestern Great Basin. Available chronological data place Pinto forms significantly earlier than their gracile counterparts. Empirical assessment of material profiles further implies that morphological variation among Pinto points can be explained in terms of toolstone availability and knapping qualities, which alter blade form more profoundly than stem/shoulder characteristics. This may have general implications for debates concerning artifact recycling trajectories, typological integrity, and the utility of dart points as time markers.

MIDDLE and Early Holocene cultural chronology across much of the Great Basin remains imperfectly understood despite more than a half century of serious study. Two factors contributing significantly to this situation are the dearth of reliable radiometric dates from buried deposits and the uncertain typological and temporal affinities of putatively ancient time-marker artifacts. It is unfortunate that on the rare occasions when early radiometric assays are obtained, there is too often insufficient attention given to the origin of dated organics and their relevancy with respect to artifact association. Dated contexts are commonly more geological than archaeological, problems in stratigraphic correlation are ignored, and assays on natural organics and bulk soils are given the same veracity as discrete materials from intact cultural features (cf. Schroth 1994). Regions rich in obsidian artifacts offer potential for circumventing at least certain of these sampling obstacles, but the hydration dating technique has yet to gain wide acceptance and use by researchers (cf. Basgall and McGuire 1988; Hall and Jackson 1989; Jones and Beck 1990; Basgall 1995).

Questions regarding the age and attribution of so-called Pinto series projectile points in the Great Basin continue to generate much controversy and debate. Some researchers persist in lumping indented-base or bifurcate-stemmed artifacts from all sectors of the Desert West as presumed contemporary forms, while some segregate points from different areas and assume slight to profound levels of chronological divergence. Still others reject the typological concept outright, seeing these and other dart points as part of an atemporal technological and recycling trajectory.

This article explores measurable morphological and temporal variation among indented-base or bifurcate-stemmed dart points in the western Great Basin, reexamining the so-called "Pinto problem" (Thomas 1971; Warren 1980) from an interregional perspective. Of principal interest is the degree of convergence manifest in the range of artifacts variously assigned to the Pinto (Amsden 1935; Rogers 1939; Harrington 1957), Little Lake (Lanning 1963; Bettinger and Taylor 1974), Silent Snake (Layton 1970), and Bare Creek Eared (O'Connell 1971, 1975) series, and whether they conform to one, two, or several distinct groups with consistent and redundant geographic or chronological profiles. The present examination is based on attribute data for nearly 700 projectile points from eight major localities in the Great Basin, four each in the central-western/northwestern and southwestern regions.

THE PINTO PROBLEM RECONSIDERED

First applied by Amsden (1935:44) to a class of projectile points discovered at the Pinto Basin locality in southeastern California (Fig. 1), the "Pinto" ascription referred to forms with a "definite though narrow shoulder and usually an incurving base." They were described as thick in section, perhaps a quarter to a third the artifact length, and finished primarily by percussion. Specific attribute measurements were not reported, but Amsden (1935) estimated the average specimen to be about 40.0 mm. long, 18.8 mm. wide, and 8.8 mm. thick.

Soon thereafter, Rogers (1939:47, 53-57) expressed dissatisfaction with the original Pinto description, proposing distinct variants and suggesting that Gypsum Cave (Harrington 1933) contracting-stem points be considered part of the broader industry.[1] Rogers (1939) described five variants: Type 1 was broad, faintly shouldered to unshouldered, and often reworked, with a wide base and marked basal concavity; Type 2 had weak, tapering shoulders and a very slight to imperceptible basal indentation; Type 3 was well-shouldered with a robust stem and clear basal notching; Type 4 was corner- to side-notched, with variable stem and basal morphology; and Type 5 was small, narrow, and lanceolate to leaf shaped.

Apart from the considerable formal variation displayed even among the specimens Rogers (1939:Plate 13) illustrated, three types pose the greatest concern from a modern vantage point. Unshouldered variants clearly grade into what researchers today refer to as the Humboldt series (Heizer and Clewlow 1968); hence, at least relict shoulders would be required for a Pinto attribution. In many cases, leaf-shaped forms do occur alongside bifurcate-stemmed points in the Mojave Desert (Basgall and Hall 1993; Hall 1993; Basgall and Hall 1994); however, this highly generalized morphology is prone to confusion with other bifacial tools and such artifact forms appear in a host of earlier and later assemblages as well. The Type 4 category has perhaps the least consistency, encompassing what appear to be atypical Pinto points as well as artifacts best ascribed to alternate types (e.g., Elko or Silver Lake series). Most should, by definition, lack basal indentations but, in fact, two of the three illustrated examples exhibit this characteristic. Rogers (1939:57) reported an average length of 32.8 mm. for the combined Pinto groups, individual types ranging from 31.0 to 35.0 mm.

Almost two decades later, Harrington (1957) offered what was to become the most widely used Pinto classification based on materials from the Stahl site near Little Lake in central-eastern California (Fig. 1). While observing that all morphologies illustrated for the Pinto Basin could be duplicated in this assemblage, Harrington (1957:49) drew attention to generally deeper basal notching and more extensive reworking within the obsidian-dominated Little Lake collection. He attributed these differences to toolstone qualities, obsidian being both more tractable and brittle than the quartzitic materials common to Pinto Basin.

Five Pinto subtypes are recognized in this typology, with distinctions made mainly on variation in shoulder configuration (Harrington 1957: Fig. 39, Fig. 41): (1) Shoulderless, with faint or absent shoulders and frequent evidence of blade

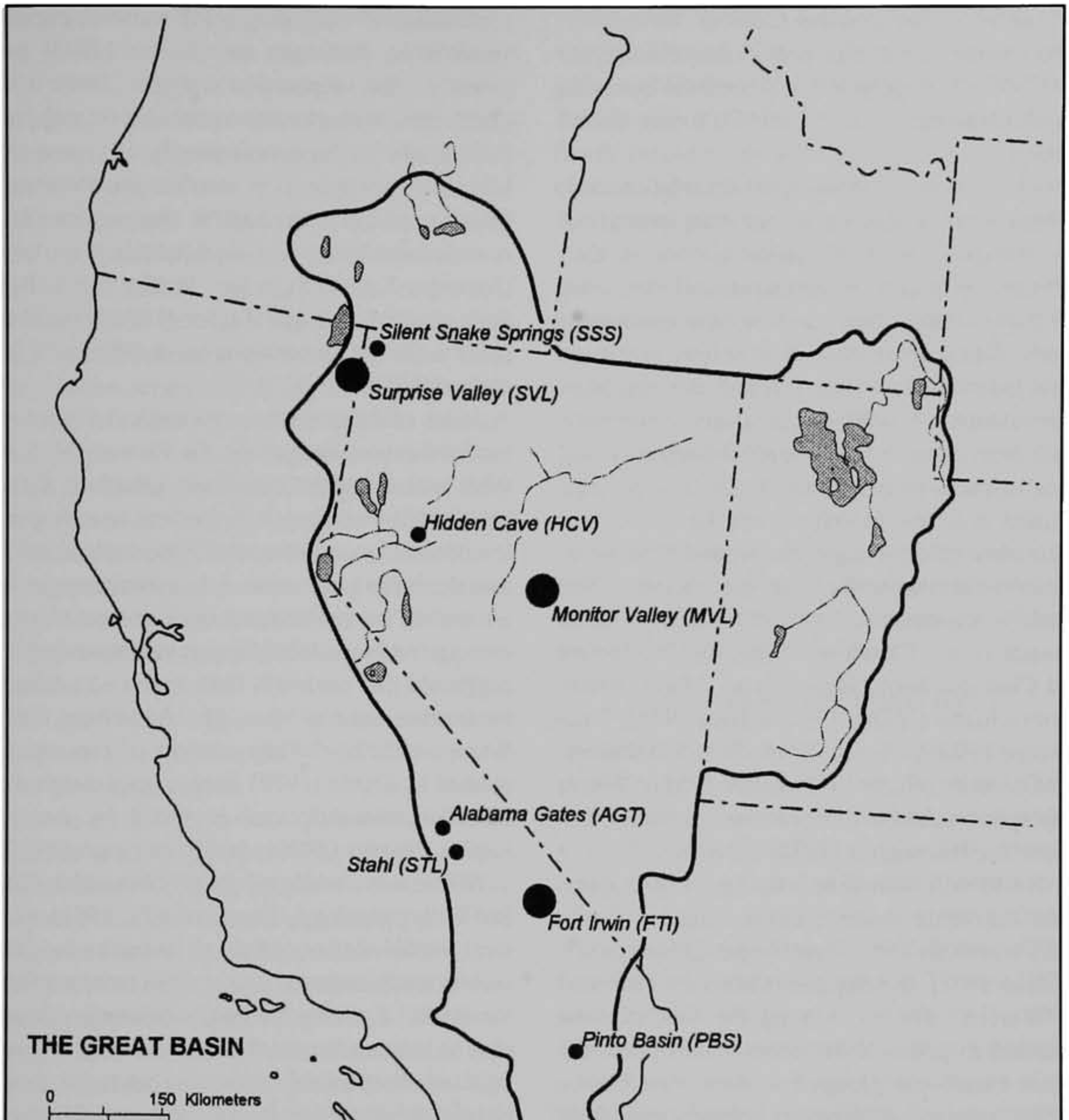

Fig. 1. Localities providing projectile point samples.

resharpening; (2) Sloping Shoulder, having weak, upturned shoulders with angles well over 180°; (3) Square Shoulder, with definite, straight shoulders that approximate 180°; (4) Barbed Shoulder, having sharp, downturned shoulders with angles less than 180°; and (5) One-Shoulder, with a single, usually weak, shoulder. Judging by the illustrations, these categories seem more consistent than those proposed by Rogers (1939). The last subtype, however, appears to contain a mixture of indented-base and other stemmed forms, and probably subsumes a range of broken and resharpened artifacts. General attribute measurement data provided by Harrington (1957:51-52) suggest a fairly uniform but wide length range between 32.0 and 70.0 mm. for all subtypes.

As imprecise as these initial descriptions are, lacking much in the way of attribute quantification and differing in numerous particulars, they collectively refer to a somewhat uniform group of relatively large, comparatively thick projectile points, characterized by robust hafting elements, basal indentations or notches, and minimal pressure retouch. Shoulder configurations are variable, but stems tend toward straightness and distal orientations are typically extreme. Archaeologists working in other parts of the Desert West were quick to apply the general type designation to similar artifacts in their areas, Pinto points being reported from central and northern Nevada (e.g., Clewlow 1968a, 1968b; Heizer and Clewlow 1968; Heizer et al. 1968), southeastern Idaho (Miller 1972; Green 1975), Utah (Aikens 1970; Dalley 1976), and even southwestern Colorado (Hurst 1945; Lister 1953). Where employed, subtype designations generally followed the Harrington (1957) scheme.

It was only sometime later that serious questions regarding internal morphological consistency within the Pinto series began to emerge (cf. Thomas 1971), developments that were reviewed by Warren (1980). Among the first to draw attention to potential variation within projectile points commonly grouped as Pinto was Layton (1970), who saw differences between specimens from Pinto Basin (Campbell and Campbell 1935) and Stahl (Harrington 1957). This notion was in turn rejected by Hester (1973:26; Heizer and Hester 1978), who noted "nothing but similarities" (particularly when atypical specimens were excluded), but Layton's view was supported by O'Connell (1971) and Bettinger and Taylor (1974). Following Lanning (1963:251), whose Little Lake series was meant to include only those "Pinto points" which "occur associated at the Stahl site" (implying some sense of regional variability), Bettinger and Taylor (1974) proposed a clear separation between Little Lake (long, thin, with extensive pressure retouch) and Pinto Basin (thick, percussion flaked) forms; the latter were thought to be restricted to the eastern Mojave and Colorado deserts. Relying on radiocarbon dates from areas considerably to the north (Spooner Lake, Surprise Valley, and Rose Spring), Bettinger and Taylor (1974) placed the Little Lake series between ca. 5,300 and 3,000 years RCYBP.

In an effort to resolve typological disarray in indented-base points along the Plateau (McKean type) and northern Great Basin interface, Green (1975:165) contributed to the fray by collapsing Humboldt Concave-base and Pinto "subvarieties" into the Little Lake series.[2] In combining the latter forms, he emphasized their presumed common age and parallel oblique retouch pattern, and suggested that the Little Lake series was older in the northern part of its range. As pointed out by Warren (1980), flaking patterns of the sort described by Green (1975) show a poor match with illustrations/descriptions provided by Amsden (1935), Rogers (1939), and Harrington (1957).

While acknowledging the problem in his Monitor Valley typology, Thomas (1971, 1981) effectively avoided many of these issues by focusing on bifurcate-stemmed points from more northern localities. Lacking the comparative data necessary to resolve the question, Thomas (1981) recognized the probable existence of more robust (likely older) "Pinto Basin" points in the southwestern Great Basin, but made no real attempt to integrate them with his treatment of the gracile "Basin Pinto" or Gatecliff series varieties.[3] More direct comparisons were made with materials from the eastern Great Basin. Here Thomas (1981:34) observed that the Sudden Shelter points are "roughly similar" (in form) to the Gatecliff Split-stem examples from central Nevada, although he noted that there is "probably more divergence between the two type definitions than was the case for the [Gatecliff] contracting stem points" based on the work of Holmer (1978, 1980). This is of potential interest given the fact that radiocarbon dates from Sudden Shelter are significantly earlier than those obtained in Monitor Valley.

Flenniken and Wilke (1989; also see Wilke and Flenniken 1991) injected still another dimension into the debate, arguing that the integrity of all Great Basin dart point types is suspect. Replicative experiments designed to show how points characteristically break during manufacture and use—and how these broken artifacts might be most effectively (and economically) returned to useful condition—suggested to them that common dart morphologies are best seen not as distinct historical types but as sequential recycling states within one technological trajectory that persisted throughout much of the Holocene.

Expressly denying the stability of hafting elements on dart points (cf. Thomas 1981:15), Flenniken and Wilke (1989) claimed that stem form is as prone to attrition and alteration as projectile point blades/shoulders. Following that model, bifurcate-stemmed points (wherever found) would be seen not as types with potential temporal and/or spatial integrity, but as the reworked offspring of broken corner-notched (e.g., Elko) or side-notched (e.g., Northern Side-notched) archetypes that might occur in virtually any context. In response to Bettinger et al.'s (1991) critique, which empirically demonstrated that supposed "derivative" point forms were in fact heavier (more massive) than purported "archetypes" in individual collections, Flenniken and Wilke (1991) contended that archaeological specimens provide an invalid test. The latter are comprised of spent, residual forms bearing little or no resemblance to the original artifact populations.

Beyond the recycling argument, which explicitly rejects the notion of typological order among the objects under discussion, these various positions allow for a minimum of two kinds of bifurcate-stemmed dart points in the Great Basin (cf. Holmer 1986): one or more northern groups, including Gatecliff Split-stem, sometimes combined with Bare Creek Eared and/or Silent Snake variants; one or more southern groups, including Pinto and perhaps the Little Lake series; and, potentially, an eastern group that at present remains undesignated. Predicated mainly on impressions concerned with such features as point robusticity and level of craftsmanship, these speculations prevail because empirical evidence needed to investigate variability has been unavailable for systematic appraisal. This situation has now changed. Recent research on large samples of projectile points from key localities in the southwestern Great Basin provides the data necessary to assess quantitatively similarities and differences in artifacts from various regions, and to achieve better chronological control of point forms in the southern deserts.

SAMPLE COMPOSITION

Data for 688 bifurcate-stemmed projectile points were incorporated into this study (Table 1). The four central-western and northwestern Great Basin localities (Fig. 1) include Monitor Valley (specimens from Gatecliff Shelter as well as other buried and surface contexts [Thomas 1983, 1988]), Hidden Cave (Thomas 1985), Silent Snake Springs (Layton and Thomas 1979), and Surprise Valley (O'Connell 1971, 1975; O'Connell and Inoway 1994). Major typological variants identified for this greater region (Gatecliff, Silent Snake, Bare Creek Eared series) are represented among the 245 considered artifacts from these "northern" localities. The remaining 443 points in the sample come from four southwestern Great Basin localities, consisting of Fort Irwin (most from the Goldstone [CA-SBR-2348], Awl [CA-SBR-4562], Rogers Ridge [CA-SBR-5250], and Floodpond [CA-SBR-5251] sites [Basgall and Hall 1993; Hall 1993; Basgall and Hall 1994]), Pinto Basin (Campbell and Campbell 1935; Schroth 1994), the Stahl site (Harring-

Table 1
SAMPLE COMPOSITION

Locality	Site	Series[a]	CCR[b]	OBS	BAS	RHY	FEL	IGN	WTF	QTZ	UNK	Total
Fort Irwin	All	ELK	50	3	5	2	1	--	--	1	--	62
Fort Irwin[c]	SBR-2348	PIN	8	6	20	6	--	--	--	--	--	40
	SBR-4562	PIN	9	2	16	7	3	--	--	1	--	38
	SBR-5250	PIN	18	15	41	13	1	--	--	5	--	93
	SBR-5251	PIN	2	6	12	5	1	--	--	--	--	26
	Other	PIN	10	6	32	7	1	--	1	2	--	59
	All	PIN	47	35	121	38	6	--	1	8	--	256
Stahl	INY-182	PIN	3	76	3	2	--	--	--	--	--	84
Alabama Gates	All	PIN	1	32	1	--	--	--	--	--	--	34
Pinto Basin	All	PIN	12	4	4	4	--	--	3	42	--	69
Monitor Valley	All	GSS	44	3	--	3	--	1	--	1	1	53
Hidden	26Ch16	GSS	22	62	4	--	--	--	--	1	--	89
Silent Snake	26Hu201	GSS	--	10	--	--	--	--	--	--	19	29
Surprise Valley	All	GSS	1	73	--	--	--	--	--	--	--	74
	Total	--	180	298	138	49	7	1	4	53	20	750

[a] ELK = Elko; PIN = Pinto; GSS = Gatecliff Split-stem.
[b] CCR = cryptocrystalline; OBS = obsidian; BAS = basalt; RHY = rhyolite; FEL = felsite; IGN = nonspecific igneous; WTF = welded tuff; QTZ = quartzitic (quartz and quartzite); UNK = unknown.
[c] SBR-2348 = Goldstone; SBR-4562 = Awl; SBR-5250 = Rogers Ridge; SBR-5251 = Floodpond.

ton 1957; Meighan 1981; Schroth 1994), and the Alabama Gates area in southern Owens Valley (Delacorte et al. 1995. Also presented below are attribute data for 62 Elko series points from Fort Irwin and illustrations of select Pinto and Elko forms recovered from the Fort Irwin and Alabama Gates localities (Figs. 2 through 6).

Morphological similarities in projectile point samples were examined with respect to 12 attributes. Most conform to criteria developed by Thomas (1971, 1981, 1983) for the Monitor Valley typology, specifically maximum length, axial length, basal indentation depth, maximum width, basal width, neck width, maximum thickness, weight, distal shoulder angle, proximal shoulder angle, and notch opening index/angle. The attribute of stem length was added in an effort to better characterize the potential mass of the hafting element. Measurable on all but the most fragmentary specimens, stem length represents the medial distance from the stem-shoulder intersection to the base of the artifact. In addition to the references cited above, attribute data were also drawn from Fort Irwin (Gilreath et al. 1988; McGuire and Hall 1988; Warren 1991; Basgall 1993a; Basgall and Hall, unpublished data); Stahl (D. H. Thomas, unpublished data); and Surprise Valley (J. F. O'Connell, unpublished data; D. H. Thomas, unpublished data). Summary statistics used in various analyses pertain to intact rather than reconstructed measurements.

Fairly consistent reporting of attribute data fa-

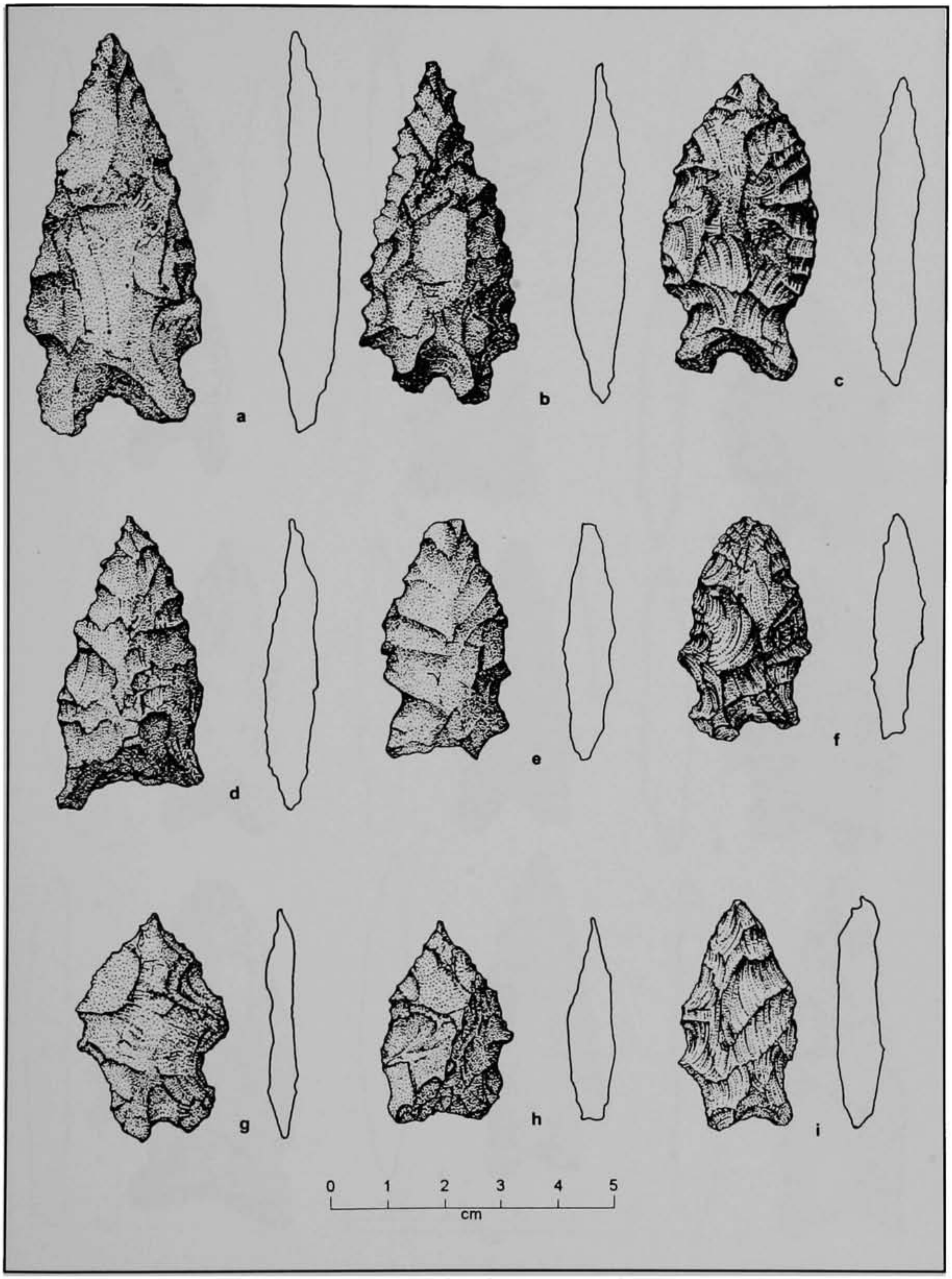

Fig. 2. Pinto series projectile points from the Awl site (CA-SBR-4562).

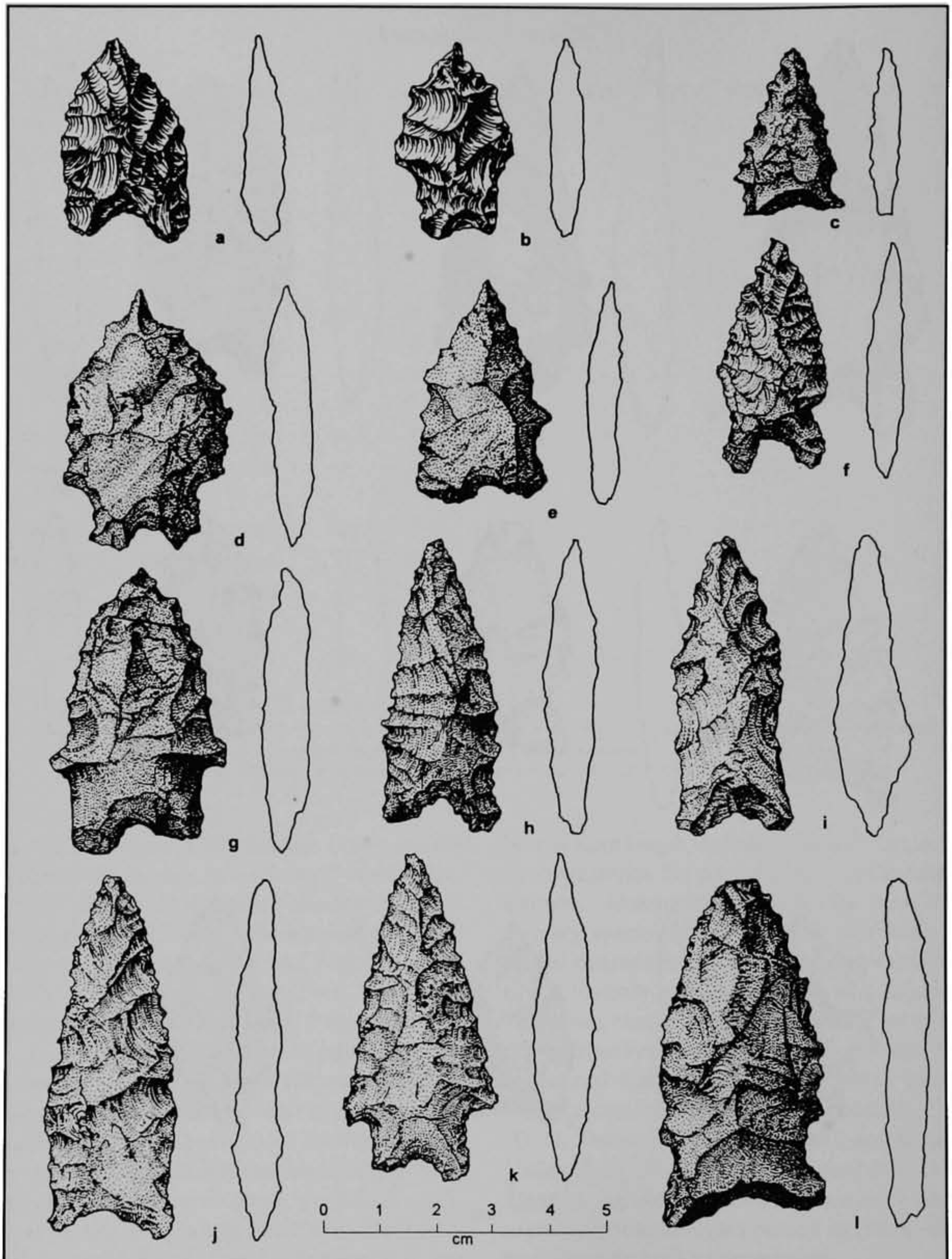

Fig. 3. Pinto series projectile points from the Goldstone site (CA-SBR-2348).

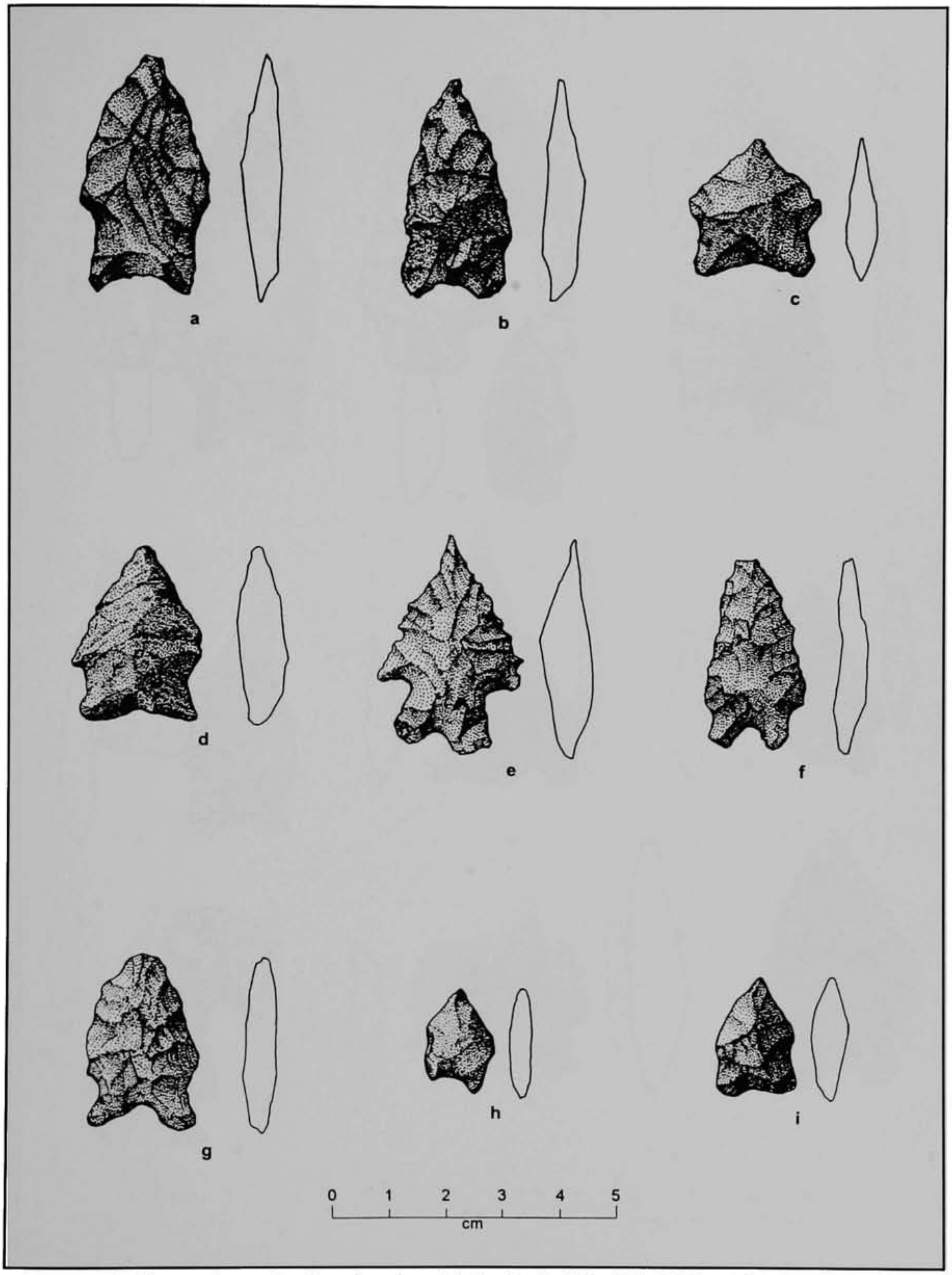

Fig. 4. Pinto series projectile points from Tiefort Basin (CA-SBR-5537 and CA-SBR-5251).

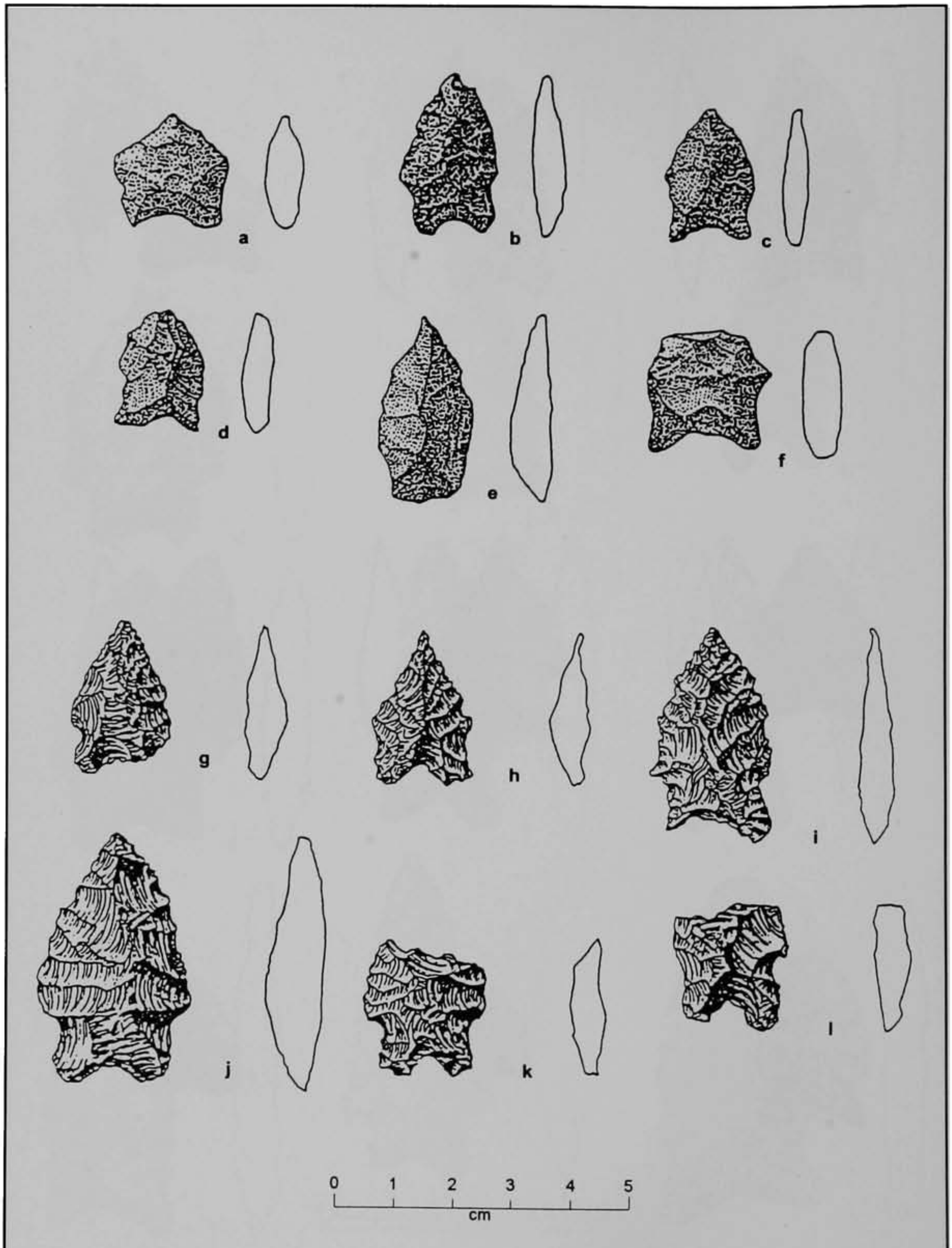

Fig. 5. Pinto series projectile points from Alabama Gates, Inyo County, California.

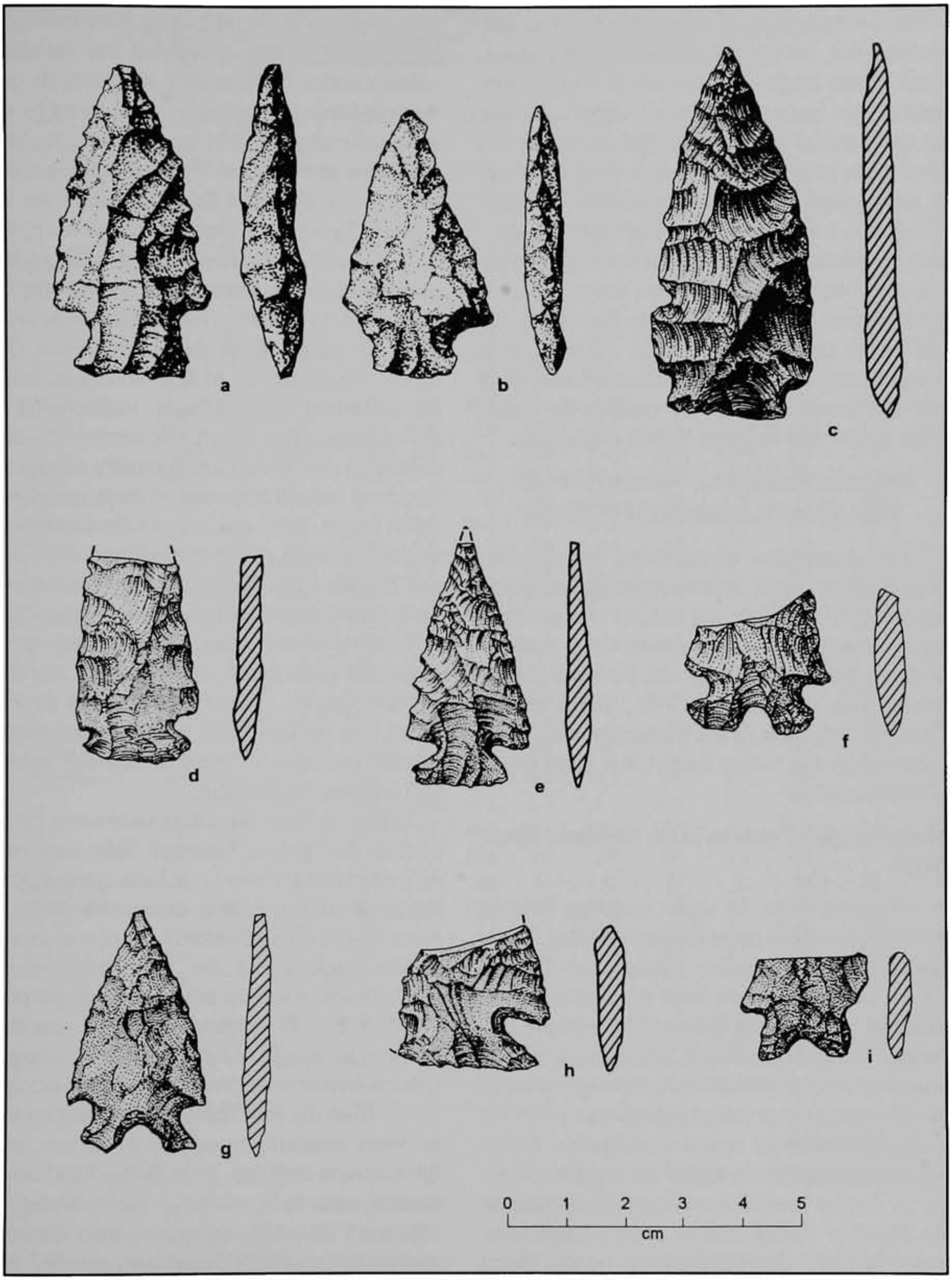

Fig. 6. Elko series projectile points from Fort Irwin, San Bernardino County, California.

cilitated the assembly of information from different localities, but several problems were encountered. Stem length was measured directly only for the Fort Irwin and Alabama Gates materials (in the authors' possession), and had to be derived from published illustrations (line drawings or photographs) for other collections. Scaling distortions were corrected using reported attribute measurements. In the case of Surprise Valley, data were assembled from several incomplete sources, hence not all values necessarily relate to the same set of artifacts. Finally, it is worth noting that a small number of additional and still unmeasured points exist in the Stahl, Pinto Basin, and Surprise Valley collections.

MORPHOLOGICAL VARIATION IN BIFURCATE-STEMMED POINTS

The quantitative examination of bifurcate-stemmed dart points from the eight subject localities suggests that there are at least two morphological expressions in the western Great Basin, a northern pattern consistent with the more gracile morphology that Thomas (1981, 1983) termed Gatecliff Split-stem, and a southern pattern characterized by the robust Pinto/Little Lake forms (Tables 2 and 3).

Morphological Patterns in the Northern Great Basin

Although there is some variation evident within the northern range (Surprise Valley, Silent Snake Springs, Monitor Valley, and Hidden Cave), projectile points from the four analyzed localities are far more similar than they are different. Using the t-statistic, comparison of Surprise Valley and Silent Snake Springs samples (northwestern Great Basin) indicates that they are indistinguishable for nearly all attributes, differing only in maximum width and weight (Table 4). A similar level of convergence is evident in the Monitor Valley-Hidden Cave comparison, these samples (central-western Great Basin) being divergent in basal width, maximum thickness, and weight. In both cases, stem form seems largely stable across collections, and variable attributes tend to be those most subject to alteration through blade reworking or constrained by toolstone differences. Differences between the Monitor Valley and Surprise Valley samples are negligible, while the Silent Snake-Hidden Cave relationship shows some considerable convergences.

The extent of similarity among these northern samples becomes more apparent when they are compared to robust (Pinto series) bifurcate-stemmed points from the southwestern Great Basin. Comparisons of Fort Irwin and Hidden Cave/Monitor Valley samples indicate that they are commensurate in only one attribute (basal indentation), while they are markedly divergent in thickness and all elements of stem morphology (stem length, basal and neck width, and shoulder angles). Similar results are indicated in the Stahl and Hidden Cave/Monitor Valley comparisons, these projectile points again differing significantly in nearly all attributes, especially stem length, basal and neck width, and proximal and distal shoulder angles. Finally, analysis of the Pinto Basin and Hidden Cave samples demonstrates equally profound differences between northern and southern expressions.

Taken together, these data underscore the conclusion that gracile Gatecliff Split-stem points differ from their Pinto/Little Lake counterparts in having shorter, narrower, contracting stems and more abrupt distal shoulders. A cluster analysis further underscores the dichotomy between northern and southern bifurcate-stemmed points (Table 5, Fig. 7). Regardless of clustering method—single linkage (nearest neighbor), complete linkage (furthest neighbor), or average linkage—points from the four northern localities manifest far more similarity to each other than to any of the southern samples. Coefficient matrices and dendrograms indicate that Surprise Valley and Monitor Valley have the most overall similarity, in turn linking with Hidden Cave, and then Silent Snake Springs. Although examination of arti-

Table 2
ATTRIBUTE STATISTICS[a] FOR BIFURCATE-STEMMED PROJECTILE POINTS FROM SELECTED LOCALITIES IN THE WESTERN GREAT BASIN

Locality	STS	ML	AL	SL	BI	MW	BW	NW	MT	WT	DSA	PSA	NOA
Stahl Site	num	77	79	31	77	84	83	83	84	77	82	82	82
(84 specimens)	avg	39.6	37.0	9.9	2.8	26.0	20.1	19.2	7.7	7.1	209	108	101
	std	8.5	8.1	2.3	1.6	3.3	3.1	2.8	1.7	3.1	20	12	23
	max	73.9	70.3	14.9	7.0	37.7	28.2	29.0	12.4	17.6	250	130	155
	min	22.6	21.7	6.3	0.1	19.6	13.5	13.0	4.9	2.4	150	80	40
Alabama Gates	num	14	14	23	34	18	25	23	22	11	27	34	27
(34 specimens)	avg	27.2	25.3	9.8	2.3	19.6	17.5	15.4	6.7	3.0	226	112	115
	std	7.6	7.3	1.7	1.2	3.3	2.7	2.0	1.4	2.1	18	15	20
	max	42.1	39.7	13.6	5.7	26.7	22.1	19.0	10.0	8.6	253	160	159
	min	18.3	16.9	6.4	0.2	15.5	12.4	12.1	4.3	1.4	186	84	64
Pinto Basin	num	59	59	74	66	68	68	69	69	59	67	67	67
(69 specimens)	avg	32.3	30.8	10.2	1.6	20.8	16.9	15.8	7.6	5.3	219	103	117
	std	6.7	6.5	1.8	0.9	3.5	2.6	2.2	1.2	2.2	15	13	19
	max	50.4	50.3	15.0	4.6	30.1	24.0	21.8	10.8	12.4	270	130	150
	min	19.9	19.3	6.1	0.1	13.6	11.2	10.6	5.4	1.6	180	70	80
Silent Snake	num	12	13	27	29	21	27	22	29	9	28	29	28
(29 specimens)	avg	42.8	38.2	8.2	3.5	25.6	13.8	13.1	5.4	4.9	167	93	73
	std	10.2	8.3	1.8	2.2	3.5	2.9	2.6	0.9	2.1	12	9	15
	max	63.1	59.0	12.1	12.3	32.5	22.4	18.8	7.8	8.3	190	110	110
	min	34.2	30.6	5.4	0.9	17.8	10.5	10.0	4.2	2.6	145	70	50
Surprise Valley	num	44	15	21	27	47	69	15	15	46	14	74	na
(74 specimens)	avg	41.2	34.9	8.9	3.0	21.6	12.9	12.9	5.0	3.0	176	95	na
	std	8.2	10.2	1.8	1.7	3.2	2.7	3.6	1.3	1.3	27	7	na
	max	62.0	na	12.1	9.9	28.0	22.0	na	na	7.2	na	113	na
	min	27.0	na	3.8	0.2	15.0	7.0	na	na	1.6	na	70	na
Monitor Valley	num	10	11	46	48	31	41	52	53	9	52	53	52
(53 specimens)	avg	37.0	34.6	8.2	2.9	22.4	12.3	12.2	5.0	2.9	181	92	89
	std	8.4	7.7	1.9	1.3	4.2	2.7	2.7	0.9	0.9	19	9	21
	max	51.7	48.2	12.2	7.0	29.7	21.3	20.3	7.7	4.5	230	100	150
	min	26.0	24.6	3.8	0.5	15.0	8.0	7.9	3.4	1.6	150	70	55
Hidden Cave	num	69	73	80	79	68	61	87	88	39	88	88	88
(89 specimens)	avg	44.6	42.1	7.9	2.8	21.3	10.9	12.1	5.9	4.7	173	89	84
	std	10.0	11.1	2.0	1.0	3.7	2.1	2.3	1.1	1.7	20	9	20
	max	71.2	75.7	12.3	5.7	29.8	17.6	18.3	9.7	8.2	250	105	155
	min	28.4	20.4	4.6	1.0	15.2	6.7	7.5	3.2	2.1	120	65	40

[a] STS = statistic; num = number of complete measurements; avg = average; std = standard deviation; max = maximum; min = minimum; ML = maximum length; AL = axial length; SL = stem length; BI = basal indentation; MW = maximum width; BW = basal width; NW = neck width; MT = maximum thickness; WT = weight; DSA = distal shoulder angle; PSA = proximal shoulder angle; NOA = notch opening angle; na = not available. Values are in millimeters (linear measure), grams (weight), and degrees (angle).

facts from other sites in this region might disclose further variation, at present it seems reasonable to incorporate Gatecliff Split-stem, Silent Snake, and Bare Creek Eared points into a single morphological series.

Morphological Patterns in the Southwestern Great Basin

Bifurcate-stemmed point morphologies in the southwestern Great Basin are not so readily dis-

Table 3
ATTRIBUTE STATISTICS[a] FOR PINTO SERIES PROJECTILE POINTS FROM FORT IRWIN SITES

Site	STS	ML	AL	SL	BI	MW	BW	NW	MT	WT	DSA	PSA	NOA
SBR-2348	num	23	24	32	33	34	28	36	35	23	36	36	36
Goldstone	avg	45.8	42.4	12.9	3.2	24.1	20.0	17.8	7.7	8.3	214	100	114
(40 specimens)	std	10.1	9.7	2.5	1.4	4.2	4.5	3.5	2.1	4.0	22	14	24
	max	62.9	59.0	16.8	5.8	33.9	33.9	27.5	14.3	16.3	260	130	160
	min	29.5	27.9	7.1	0.6	15.8	13.2	11.3	4.0	2.7	180	70	75
SBR-4562	num	26	27	38	37	31	32	36	35	23	37	38	37
Awl	avg	43.9	39.8	10.7	3.3	24.7	19.6	17.7	7.8	8.5	217	108	109
(38 specimens)	std	11.3	11.2	2.8	1.7	3.2	3.4	3.3	1.1	4.2	19	17	24
	max	68.4	63.4	17.5	7.0	31.2	28.0	24.6	10.3	20.6	258	153	154
	min	25.9	20.7	5.1	0.2	19.5	11.9	9.3	5.6	2.7	182	75	64
SBR-5250	num	41	48	66	61	66	63	83	81	24	92	93	92
Rogers Ridge	avg	37.1	33.5	10.9	3.1	22.3	18.1	16.6	7.3	5.5	218	102	117
(93 specimens)	std	7.9	9.0	2.9	1.3	3.9	2.6	2.5	1.5	2.6	20	13	25
	max	56.2	60.6	20.9	6.1	30.5	23.6	22.6	11.6	10.1	266	130	169
	min	24.6	17.0	3.8	0.5	14.2	12.0	9.9	4.4	2.0	180	74	70
SBR-5251	num	14	14	24	21	17	24	23	22	5	24	25	24
Floodpond	avg	33.8	30.8	11.2	2.7	21.9	19.1	16.9	6.8	4.2	224	109	114
(26 specimens)	std	7.6	7.2	3.3	1.4	4.3	2.8	2.8	1.7	2.2	21	13	20
	max	50.0	46.0	20.0	5.0	29.0	25.0	22.0	10.0	6.0	265	130	151
	min	23.6	21.8	5.0	0.8	16.0	15.0	11.0	3.5	2.0	188	90	72

[a] STS = statistic; num = number of complete measurements; avg = average; std = standard deviation; max = maximum; min = minimum; ML = maximum length ; AL = axial length; SL = stem length; BI = basal indentation; MW = maximum width; BW = basal width; NW = neck width; MT = maximum thickness; WT = weight; DSA = distal shoulder angle; PSA = proximal shoulder angle; NOA = notch opening angle. Values are in millimeters (linear measure), grams (weight), and degrees (angle).

tilled. While cluster analyses suggest that samples from four southern localities (Fort Irwin, Pinto Basin, Alabama Gates, and Stahl) are more similar to each other than to the northern Gatecliff collections (Table 5, Fig. 7), t-statistics for individual pairings indicate significant divergence (Table 4). Fort Irwin and Pinto Basin forms, for example, show equivalency only in regard to thickness and shoulder angles; Fort Irwin points are consistently larger in all other measures, which accounts for the contrasting weight distributions.

Comparison of Fort Irwin and Alabama Gates samples indicates slightly more morphological similarity (including stem length and basal width), but again the Fort Irwin artifacts tend to be more massive than those from the southern Owens Valley. Forms from Fort Irwin and Stahl exhibit dissimilarity of another order, in that they are comparable in length and thickness but display very different width and shoulder configurations; Pinto/Little Lake points from Stahl have broad blades/stems and better shoulder definition (reduced distal shoulders and notch openings). The Stahl samples likewise differ in almost all respects (reduced stem length and thickness) from the Pinto Basin materials, being larger in average size with more defined notches/shoulders.

Perhaps the most surprising results emerge from comparison of the Stahl and Alabama Gates samples, localities in relative geographic proximity (35 to 40 km.) that are both dominated by obsidian. Based on these commonalities, whatever the range of variation expressed across the wider Mojave Desert, Stahl and Alabama Gates points would be expected to show close morpho-

Table 4
STATISTICAL COMPARISON (T-TESTS) OF SELECTED PROJECTILE POINT SAMPLES[a]

	SVL-SSS		SVL-HCV		HCV-SSS		MVL-SSS		MVL-HCV	
	t-value	df	t-value	df	t-value	df	t-value	df	t-value	df
ML	0.57 *	54	1.89 *	111	0.57 *	79	1.44 *	20	2.29 *	77
AL	0.93 *	26	2.32	86	1.21 *	84	1.09 *	22	2.16 *	82
SL	1.34 *	46	2.08	99	0.69 *	105	0.00 *	71	0.83 *	124
BI	0.95 *	54	0.74 *	104	2.27 *	106	1.51 *	75	0.49 *	125
MW	4.63	66	0.45 *	113	4.71	87	2.88	50	1.31 *	97
BW	1.44 *	94	4.67	128	5.29	86	2.18 *	66	2.94	100
NW	0.20 *	35	1.13 *	100	1.77 *	107	1.32	72	0.23 *	137
MT	1.20 *	42	2.85	101	2.21 *	115	1.92 *	80	5.03	139
WT	3.60	53	5.22	83	0.31 *	46	2.63	16	3.06	46
DSA	1.50 *	40	0.50 *	100	1.50 *	114	3.53	78	2.32 *	138
PSA	1.20 *	101	4.67	160	2.08 *	115	0.48 *	80	1.92 *	139
NOA	na	na	na	na	2.68	114	3.57	78	1.40 *	138

	FTI-HCV		FTI-MVL		FTI-PBS		FTI-AGT		FTI-STL	
	t-value	df	t-value	df	t-value	df	t-value	df	t-value	df
ML	3.13	208	0.98 *	149	5.64	198	4.83	153	0.38 *	216
AL	3.77	222	0.66 *	160	4.20	208	4.20	163	0.31 *	228
SL	8.56	294	6.07	260	2.16	288	1.88 *	237	1.96 *	245
BI	2.19 *	283	1.28 *	252	8.20	270	3.33	238	1.96 *	281
MW	3.70	267	1.18 *	230	4.69	267	3.90	217	5.57	283
BW	16.70	253	11.14	233	3.75	260	1.55 *	217	3.45	275
NW	13.98	321	10.76	286	3.50	303	2.73	257	5.18	317
MT	8.55	318	11.19	283	1.01 *	299	2.10 *	252	1.51 *	314
WT	3.93	142	3.49	112	3.37	162	3.71	114	0.20 *	180
DSA	18.51	331	12.60	295	0.00 *	310	1.74 *	270	3.92	325
PSA	8.83	334	5.61	299	0.50 *	313	2.92	280	2.19 *	328
NOA	10.84	331	7.24	295	0.63 *	310	0.00 *	270	4.62	325

	STL-AGT		STL-PBS		STL-MVL		STL-HCV		AGT-HCV	
	t-value	df	t-value	df	t-value	df	t-value	df	t-value	df
ML	5.10	89	5.43	134	0.91 *	85	3.26	144	6.15	81
AL	5.05	91	4.83	136	0.92 *	88	3.25	150	5.43	85
SL	0.18 *	52	0.72 *	103	3.54	75	4.53	109	4.14	101
BI	1.63 *	109	5.40	141	0.36 *	123	0.00 *	154	2.29 *	111
MW	7.47	100	9.40	150	4.81	113	8.27	150	1.77 *	84
BW	3.78	106	6.78	149	13.73	122	20.04	142	12.15	84
NW	5.86	104	8.20	150	14.33	133	18.10	168	6.28	108
MT	2.54	104	0.41 *	151	10.65	135	8.28	170	2.88	108
WT	4.24	86	3.79	134	4.03	84	4.50	114	2.78	48
DSA	3.92	107	3.39	147	8.05	132	11.73	168	12.32	113
PSA	1.51 *	114	2.44	147	8.31	133	11.73	168	10.37	120
NOA	2.83	107	4.56	147	3.04	132	5.13	168	7.05	113

	AGT-PBS		PBS-HCV		PBS-RRG		AGT-RRG		STL-AWL	
	t-value	df	t-value	df	t-value	df	t-value	df	t-value	df
ML	2.50	71	8.03	126	3.27	98	4.08	53	2.04 *	101
AL	2.78	71	6.92	130	1.80 *	105	3.12	60	1.40 *	104
SL	0.94 *	95	7.48	152	1.74 *	138	1.71 *	87	1.28 *	67
BI	3.28	98	7.53	143	8.71	125	2.95	93	1.53 *	112
MW	1.31 *	84	0.81 *	134	2.34 *	132	2.50	82	1.89 *	113
BW	0.98 *	91	14.31	127	2.64	129	0.97 *	86	0.75 *	113
NW	0.77 *	90	10.17	154	2.07 *	150	2.12 *	104	2.54	117
MT	2.94	89	9.23	155	1.34 *	148	1.69 *	101	0.32 *	117
WT	3.20	68	1.44 *	96	0.36 *	81	2.79	33	1.74 *	98
DSA	1.93 *	92	15.75	153	0.34 *	157	1.87 *	117	2.05 *	117
PSA	3.12	99	7.92	153	0.48 *	158	3.68	125	0.00 *	118
NOA	0.45 *	92	10.40	153	0.00 *	157	0.38 *	117	1.73 *	117

Table 4 (continued)
STATISTICAL COMPARISON (T-TESTS) OF SELECTED PROJECTILE POINT SAMPLES[a]

	GLD-AWL		AWL-RRG		RRG-FLP		FIC-FIF		CCR-OBS	
	t-value	df	t-value	df	t-value	df	t-value	df	t-value	df
ML	0.62 *	47	2.99	65	1.36 *	53	2.37 *	139	5.42	42
AL	0.88 *	49	2.74	73	1.03 *	60	2.96	149	5.96	47
SL	3.44	68	0.35 *	102	0.42 *	88	2.33 *	214	1.30 *	63
BI	0.27 *	68	0.65 *	96	1.22 *	80	2.31 *	204	1.35 *	61
MW	0.64 *	63	3.06	95	0.37 *	81	2.21 *	199	3.57	58
BW	0.39 *	58	2.42 *	93	1.57 *	85	1.15 *	192	0.52 *	59
NW	0.12 *	70	2.02 *	117	0.50 *	104	3.64	234	1.41 *	69
MT	0.25 *	68	1.77 *	114	1.35 *	101	0.00 *	230	3.17	69
WT	0.17 *	44	3.10	45	1.04 *	27	1.69 *	103	4.04	34
DSA	0.62 *	71	0.26 *	127	1.30 *	114	0.36 *	243	2.91	73
PSA	2.20 *	72	2.18 *	129	2.39 *	116	0.51 *	246	1.64 *	75
NOA	0.89 *	71	1.68 *	127	0.54 *	114	0.00 *	243	3.40	73

	CCR-BAS		CCR-RHY		OBS-QTZ		OBS-AGT		OBS-PBS	
	t-value	df	t-value	df	t-value	df	t-value	df	t-value	df
ML	0.37 *	94	2.20 *	50	1.93 *	16	0.79 *	26	1.77 *	71
AL	0.09 *	96	2.34 *	55	2.28 *	20	0.00 *	30	3.39	75
SL	0.91 *	147	2.24 *	74	1.00 *	26	0.15 *	42	1.00 *	93
BI	0.67 *	141	1.06 *	70	0.17 *	25	0.54 *	52	3.31	84
MW	0.40 *	130	0.61 *	64	0.80 *	30	0.50 *	41	0.69 *	91
BW	0.73 *	130	0.83 *	66	0.00 *	26	0.50 *	44	1.53 *	87
NW	2.36 *	155	1.40 *	77	1.12 *	34	0.12 *	49	0.51 *	95
MT	0.75 *	151	0.84 *	73	2.63 *	36	0.49 *	50	2.47 *	97
WT	0.37 *	68	1.52 *	38	0.88 *	12	0.95 *	21	2.41 *	69
DSA	1.99 *	162	1.08 *	81	1.22 *	35	0.20 *	54	2.21 *	94
PSA	0.00 *	164	0.62 *	82	0.35 *	36	3.46	62	1.33 *	95
NOA	1.40 *	162	1.10 *	81	1.26 *	35	2.49 *	54	2.60 *	94

	QTZ-PBS		CCR-STL		FIP-FIE		FIP-GEC		FIP-GEE	
	t-value	df	t-value	df	t-value	df	t-value	df	t-value	df
ML	0.44 *	61	0.78 *	105	4.09	154	2.35	188	0.41 *	153
AL	0.03 *	61	0.29 *	108	4.65	164	3.70	197	0.19	163
SL	0.84 *	79	1.25 *	73	7.70	270	14.50	378	6.69	252
BI	2.27	71	0.70 *	118	2.64	260	7.89	252	0.74 *	218
MW	0.58 *	73	3.26	117	3.76	243	1.13 *	308	0.49 *	224
BW	0.97 *	73	3.08	121	2.95	234	1.64 *	340	1.59 *	232
NW	1.43 *	75	4.82	124	4.02	292	22.10	440	9.93	293
MT	1.80 *	75	1.00 *	123	9.51	291	3.58	440	13.10	289
WT	0.45 *	59	0.42 *	99	1.36 *	116	4.95	137	6.26	162
DSA	0.18 *	73	1.07 *	126	16.50	302	57.90	450	16.20	285
PSA	1.24 *	73	1.21 *	127	9.48	304	36.30	429	13.10	304
NOA	0.14 *	73	1.80 *	126	17.87	298	42.80	426	21.10	285

[a] * denotes statistically indistinguishable samples (alpha = 0.05); Sites: SVL = Surprise Valley; SSS = Silent Snake Springs; HCV = Hidden Cave; MVL = Monitor Valley (including Gatecliff Shelter); FI = Fort Irwin inclusive; PB = Pinto Basin; AG = Alabama Gates (INY-328/H, INY-3766, INY-3767); STL = Stahl site; GLD = Goldstone; AWL = Awl; RRG = Rogers Ridge; FLP = Floodpond; CCR = cryptocrystalline; OBS = obsidian; BAS = basalt; RHY = rhyolite; QTZ = quartz and quartzite; FIC = coarse-grained (BAS, RHY, QTZ) Pinto, Fort Irwin; FIF = fine-grained (CCR, OBS, FEL) Pinto, Fort Irwin; FIP = Fort Irwin Pinto, inclusive; FIE = Fort Irwin Elko, inclusive; GEC = Elko Corner-notched, Gatecliff Shelter; GEE = Elko Eared, Gatecliff Shelter. Statistics: ML = maximum length; AL = axial length; SL = stem length; BI = basal indentation; MW = maximum width; BW = basal width; NW = neck width; MT = maximum thickness; WT = weight; DSA = distal shoulder angle; PSA = proximal shoulder angle; NOA = notch opening angle.

Table 5

DISSIMILARITY COEFFICIENT MATRICES (SQUARED EUCLIDEAN DISTANCE) BETWEEN BIFURCATE-STEMMED PROJECTILE POINTS FROM SELECTED WESTERN GREAT BASIN LOCALITIES AND FORT IRWIN TOOLSTONE CATEGORIES[a]

General Localities

	STL	AGT	PBS	SSS	SVL	MVL	HCV
AGT	29.28						
PBS	17.79	7.54					
SSS	27.65	48.44	41.72				
SVL	32.29	29.51	28.14	6.57			
MVL	35.00	28.37	27.49	7.56	1.56		
HCV	37.07	46.76	35.54	7.59	5.91	6.48	
FTI	4.77	23.59	13.99	29.02	27.89	31.17	33.33

Fort Irwin Sites and Other Localities

	STL	AGT	PBS	SSS	SVL	MVL	HCV	GLD	AWL	RRG
AGT	29.53									
PBS	19.77	7.53								
SSS	28.28	51.48	45.52							
SVL	32.62	31.18	29.87	6.92						
MVL	34.37	29.50	28.12	7.97	1.46					
HCV	37.59	46.77	35.79	8.72	5.30	6.11				
GLD	9.90	44.66	29.35	36.52	39.44	43.76	40.02			
AWL	3.66	36.31	25.66	30.56	35.34	38.62	37.25	3.75		
RRG	8.50	13.81	10.27	28.06	21.75	22.45	28.98	10.40	7.98	
FLP	11.86	6.18	7.32	36.90	25.37	26.09	38.05	19.00	14.95	2.87

Fort Irwin Material Groups and Other Localities

	STL	AGT	PBS	CCR	OBS	BAS	QTZ	FEL	RHY	SSS	SVL	MVL
AGT	29.88											
PBS	20.46	7.56										
CCR	3.95	24.69	15.01									
OBS	27.52	4.28	6.43	20.52								
BAS	5.22	26.43	20.41	2.08	21.45							
QTZ	14.88	11.49	4.40	9.06	5.74	12.03						
FEL	3.56	21.66	13.63	3.90	22.11	6.28	13.52					
RHY	12.31	45.96	31.28	5.12	38.68	5.48	20.88	13.80				
SSS	31.04	52.99	46.38	28.32	46.75	31.38	40.51	24.63	42.75			
SVL	35.35	32.18	30.17	28.02	29.21	31.23	28.93	22.89	44.89	7.21		
MVL	38.07	31.58	29.42	31.03	26.76	34.57	29.02	26.10	50.83	8.07	1.58	
HCV	42.89	49.02	37.71	32.98	42.11	40.00	37.16	29.46	46.73	9.14	4.39	5.85

[a] STL = Stahl; AGT = Alabama Gates; PBS = Pinto Basin; SSS = Silent Snake Springs; SVL = Surprise Valley; MVL = Monitor Valley; HCV = Hidden Cave, FTI = Fort Irwin inclusive; GLD = Goldstone (SBR-2348); AWL = Awl (SBR-4562); RRG = Rogers Ridge (SBR-5250); FLP = Floodpond (SBR-5251); CCR = FTI cryptocrystalline; OBS = FTI obsidian; BAS = FTI basalt; QTZ = FTI quartz and quartzitic; FEL = FTI felsite; RHY = rhyolite.

logical parallels. Instead, the samples deviate in form fully as much as any pair of localities, showing convergence only in stem length, basal indentation depth, and proximal shoulder angle (Table 4). The Alabama Gates specimens share greatest similarity with Pinto Basin points in the Colorado Desert, variants from each locality being indistinguishable in width and stem charac-

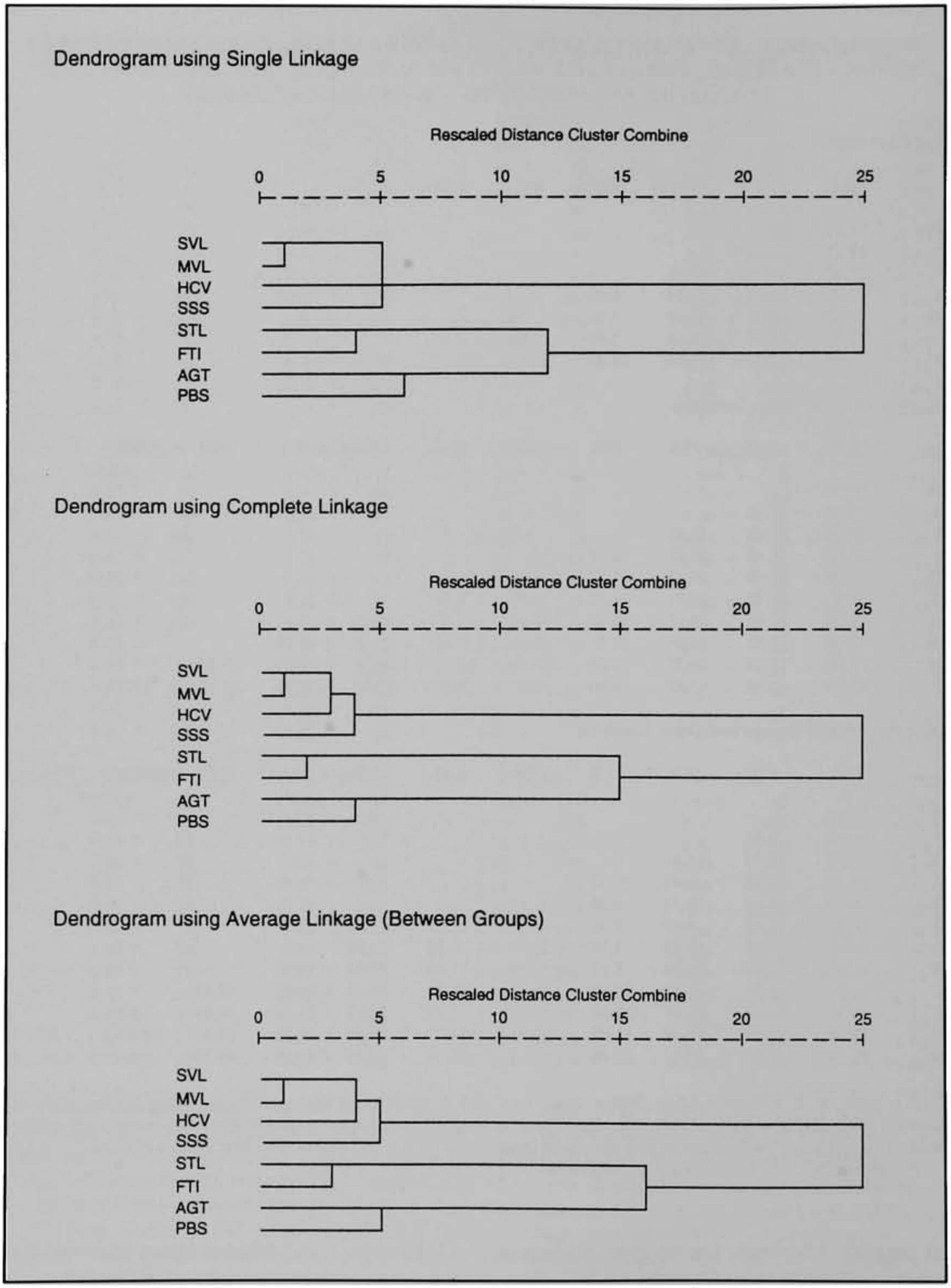

Fig. 7. Cluster analysis results, general localities compared. SVL = Surprise Valley; MVL = Monitor Valley; HCV = Hidden Cave; SSS = Silent Snake Springs; STL = Stahl; FTI = Fort Irwin inclusive; AGT = Alabama Gates; PBS = Pinto Basin.

teristics and differing mainly in length and thickness, in that Pinto Basin forms appear to be more massive than their Owens Valley counterparts.

At face value, these initial comparisons imply that there is little morphological order to the southern bifurcate-stemmed point expression, that each collection is essentially unique and observed relationships among samples from different localities are merely random. However, this is a misleading appraisal. Further examination of the southern samples suggests that there are, in fact, quite predictable relationships within these point populations.

When segregated by individual site, the Fort Irwin collections themselves show a surprising amount of morphological variation. Two distinct groups or modes are apparent among the four Fort Irwin locations that yielded 25 or more points (Tables 3 and 4), one (from the Awl and Goldstone sites) characterized by larger, more robust artifacts, the other (from the Rogers Ridge and Floodpond sites) by much smaller specimens. It is probably significant that these two modes closely track toolstone material distributions at the installation, with sites yielding "large" points situated in proximity to extensive alluvial deposits that contain abundant basalt and cryptocrystalline cobbles, and those with "small" points located in Tiefort Basin, a toolstone-poor valley along the southeastern margin of the fort (Basgall 1993a; Hall 1993; Basgall and Hall 1994). The two groups separate cleanly, the Awl/Goldstone specimens differing only with respect to stem length, while the Rogers Ridge/ Floodpond samples show no significant differences in any attributes.

Results of Awl/Rogers Ridge comparisons highlight the large-versus-small contrasts alluded to above, showing divergence in variables of length, blade width, and weight, but uniformity in elements of thickness and stem form (neck and basal widths, shoulder configuration). Morphological variation evident among Pinto points within an area as restricted as Fort Irwin, at sites that are no more than 30 km. distant from one another, mirrors that seen in the Stahl/Alabama Gates analysis. In both instances, there is at least general correspondence between point form and raw material distribution, with contexts more distant from toolstone sources marked by artifacts of reduced mass. These relationships are best exemplified at Fort Irwin, where modal similarities are greatest among attributes least prone to alteration from resharpening (e.g., stem morphology), and most divergent in variables more susceptible to use-related modification (e.g., blade morphology).

Once segregated by site, there is a much better fit between the Fort Irwin bifurcate-stemmed points and those from other southern localities (Table 4). The "small" mode evidenced with the Rogers Ridge specimens shows striking similarities with the Pinto Basin forms, comparable especially in stem morphology but also in most length, width, and thickness measures. The Rogers Ridge/Alabama Gates comparisons are somewhat less parallel, but there is clearly greater correspondence than suggested by the initial assessment using inclusive Fort Irwin projectile point data. Equally compelling are the Stahl/Awl data, which demonstrate strong convergence between the "large" Fort Irwin mode and points from Little Lake; these samples differ significantly only with respect to one of 12 attributes (neck width).

Cluster analyses of points from specific Fort Irwin sites and the other major localities (Table 5, Fig. 8) identified three main morphological clusters. While the four northern Gatecliff Split-stem localities continue to form a discrete unit, the southern localities align themselves in an altogether different fashion. Conforming essentially to the "large" and "small" modes described above, the former (more similar) cluster includes points from Awl, Goldstone, and Stahl; greater variation is evident in the other cluster, Rogers Ridge and Floodpond forms being most closely related, and Alabama Gates and Pinto Basin

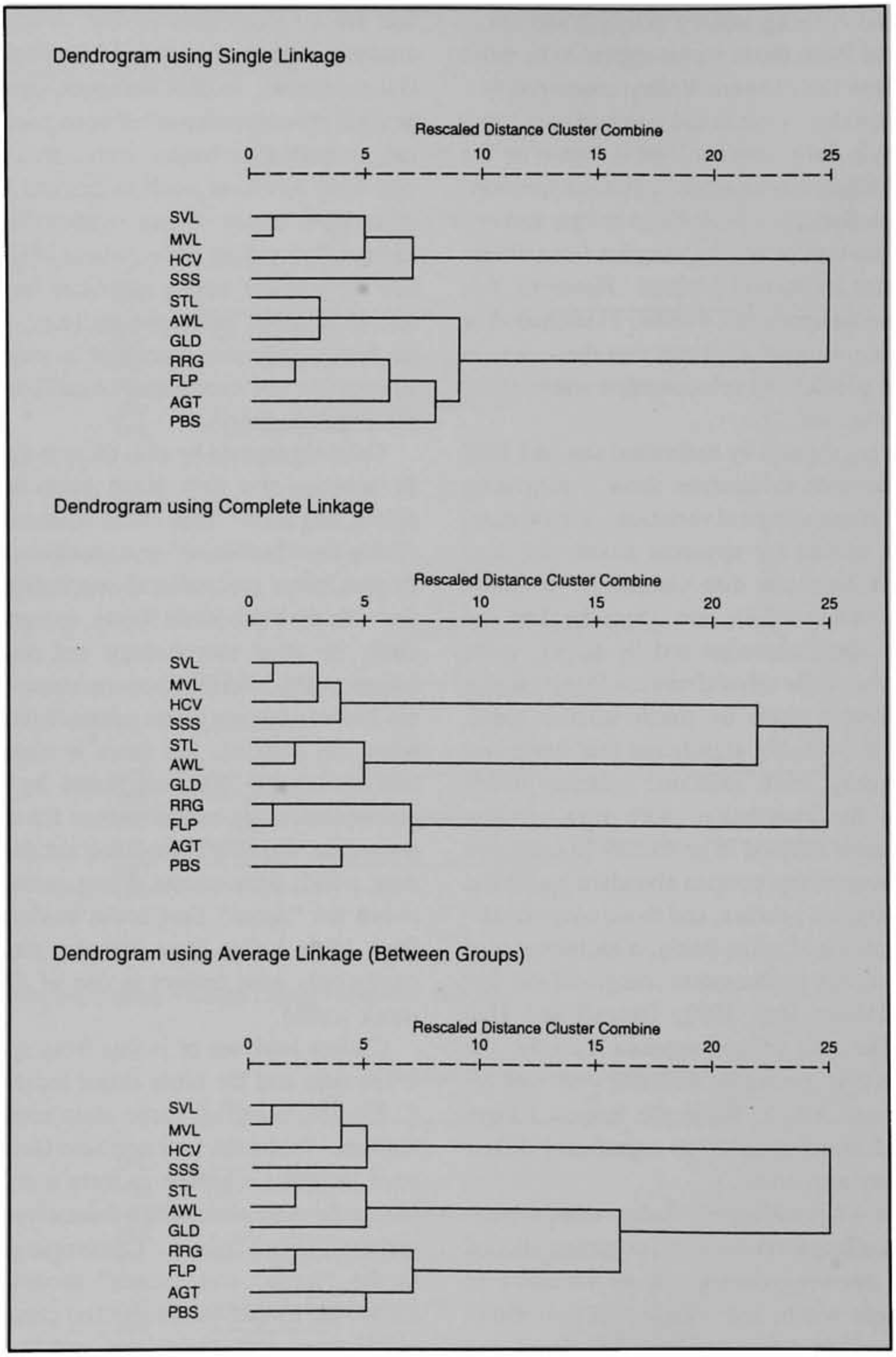

Fig. 8. Cluster analysis results, Fort Irwin sites and other localities compared. SVL = Surprise Valley; MVL = Monitor Valley; HCV = Hidden Cave; SSS = Silent Snake Springs; STL = Stahl; AWL = Awl; GLD = Goldstone; RRG = Rogers Ridge; FLP = Floodpond; AGT = Alabama Gates; PBS = Pinto Basin.

more distantly linked. It is noteworthy that the complete linkage (furthest neighbor) clustering technique indicates greater overall similarity between Gatecliff and "large" Pinto/Little Lake series points than either group has to the "small" mode, presumably a consequence of closer parallels in general size parameters (i.e., length, maximum width, weight).

Raw Material Effects in the Southwestern Great Basin

The patterns derived through a more thorough dissection of bifurcate-stemmed projectile points from the subject southwestern Great Basin localities suggest that there are other, regular factors conditioning the form of Pinto points in particular contexts. As geography or spatial proximity both fail to account for relative similarity/dissimilarity, raw material characteristics emerge as likely determinants. This could operate at two levels: first, patterns might reflect toolstone access, perhaps related to reduced availability—either of stone in general or of specific preferred lithic types—prompting increased artifact recycling; or second, the patterns may have emerged as a result of the general flaking qualities of specific material types. Both factors can have important consequences for tool morphology, strongly influencing variation in point size and shape.

The role of toolstone composition can be approached by examining relationships between lithic groups in the diverse Fort Irwin collection and considering how these relate to morphological patterns for the remaining localities (Tables 4 and 6). Generally speaking, all of the identified materials, with the exception of obsidian, occur naturally at Fort Irwin,[4] although it is apparent that basalts and cryptocrystallines are more widely distributed than rhyolite, felsite, or quartzitics. Whereas cobbles/nodules of the former are common constituents of alluvial fan deposits across the installation, the latter occurs in only a few primary contexts.

Looking first at material relationships within Fort Irwin, the greatest morphological similarities are exhibited by Pinto points fashioned from locally available toolstones (Table 4). Comparisons of cryptocrystalline-basalt, cryptocrystalline-rhyolite, and basalt-felsite sample pairings disclosed no attribute differences, while the cryptocrystalline-obsidian and basalt-obsidian pairings showed few convergences. These patterns have two implications. First, the similarity between points manufactured from fine-grained cryptocrystalline/felsite and coarse-grained igneous stone suggests that form is not overly constrained by material qualities. This is evidenced on the whole by minimal attribute differences (axial length and neck width only) between Fort Irwin points of combined fine-grained (cryptocrystalline, obsidian, felsite) and coarse-grained (basalt, rhyolite, quartzitic) toolstones. Second, variability in the obsidian specimens is primarily evident in attributes that are most susceptible to attrition through use (point length, blade width, weight).

That stem characteristics remain mostly stable across both local and exotic toolstone classes not only reflects the effects of reworking, but implies that all artifacts derived from the same initial population. Inasmuch as it is assumed that quartzitic points were typically made from indigenous material, parallels with the morphology of obsidian forms likely arise from other factors (see below). These same broad affinities extend to other localities in the southwestern Great Basin. Statistics underscore the convergence of Fort Irwin obsidian points with samples from Alabama Gates and Pinto Basin, of Fort Irwin quartzitic points with Pinto Basin, and of Fort Irwin cryptocrystalline points with Stahl, in the last instance differing according to certain width variables.

Cluster analyses further emphasized levels of overall similarity among the samples (Table 5, Fig. 9). Not surprisingly, bifurcate-stemmed points from the northern Gatecliff-type localities again comprise a distinct group relatively distantly related to those in the southern group, and it is

Table 6
ATTRIBUTE STATISTICS[a] FOR PINTO SERIES PROJECTILE POINTS FROM FORT IRWIN BY MATERIAL TYPE

MTR	STS	ML	AL	SL	BI	MW	BW	NW	MT	WT	DSA	PSA	NOA
CCR	num	30	31	44	43	35	40	43	41	24	46	47	46
	avg	41.0	37.5	10.7	3.0	23.8	18.3	16.6	8.0	7.4	213	105	109
	std	7.8	8.1	3.0	1.3	3.5	2.9	3.0	1.4	3.0	21	16	26
	max	62.9	58.7	20.9	6.1	30.0	25.0	22.6	11.6	13.1	260	144	160
	min	28.0	24.7	3.8	0.6	16.3	13.0	9.3	5.5	2.7	174	75	60
OBS	num	14	18	21	20	25	21	28	30	12	29	30	29
	avg	29.0	25.3	9.7	2.5	20.2	17.9	15.5	6.9	3.7	227	99	128
	std	3.9	4.0	2.7	1.5	4.3	2.7	3.5	1.5	1.4	19	15	19
	max	35.6	32.7	16.8	4.5	35.5	23.0	26.8	11.0	6.5	266	131	169
	min	23.6	17.0	5.4	0.2	14.2	13.5	9.9	4.4	2.0	192	70	94
BAS	num	66	67	105	100	97	92	114	112	46	118	119	118
	avg	40.3	36.8	11.2	3.4	24.1	18.8	17.9	7.0	7.1	220	105	115
	std	8.8	8.6	3.1	1.3	3.9	3.9	3.1	1.4	3.3	20	15	24
	max	60.9	56.3	23.2	7.0	33.9	33.9	28.4	11.0	16.3	271	153	182
	min	19.2	16.2	4.4	0.7	13.0	8.9	11.6	3.5	1.1	180	71	64
QTZ	num	4	4	7	7	7	7	8	8	2	8	8	8
	avg	33.8	30.9	10.8	2.4	21.6	17.9	17.0	8.4	4.6	218	97	118
	std	6.1	6.4	1.8	0.7	3.1	2.6	2.6	1.1	0.1	16	12	23
	max	42.0	39.0	13.3	3.2	28.0	23.0	23.0	10.4	4.7	244	116	150
	min	26.8	23.6	8.2	1.3	17.5	14.3	15.0	6.5	4.5	193	78	77
FEL	num	5	5	6	6	5	6	6	6	5	6	6	6
	avg	40.7	38.2	9.8	2.5	23.9	18.4	17.2	6.6	6.9	207	110	98
	std	9.6	11.0	2.1	1.2	2.7	3.4	3.4	0.9	3.6	15	10	16
	max	59.1	58.9	14.0	4.1	27.9	23.9	24.1	7.9	13.8	232	127	124
	min	31.4	27.3	7.7	0.2	21.5	14.3	13.2	4.9	4.1	185	100	83
RHY	num	22	26	32	29	31	28	36	34	16	37	37	37
	avg	46.5	43.1	12.2	3.4	23.3	18.9	17.4	8.3	9.1	218	103	115
	std	10.2	10.0	2.7	1.9	3.1	3.0	1.8	1.7	4.1	21	13	23
	max	68.4	63.4	20.0	10.1	31.2	27.3	23.9	14.3	20.6	250	127	154
	min	25.9	25.2	7.0	0.7	19.2	11.9	14.9	5.6	2.7	180	77	70
ALL	num	141	151	216	206	201	194	236	232	105	245	248	245
	avg	40.1	36.6	11.0	3.2	23.3	18.6	17.2	7.4	7.0	219	104	115
	std	9.7	9.8	3.0	1.5	3.9	3.4	3.1	1.5	3.5	20	15	24
	max	68.4	63.4	23.2	10.1	35.5	33.9	28.4	14.3	20.6	271	153	182
	min	19.2	16.2	3.8	0.2	13.0	8.9	9.3	3.5	1.1	174	70	60

[a] MTR = lithic material; CCR = cryptocrystalline; OBS = obsidian; BAS = basalt; QTZ = quartz and quartzitic; FEL = felsite; RHY = rhyolite; ALL = all specimens; STS = statistic; num = number of complete measurements; avg = average; std = standard deviation; max = maximum; min = minimum; ML = maximum length; AL = axial length; SL = stem length; BI = basal indentation; MW = maximum width; BW = basal width; NW = neck width; MT = maximum thickness; WT = weight; DSA = distal shoulder angle; PSA = proximal shoulder angle; NOA = notch opening angle. Values are in millimeters (linear measure), grams (weight), and degrees (angle). Total of 256 projectile points in sample.

the latter that are of key interest. As before, there are two principal clusters indicated, corresponding loosely to the "large" and "small" modes identified previously. Obsidian and quartzitic points from Fort Irwin conform morphologically most closely with samples from Alabama Gates and Pinto Basin, respectively. These relationships are especially intriguing given that

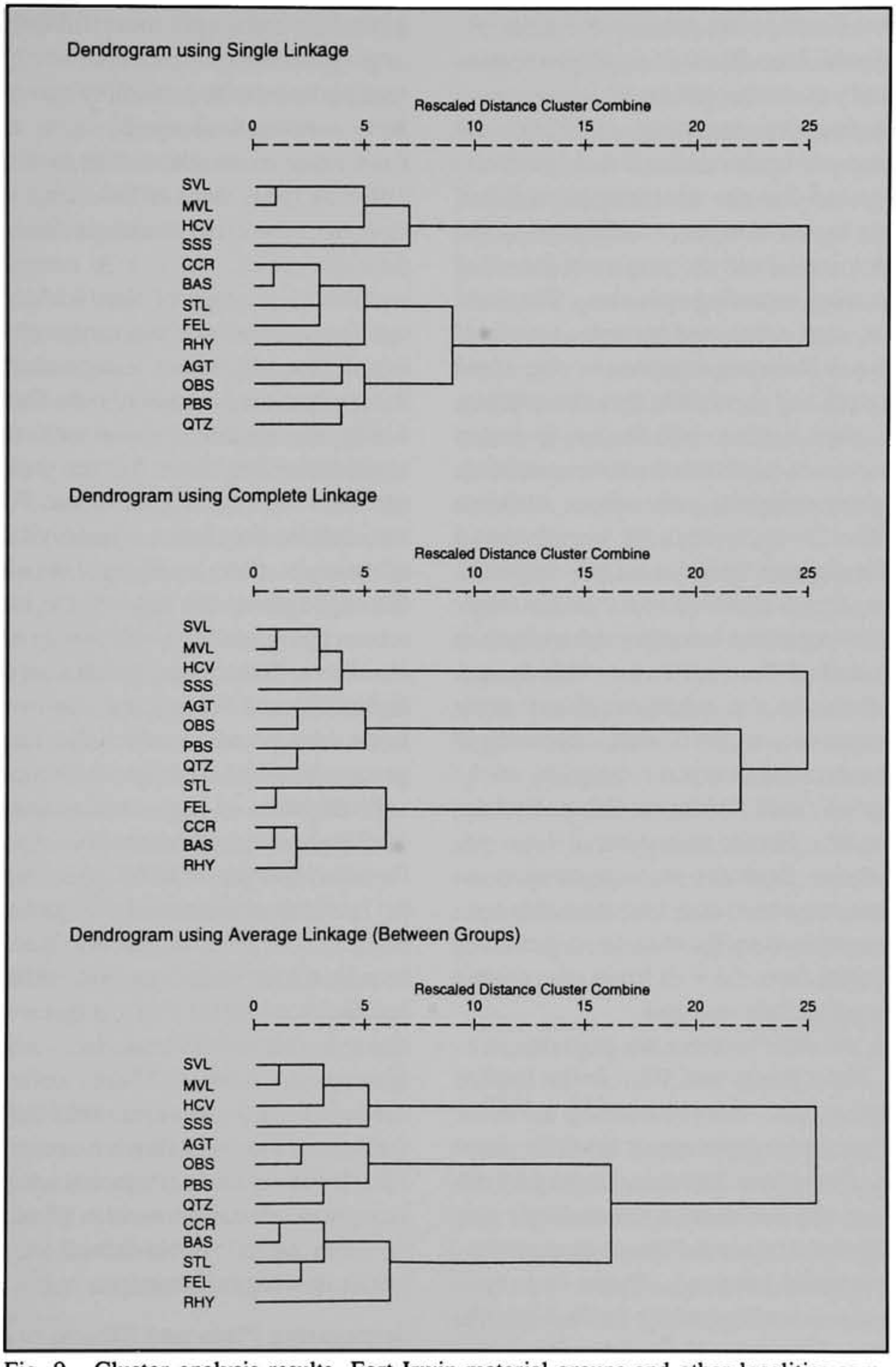

Fig. 9. Cluster analysis results, Fort Irwin material groups and other localities compared. SVL = Surprise Valley; MVL = Monitor Valley; HCV = Hidden Cave; SSS = Silent Snake Springs; STL = Stahl; AGT = Alabama Gates; PBS = Pinto Basin; CCR = cryptocrystalline; BAS = basalt; FEL = felsite; RHY = rhyolite; OBS = obsidian; QTZ = quartz.

the Alabama Gates points are almost wholly obsidian, while the Pinto Basin assemblage contains predominantly quartzitic points.

Two inferences regarding obsidian and quartzitic use can be drawn from these patterns. First, it appears that the character of obsidian points in the region is highly conditioned by access to raw material and the presumed extended lag time between retooling episodes. The Stahl assemblage, also dominated by volcanic glass, comes from a location adjacent to the Coso obsidian source and expectedly contains artifacts that, even when broken, still frequently retain considerable mass and rejuvenation potential. Volcanic glass projectile points from Alabama Gates and Fort Irwin, by contrast, were moved a considerable distance from the source, probably as part of an active toolkit, and the archaeological specimens represent heavily used artifacts at or near the end of their use-lives. This has resulted in substantial size reduction, as well as alteration to certain elements of stem morphology. What seems apparent is that the three sets of obsidian samples (Stahl, Alabama Gates, Fort Irwin), however different in empirical shape parameters, derive from the same population; to suggest otherwise would entail the untenable conclusion that depositionally associated points of other lithologies from the Fort Irwin sites constitute an altogether different type.

Second, parallels between the quartzitic samples from Pinto Basin and Fort Irwin require another explanation. Notwithstanding the small number of quartzitic specimens available from Fort Irwin, similarities between the samples remain striking. In this case, it seems likely that shared attributes relate to the mechanical properties of the material involved. Points from both collections are exceedingly thick for their length, display some of the most shallow basal indentations, and manifest perhaps the weakest shouldering of any categories under consideration. Consistent with the original observations of Harrington (1957), these characteristics suggest that quartzitics are simply more difficult to form into large, thin, well-notched artifacts. Again, disregarding the remote possibility that quartzitic artifacts recovered alongside those manufactured from other materials at Fort Irwin comprise a different type, there is little choice but to conclude that the Pinto Basin specimens are part of the same series.

The morphology of Fort Irwin points of the remaining material types (cryptocrystalline, basalt, felsite, rhyolite) corresponds closely to bifurcate-stemmed forms from the Stahl site (Table 5, Fig. 9). Specific comparisons vary according to clustering technique, but the greatest similarities were indicated for Stahl and Fort Irwin felsite, and for Fort Irwin cryptocrystalline and basalt samples; Fort Irwin rhyolite points are more distantly linked, but fall into the same group or series. Incorporating a wide range of materials—obsidian at Stahl, fine-grained Fort Irwin cryptocrystalline and felsite, and coarse-grained Fort Irwin basalt and rhyolite—the formal convergence reflected in this group is more consistent with elements of raw material availability than working qualities. These nonobsidian points from Fort Irwin, made of lithic types uniformly present (sometimes abundantly) in geological formations in and around the installation, conform broadly to the "large" mode identified previously and likely represent artifacts that were discarded closer to the time of manufacture than obsidian forms from the fort. Taken collectively, both site location and toolstone variables conditioning the appearance of bifurcate-stemmed points at Fort Irwin relate in predictable fashion to artifacts from other southwestern Great Basin localities, leaving little doubt that all are part of a single morphological series.

Segregating Pinto and Elko Series Points in the Southwestern Great Basin

The Monitor Valley typology (Thomas 1981, 1983) effectively segregates Gatecliff Split-stem and Elko series projectile points in the central-western and northwestern Great Basin, but the issue has yet to be explored fully with regard to Pinto and Elko series forms in the southwestern region. While the two groups seem different on a qualitative, impressionistic basis, of concern is the degree to which attributes overlap and type attributions can be replicated between observers. In their evaluation of a small sample of Pinto points from the Awl site, Vaughan and Warren (1987) found the Monitor Valley system unfit for the task. When applied to the Mojave Desert samples, criteria developed to separate Gatecliff Split-stem and Elko series forms in central Nevada incorrectly identified 15 of 21 (71.4%) Pinto specimens as Elko points, and two others were left untyped. Obtained because proximal shoulder values on the sample artifacts frequently exceeded 110°, these poor results highlight the need for region-specific discriminating procedures (as Thomas [1981] cautioned).

Univariate t-statistic comparisons of Pinto and Elko points from Fort Irwin showed substantial differences (alpha = 0.05) in every attribute except weight: maximum length, t = 4.09/154 degrees of freedom (df); axial length, t = 4.65/164 df; stem length, t = 7.70/270 df; basal indentation, t = 2.64/260 df; maximum width, t = 3.76/243 df; basal width, t = 2.95/234 df; neck width, t = 4.02/292 df; maximum thickness, t = 9.51/291 df; weight, t = 1.36/116 df; distal shoulder angle, t = 16.50/302 df; proximal shoulder angle, t = 9.48/304 df; notch opening angle, t = 17.87/298 df (Tables 6 and 7). Five measures were especially divergent, Pinto points having significantly longer stems, greater thickness, and markedly different shoulder configurations (increased distal shoulder angles, reduced proximal shoulder angles, much wider notch opening angles).

Much the same pattern emerged through statistical comparison of the same Pinto sample with Elko series points from Gatecliff Shelter (Thomas 1983). Pinto points differed significantly from corner-notched variants in all measures except maximum and basal width, most markedly in stem length, neck width, and shoulder angles. Divergence with eared variants was less extreme, but major differences in stem length, neck width, thickness, and shoulder morphology remained.

Even with such clear-cut morphological differentiation, application of Monitor Valley criteria to the much larger Fort Irwin sample under examination here yielded results similar to those of Vaughan and Warren (1987). The existing key incorrectly classified eight of 54 (14.8%) Elko, and 59 of 256 (23.0%) Pinto points, again mainly due to unanticipated variance in proximal shoulder measures (Tables 2 and 6). Proximal shoulder angles for bifurcate-stemmed points from Monitor Valley average 12° smaller than for equivalent Fort Irwin examples; stem elements on Pinto points from the Mojave Desert tend to expand more than on Gatecliff Split-stem forms in the north. Perhaps the simplest solution to this problem in the southwestern Great Basin lies in revising classification criteria to use notch opening angle as a discriminator for both Elko and Pinto series points. As distal shoulder values also tend to be greater among Pinto forms, a notch opening threshold of 80° provides effective segregation without the need to develop wholly new attributes (cf. Vaughan and Warren 1987); thus,

Elko series = BW > 10.0 mm.; 110° ≤ PSA ≤150°, or NOA < 80°
Pinto series = BW > 10.0 mm.; PSA ≤ 100°, or NOA ≥ 80°

where BW is basal width, PSA is proximal shoulder angle, and NOA is notch opening angle. This regional adjustment to the Monitor Valley key improves classification success dramatically, incorrectly assigning just four of 54 (7.4%) Elko and nine of 256 (3.5%) Pinto series artifacts in the Fort Irwin collection.

Discriminant analysis techniques can also be used to compare the Elko and Pinto series samples. Attributes of interest include measures that are both most stable and commonly preserved on

Table 7
ATTRIBUTE STATISTICS[a] FOR ELKO SERIES PROJECTILE POINTS FROM FORT IRWIN

Toolstone	STS	ML	AL	SL	BI	MW	BW	NW	MT	WT	DSA	PSA	NOA
CRS	num	4	4	8	8	6	7	8	8	3	8	8	8
	avg	43.8	42.2	9.9	1.5	25.1	22.2	17.7	7.3	9.2	187	125	62
	std	8.8	8.8	0.9	1.0	4.1	2.8	2.6	1.7	3.9	16	14	26
	max	52.8	51.6	11.0	2.8	30.0	26.8	22.3	10.5	12.8	201	141	100
	min	35.5	35.0	8.1	0.0	19.0	19.2	15.0	5.6	6.9	165	101	25
FNE	num	11	11	48	48	38	35	50	53	10	51	50	47
	avg	54.2	51.9	7.4	2.6	25.9	20.0	15.0	5.1	8.1	170	125	48
	std	15.2	14.4	1.4	2.8	3.5	3.3	3.7	0.9	3.8	18	16	27
	max	82.2	71.8	11.4	10.4	35.2	28.0	25.2	7.0	15.3	210	161	96
	min	33.6	30.8	4.0	0.0	19.4	12.9	7.7	2.8	3.7	139	92	7
ALL	num	15	15	56	56	44	42	58	61	13	59	58	55
	avg	51.4	49.4	7.8	2.5	25.7	20.3	15.3	5.4	8.4	172	125	50
	std	14.0	13.4	1.6	2.5	3.5	3.3	3.7	1.3	3.6	18	16	26
	max	82.2	71.8	11.4	10.4	35.2	28.0	25.2	10.5	15.3	210	161	100
	min	33.6	30.8	4.0	0.0	19.0	12.9	7.7	2.8	3.7	139	92	7

[a] ALL = all specimens; CRS = coarse-grained toolstone (basalt, rhyolite, quartz, quartzite); FNE = fine-grained toolstone (cryptocrystalline, obsidian, felsite); STS = statistic; num = number of complete measurements; avg = average; std = standard deviation; max = maximum; min = minimum; ML, maximum length; AL = axial length; SL = stem length; BI = basal indentation; MW = maximum width; BW = basal width; NW = neck width; MT = maximum thickness; WT = weight; DSA = distal shoulder angle; PSA = proximal shoulder angle; NOA = notch opening angle. Values are in millimeters (linear measure), grams (weight), and degrees (angle). Total of 62 projectile points in sample.

fragmentary artifacts, apart from thickness confined to seven elements of stem morphology (stem length, neck and basal width, basal indentation, distal and proximal shoulder angles, and notch opening angles). All of these variables were considered in the initial comparison, with results suggesting a high level of segregation ($x^2 = 330.56$, df = 8, $p < 0.0001$) and derived function coefficients successfully classifying 97.2% of 318 cases (97.7% of 256 Pinto, 95.2% of 62 Elko).

Results further indicated that similar levels of discrimination might be achieved with fewer variables, three (stem length, basal width, and notch opening angle) again showing strong differences ($x^2 = 284.34$, df = 3, $p < 0.0001$) and generating a function that classified 95.3% of the cases correctly (95.3% Pinto, 95.2% Elko). This function can be used to segregate Elko and Pinto series points in the Mojave Desert:

type = (SL x 0.1817) + (NOA x 0.0347) - (BW x 0.0941) - 3.6756

(< -1.0 = Elko assignment, > -1.0 = Pinto attribution)

where SL is stem length, NOA is notch opening angle, and BW is basal width. Whether differentiated according to revised Monitor Valley criteria or using this discriminant function, Elko and Pinto series points in the southwestern Great Basin can be identified with some reliability. Morphological overlap clearly exists, probably as a consequence of tool breakage/reworking and toolstone flaking qualities, coarse-grained Elko points having more poorly defined notches and shoulders than fine-grained specimens (Table 7); as well, quantitative procedures will never fully replace the role of context and regional experience in tool classification.

Bifurcate-Stemmed Points in the Eastern Great Basin

Comparable attribute measurement data are unavailable for the eastern Great Basin; however, Holmer (1980, 1986) offered a number of important observations based on analyses of bifurcate-stemmed samples from several localities. For example, discriminant analysis of 24 illustrated Pinto variants from the Stahl site (Harrington 1957) showed no significant difference from specimens recovered in Utah, suggesting that the two populations are morphologically very similar. By contrast, a comparison of Gatecliff Split-stem points from Monitor Valley with collections from the eastern Great Basin (Sudden Shelter, Danger Cave, and Hogup Cave) indicated significant divergence in form (Holmer 1986); derived discriminant function coefficients reportedly misidentified just four of 75 artifacts (5.3%). Holmer (1986) suggested that the key differences between the two groups related to the configuration of basal notches and stem shape; that is, broader, deeper indentations on the Gatecliff points, resulting in more pointed basal projections and smaller proximal shoulders on Gatecliff forms, contributing to wider notch openings. Any final determination must await further analysis of the Utah samples, but these descriptions suggest close morphological relationships with points from the southwestern Great Basin and would provisionally support the Pinto attribution proposed by Holmer (1986).

Barlow and Metcalfe's (1993) discussion of projectile points from Joes Valley Alcove in central Utah highlights the caution that must be exercised with any quantitative classificatory scheme. Using Holmer's (1986) criteria, five specimens from lower strata at the site were classed as Pinto forms, with three of the five assigned as Gatecliff Contracting-stem (cf. Gypsum Cave or Elko Contracting-stem) and two as Gatecliff Split-stem using the Monitor Valley system (Thomas 1981, 1983). Only one of the latter bears any real resemblance to typical Pinto forms from the southwestern Great Basin, the remainder looking more akin to atypical Elko forms (and were, in fact, identified as such by the second highest classification coefficient in Holmer's [1986] model). There is clearly much more work that remains in sorting eastern Great Basin dart point morphologies.

TEMPORAL VARIATION IN BIFURCATE-STEMMED POINTS

Statistical comparisons demonstrated that bifurcate-stemmed points from the western Great Basin form two distinct morphological groups, gracile Gatecliff (split-stem) series forms in central and northern Nevada, and robust Pinto series variants in the southwestern Great Basin and California deserts. Points from sites in the eastern Great Basin may comprise still a third group, but share clear similarities to the Pinto series. It still remains, however, to examine the temporal parameters of these morphological units.

Thomas (1981) summarized much of the radiometric support for Gatecliff series dart points, and there seems little doubt they are primarily Late-Middle and Late Holocene time markers throughout their primary geographic range. At Gatecliff Shelter itself (Thomas 1983), the floruit of split-stem points (Horizons 8-9) was bracketed by radiocarbon dates of 4,140 ± 70 RCYBP (UCLA-1895E) and 3,125 ± 75 RCYBP (UCLA -1895J). Dates from Hidden Cave (Thomas 1985) are comparable, ranging from 5,365 ± 380 RCYBP (WSU-2452) to 3,050 ± 200 RCYBP (L-289-BB). Also comparable was a suite of 10 radiocarbon assays from Kramer Cave (Hattori 1982), which extends from 3,900 ± 100 RCYBP (UCLA-670) to 3,620 ± 80 years RCYBP (UCLA-976). Notably, a foreshaft from this deposit retaining a Gatecliff series point assayed at 3,830 ± 110 RCYBP (GaK-2387).

More problematic dates are available from Surprise Valley and Silent Snake Springs. O'Connell (1971) reported an age of 2,850 ± 80 RCYBP (UCLA-1222) for a house floor at the Rodriguez site bearing Gatecliff points, suggesting that this dates the latest persistence of the form and may, in fact, be slightly too recent. A single assay of 5,250 ± 380 RCYBP (WSU-994) on artiodactyl bones from the Silent Snake Springs site (Layton and Thomas 1979) is not directly associated with split-stem points, but the inferred depositional span is short and such artifacts clearly relate to the principal component. All in all, radiometric data continue to confirm the estimate of Thomas (1981), providing Gatecliff series forms with an age of ca. 5,000 to 3,250 B.P.

Temporal Patterns in the Southwestern Great Basin

Although controversy still surrounds the age of bifurcate-stemmed points in the southwestern Great Basin, Pinto points certainly appear to predate their northern counterparts. Particulars are taken up elsewhere (Basgall n.d.b, 1995; Schroth 1994), but even a brief review of the evidence substantiates the relative antiquity of the form. As alluded to above, it has proven difficult to obtain radiometric estimates for materials in reliable association with Pinto artifacts. Usually consisting of shallow, open deposits with complex formational histories, many dated sites also contain numbers of Great Basin Stemmed (cf. Lake Mohave, Silver Lake) points, which are Early Holocene markers for the region. In these cases, it is difficult, if not impossible, to directly relate the few and scattered radiocarbon determinations to specific artifact types or assemblages.

Acknowledging these constraints, a cautious reading of feature-derived radiocarbon assays and obsidian hydration measurements from Fort Irwin (Basgall n.d.b, 1993b, 1995; Basgall and Hall 1994) suggests that Pinto components fall between ca. 7,500 and 4,000 years in age. Determinations in this range include single radiocarbon assays from Goldstone (5,540 ± 90 RCYBP [Beta-55691]) and Floodpond (6,640 ± 65 RCYBP [Beta-45611]), four of five from the Henwood site (7,400 ± 280 RCYBP [AA-800] to 4,360 ± 280 RCYBP [AA-798]), and two of seven dates from Rogers Ridge (5,050 ± 230 RCYBP [Beta-12186] and 4,040 ± 110 RCYBP [Beta-12841]). Pinto series points are common in all these contexts, but only Goldstone and Floodpond lack the Great Basin Stemmed variants (Hall 1993; Basgall and Hall 1994).

Hall (1993) evaluated the full suite of dates from Rogers Ridge in some detail, underscoring the especially complex history of site sediments and discussing the likelihood that several of the earliest dates relate to spring-deposited organics rather than cultural activity. Although two dates on a hearth at the base of the Awl site deposit (9,470 ± 115 RCYBP [Beta-16313] and 9,410 ± 115 RCYBP [Beta-16100]) have been cited by some in support of an Early Holocene age for Pinto points (e.g., Schroth 1994), they in fact appear to pertain to a lower, mixed component containing mostly Great Basin Stemmed forms (Basgall and Hall 1993); Pinto points occur primarily in the upper component and on the site surface.

Accelerator mass spectrometry (AMS) dates obtained from *Olivella* Type A1 beads (see Bennyhoff and Hughes 1987) from most of these same sites (Goldstone, Floodpond, Rogers Ridge, and Awl) pose further interpretational difficulties (Basgall and Hall 1994). All are from contexts believed to have firm Pinto affinity, with assays for these ornaments ranging between 10,085 ± 85 RCYBP (AA-12405) at Rogers Ridge and 8,930 ± 85 RCYBP (AA-12406) at Floodpond. While the beads themselves are of certain human introduction, there are other reasons to question the reliability of these dates, in that charcoal-shell pairings at Goldstone and Floodpond are inconsistent, differing by 2,300 to 3,600 years even after correction for reservoir effect (ca. 700 ± 200 years [cf. Taylor et al. 1986]). They also show a poor fit with hydration studies of obsidian artifacts from the subject sites (see below) which, with the exception of Rogers Ridge, are consonant with occupation primarily during the Middle Holocene. Processes leading to these discrepancies could conceivably have a technical or cultural origin, relating variously to problems in the AMS dating of small shell samples, presence of older artifacts within what are generally more recent deposits, or the use of fossil materials for ornament production.

Schroth (1992, 1994) reported a series of radiometric dates from the Stahl and Pinto Basin localities. Assays for a variety of materials from Stahl ranged between 8,900 ± 65 RCYBP (AA-10536) and "modern" (UCR-2623), with five charcoal and bone collagen determinations less than 2,500 years old, three *Olivella* beads predating 8,000 years, and four carbonized "organic" samples (substances adhering to bone) of uncertain origin ranging between ca. 8,900 and 4,400 years. These dates show no tendencies to cluster by depth, the same kinds of organic materials yielding comparable estimates at the top and bottom of the deposit. Six assays (four on beads, and one each on charcoal and bone) from Pinto Basin were uniformly ancient, ranging between 9,330 ± 90 (AA-8613) to 7,225 ± 85 (AA-8615) RCYBP, except one postdating 8,000 years.

This is not the place to examine the contextual implications of these results at great length, but two comments merit notation in view of the wide citation they have been given. First, there are serious questions regarding depositional association, both localities having produced Great Basin Stemmed as well as Pinto artifacts, and the charcoal/collagen dates from Stahl being consonant with marked stratigraphic disturbance. Second, the oldest assays consistently relate to shell and "unknown" organics (the latter identified as possible carbonized flesh or sinew by Schroth [1994], but which are absent from other, often later faunal assemblages in the same region). Insofar as Pinto points do occur regularly in deposits after ca. 7,500 years B.P. in the region, whatever their time of appearance, it is perhaps significant that 10 of 11 (90.9%) of reported *Olivella* bead dates (Basgall and Hall 1994; Schroth 1994) are older than this. Given the various uncertainties and contradictions, for the moment it seems risky to simply accept these dates as reliable signatures of Pinto occupation in the southwestern Great Basin.

Meighan (1981) was first to bring obsidian hydration to bear on the age of Pinto series points, evaluating measurements from Stahl in terms of two hydration rates (220 years/micron [Meighan 1978] and 340 years/micron [Ericson 1977]).[5] Two groups or modes were recognized in his hydration profile, an earlier range of 17.3 to 13.5 microns and a later range of 12.3 to 6.4 microns, but this was primarily a function of the plotting intervals used (Meighan 1981:207). The Stahl site hydration distribution is better characterized as having one mode and a long tail (Basgall and Hall 1994; Basgall 1995).

Based on the aforementioned rates, Meighan (1981) calculated estimates for the main periods of site occupation (2,700 to 1,410 and 4,180 to 2,180 B.P.) and for the overall span of artifact deposition (3,810 to 1,410 and 5,880 to 2,180 B.P.). These were found in general agreement with select radiocarbon dates (mostly from sites well to the north) and with the original ca. 4,000 to 3,000 B.P. site age estimate advanced by Harrington (1957), although Meighan (1981) placed the occupation peak between ca. 3,400 and 2,100 years ago. Jenkins and Warren (1984) subsequently contrasted Stahl data to measurements on 65 artifacts (mostly debitage) from the Awl site, using the 344 years/micron rate (Ericson 1977) to derive actual age estimates. Excluding values under 8.0 microns (as intrusive) from both samples and larger outliers (as marking an earlier occupation) from Awl, they concluded that occupations at the the two sites extended between 5,920 and 2,790 B.P. and between 6,190 and 2,960 B.P.

These dates effectively represent the first "absolute" age estimates for Pinto artifacts in the southwestern Great Basin, all prior guesses being based on impressions regarding the relationship of site context and inferred paleoclimatic conditions, or on radiocarbon ages for presumed later materials or sites outside the region. It is now possible to question certain premises of these studies: that hydration data from Stahl and Awl can be compared directly without adjustment for differences in effective hydration temperature (EHT); that inclusive hydration measurement ranges provide an accurate reflection of site (and Pinto Period) occupation; and that a hydration rate of 344 years/micron is the best available for assigning age to the artifacts.

More recent examinations of the hydration rate of Coso obsidian provide a better idea of the age of these and other Pinto-age obsidian samples. After correction for differential EHT,[6] the Stahl mean of 11.8 microns (n = 61, standard deviation [std] = 2.9) is statistically commensurate with hydration profiles for Goldstone (n = 48, mean = 11.7, std = 1.8), Floodpond (n = 15, mean = 11.6, std = 2.2), Awl (n = 141, mean = 11.9, std = 2.4), and Henwood (n = 66, mean = 12.2, std = 3.2). The hydration distribution at Rogers Ridge is markedly larger (n = 103, mean = 15.7, std = 3.3), and is more consistent with Fort Irwin components dominated by Great Basin Stemmed point forms (Warren 1991; Basgall 1993a, 1995; Hall 1993).

Upon EHT correction, an empirical hydration rate developed recently using radiocarbon assay/hydration measurement pairings from sites in the southern Owens Valley[7] yielded age estimates of ca. 6,200 to 5,720 B.P. for mean Fort Irwin and Stahl site values (excepting Rogers Ridge, which converts to 9,770 B.P.). Using 20% and 80% percentiles to determine peak occupation spans (i.e., excluding the lower 20% and upper 20% of hydration readings per site-specific profile)—which is preferable to inconsistently including/excluding outlier values—provides the following age estimates for Pinto occupation at individual locations: 6,300 to 3,400 B.P. for Stahl, 7,050 to 4,350 B.P. for Goldstone, 7,400 to 3,800 B.P. for Floodpond, 7,400 to 4,450 B.P. for Awl, and 7,500 to 4,000 B.P. for the Henwood site.

Together, these results lend strong support to the argument that Pinto point-bearing components in the southwestern Great Basin date mainly between ca. 7,500 and 4,000 years B.P., older radiocarbon assays notwithstanding. The currently intractable problem of firmly linking specific radiocarbon dates, obsidian hydration measurements, and artifact forms in such deposits precludes a simple solution. Indeed, if the same requirements set for establishing the authenticity of pre-Clovis occupations in the New World were applied to radiometric associations within these contexts (cf. Toth 1991; Meltzer 1993), many would fail. But whatever the final conclusion, extant data from the southwestern Great Basin substantiate a Middle (and perhaps an Early) Holocene age for the Pinto projectile point series.

Temporal Patterns in the Eastern Great Basin

Radiocarbon dates ascribed to bifurcate-stemmed points in the eastern Great Basin (and Colorado Plateau) conform most closely to age estimates for Pinto forms in the Mojave and Colorado deserts (Aikens 1970; Holmer 1980, 1986). Bifurcate-stemmed points at Sudden Shelter occurred in Strata 1 through 7, but were most prevalent within Strata 3 through 7 (Holmer 1980); this floruit is bracketed by radiocarbon dates of 7,840 ± 330 RCYBP (RL-474) and 7,565 ± 115 RCYBP (UGa-903) in Stratum 2, and an assay of 6,310 ± 240 RCYBP (UGa-906) from the bottom of Stratum 8.

While Hogup Cave dating seems broadly similar, incongruent stratigraphic relationships within the deposit complicate associations. Radiometric assays and artifact distributions imply more than one period of bifurcate-stemmed point deposition (as they do for other dart point forms), ranging between 7,815 ± 350 (GX-1287) and 5,960 ± 100 (GaK-1567) RCYBP (Strata 3 through 7), between 4,610 ± 100 (GaK-1568) and 3,200 ± 140 (GaK-1564) RCYBP, and perhaps later. An age of 8,940 ± 180 RCYBP (Beta-39353) was obtained from the base of Joes Valley Alcove (Barlow and Metcalfe

1993), but it is not certain that the associated points are Pinto forms. Later Holocene occurrence is indicated as well at Swallow Shelter (Dalley 1976), where split-stem points were bracketed by dates of 5,410 ± 170 (RL-235) and 2,850 ± 100 (RL-87) RCYBP. The artifacts from this site (Dalley 1976:26), however, appear to resemble the gracile Gatecliff series more so than the robust, Pinto-like specimens from Sudden Shelter; similar relationships might also account for the later dates from Hogup Cave. Comparable early and late occurrences of bifurcate-stemmed forms are reported in southern Idaho (Miller 1972; Swanson 1972; Butler 1978), where Holmer (1986) attributed those in the early contexts to the Pinto series, and the more recent points to the Gatecliff series.

DISCUSSION

An examination of formal variation in bifurcate-stemmed dart points of the western Great Basin suggests the existence of two major morphological series. Forms in these series share traits of general size—with the attributes of length and width, for example, displaying continuous distributions (Fig. 10)—but are significantly different in attributes of stem and shoulder morphology (Figs. 11 and 12). The northern Gatecliff series has a thinner, more elongate appearance, gracile stems that are short relative to length (average [by locality] stem length/maximum length ratios of 0.18 to 0.22), blades that are narrow relative to width (basal width/maximum width ratios of 0.51 to 0.60), and has well-defined, straight to barbed distal shoulders (angles of 167° to 181°) and parallel proximal shoulders (angles of 89 to 95°). The Pinto series is distinguished by a thicker, squatter configuration, robust stems that are longer and wider (stem length/maximum length ratios of 0.25 to 0.36; basal width/maximum width ratios of 0.77 to 0.89), and shoulders with weaker distal (209° to 226°) and expanding proximal (103° to 112°) angles.

Technological attributes are more difficult to characterize, reflecting expected differences between lithic types and sites, but Gatecliff series points tend to express more refined pressure retouch than Pinto specimens; as with thickness and shoulder form, stoneworking techniques are surely influenced by material properties and common use of coarse-grained toolstone for Pinto artifacts. Lithological/site-specific relationships among assemblages in the southwestern Great Basin further indicate that apparent morphological variation is primarily a function of toolstone constraints. Although somewhat divergent in absolute form, it seems clear that points from Pinto Basin, Fort Irwin, Stahl, and Alabama Gates comprise a single morphological series, and that the Stahl site artifacts are not worthy of unique classification. As with various of the early Gatecliff monikers (cf. Bare Creek, Silent Snake), the concept of a Little Lake series (Lanning 1963; Bettinger and Taylor 1974) can now be abandoned to eliminate continuing confusion.

Available chronological data suggest temporal segregation of the two bifurcate-stemmed point groups. Gatecliff series forms are later Holocene markers dating ca. 5,000 to 3,000 years B.P. throughout their range, while Pinto series points are predominantly Middle Holocene indicators predating ca. 4,000 years B.P. Radiocarbon and obsidian hydration evidence reviewed above imply that the latter first appear in significant numbers at or around ca. 7,500 years B.P. in the southwestern Great Basin, but there are arguments that the series dates substantially earlier in some contexts. For example, based on his evaluation of stratigraphic relationships at Rogers Ridge (Fort Irwin), Jenkins (1987) proposed a maximum age of at least 8,400 years, while Schroth (1994) claimed associations with radiocarbon dates in excess of 8,900 years at both Stahl and Pinto Basin. For reasons summarized here and elsewhere (Basgall n.d.a, 1995; Hall 1993; Basgall and Hall 1994), the authors believe that these ancient dates are problematic; how-

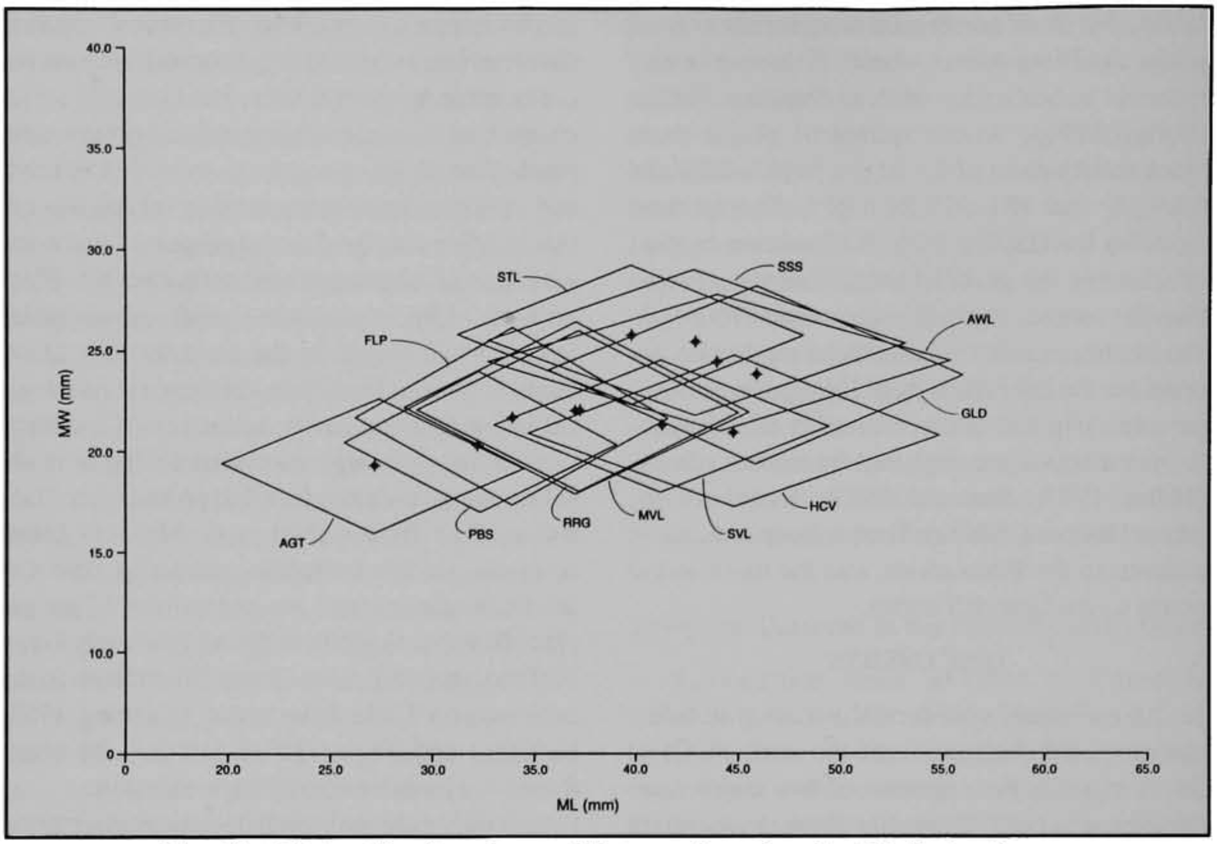

Fig. 10. Relationship of maximum width to maximum length at 11 site locations.

ever, there should be no debate regarding the fact that Pinto points are significantly older than Gatecliff Split-stem points. Temporal consistency among bifurcate-stemmed forms from the localities under consideration further justifies dispensing with the Little Lake series, as commonalities in hydration profiles from Fort Irwin and the Stahl site connote comparable age.[8]

Schroth's (1994:374-375) conclusion that "Pinto" points from the inclusive Great Basin are poor time markers results from imprecise framing of the problem. By overlooking patterned morphological variation in so-called "square-shouldered, indented-base" points across this tremendous expanse, and by incorporating sometimes questionable) radiocarbon associations from throughout the same, she could hardly avoid concluding that such artifacts had no chronological integrity. This purported lack of temporal integrity encouraged Schroth (1994) to believe that dart point form is primarily a consequence of artifact recycling/rejuvenation and has no culture-historical significance (cf. Flenniken 1985; Flenniken and Raymond 1986; Flenniken and Wilke 1989).

Geographic limits of the gracile and robust series remain indistinct, but along the western periphery of the Great Basin a break appears to occur somewhere north of Mono Lake Basin. Bifurcate-stemmed points from the southern Walker Basin vicinity, for example, have greater morphological affinities with the Gatecliff series than southern Pinto forms (Hall 1986). There is almost certainly a good deal of north-south overlap to be established through empirical study of individual assemblages and localities, a situation that has already been noted with regard to the eastern Great Basin (cf. Holmer 1986). Addi-

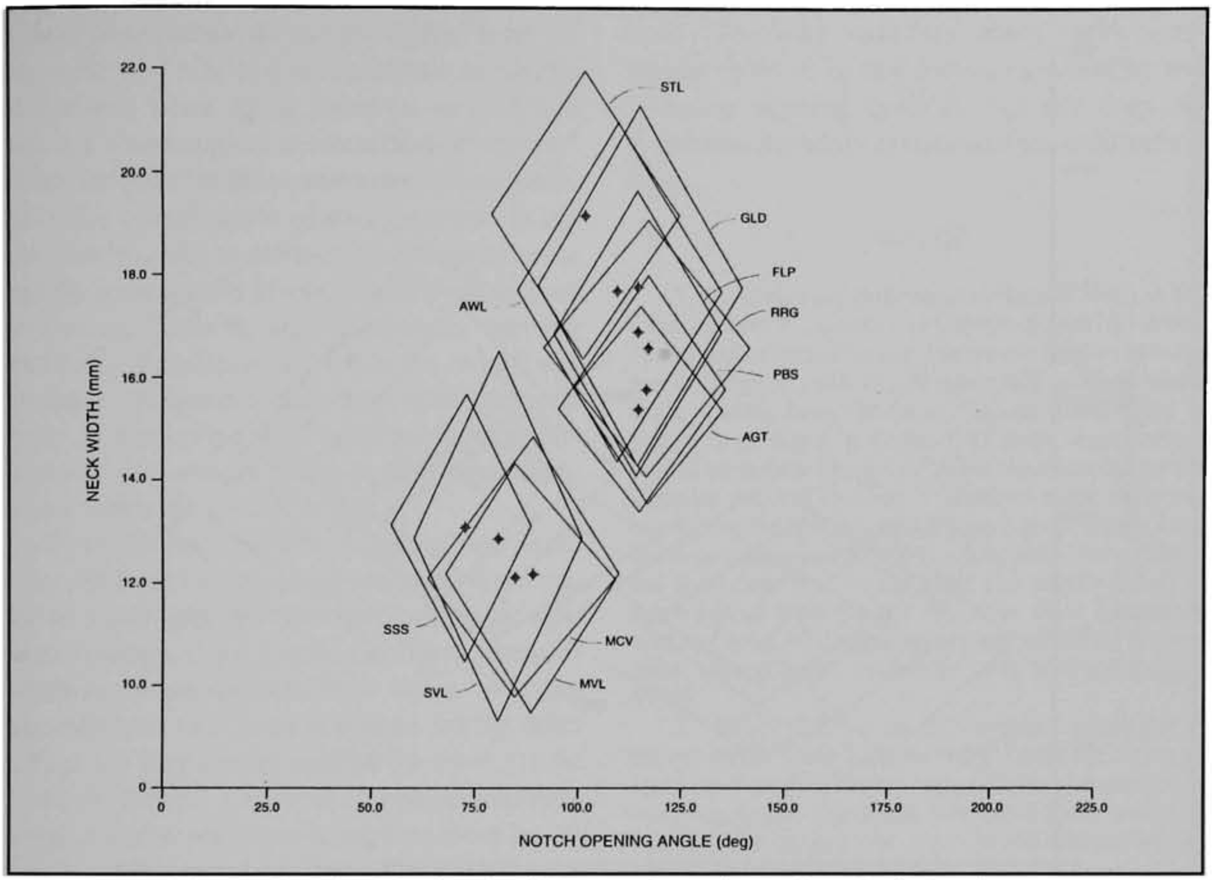

Fig. 11. Relationship of neck width to notch opening angle at 11 site locations.

tionally, there is a possibility of "site-" or "trait-unit" intrusions (Willey et al. 1956), cases where discrete occurrences of gracile and robust bifurcate-stemmed points can be identified within areas otherwise dominated by one group or the other. The multicomponent Humboldt Lakebed locality (Heizer and Clewlow 1968:76) may represent just such an instance, as it contained bifurcate-stemmed points that bore an unmistakable resemblance to the Pinto series.

Inasmuch as morphological variation within the Pinto series seems strongly conditioned by raw material parameters, constrained by toolstone qualities as well as differential access, such variation has important implications for arguments concerning recycling and the formal integrity of dart point types. Although some fundamental size distributions in the Fort Irwin samples appear broadly consistent with the notion that Pinto specimens could be derivative of Elko forms (cf. Bettinger et al. 1991), being typically shorter and narrower, the observation that they are consistently significantly thicker suggests that this possibility should be rejected.

It is perhaps most noteworthy that these two point groups at Fort Irwin have dramatically divergent material profiles, Elko forms consisting nearly exclusively of cryptocrystallines and Pinto forms dominated by coarse-grained, igneous stone. While reported previously in a host of contexts (Gilreath et al. 1988; C. N. Warren, personal communication 1990; Grayson 1993), these disjunctions have never been quantified formally in the Mojave Desert (Table 1). A chi-square statistic shows a significant difference in the samples (x^2 = 90.04, df = 5, p < 0.0001),

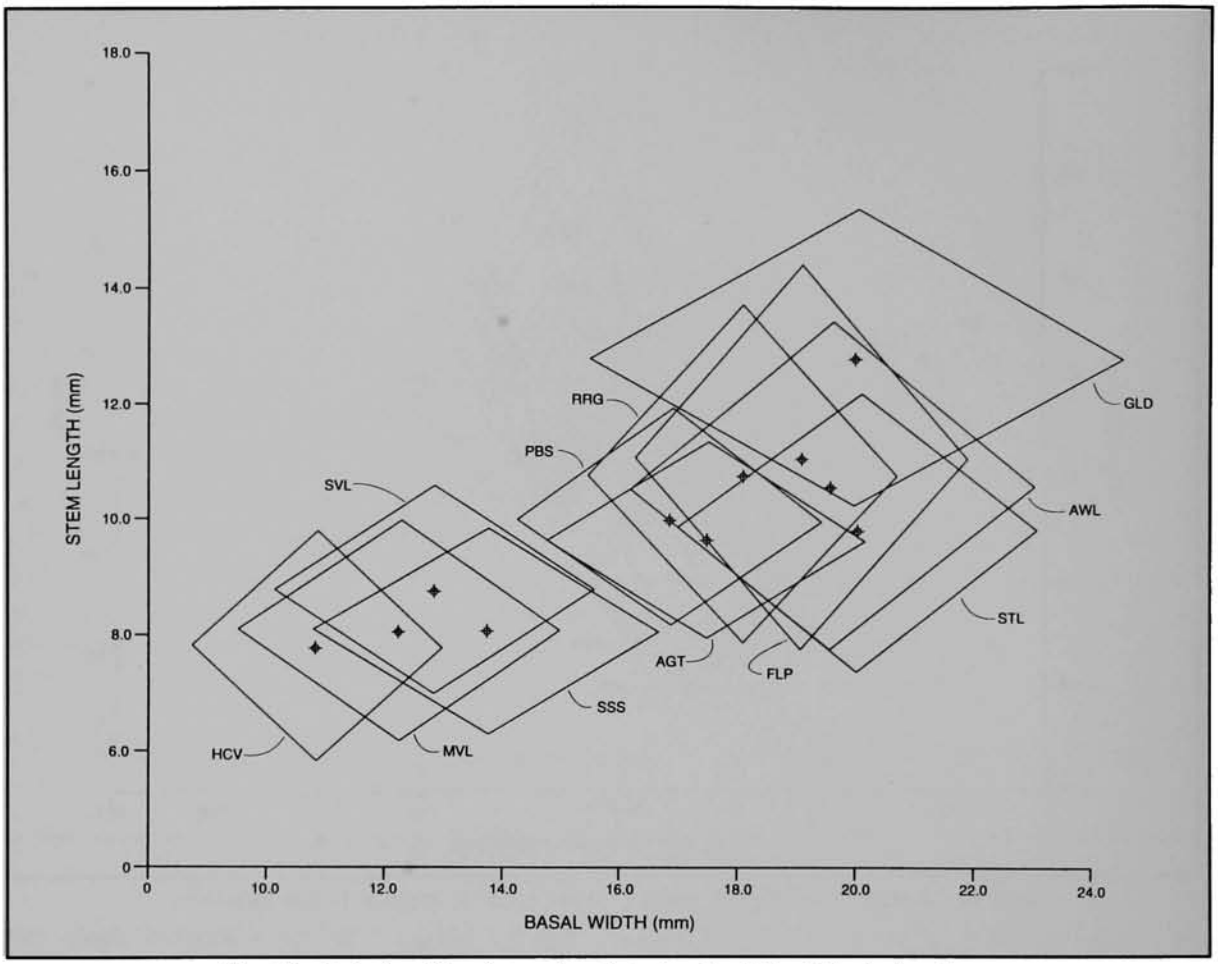

Fig. 12. Relationship of stem length to basal width at 11 site locations.

adjusted residuals revealing greater than expected ($p = 0.05$) numbers of cryptocrystalline Elko points, as well as basalt and rhyolite Pinto variants (Everitt 1977). Given that most artifacts in the Fort Irwin sample are manufactured from local toolstones, with inconsequential differences in acquisition cost (cf. O'Connell and Inoway 1994),[9] these patterns seriously compromise the recycling model.

Attribute relationships within the Fort Irwin material-specific samples give cause to question the corollary hypothesis that hafting elements are as unstable as blade/shoulder form. Instead, empirical data demonstrate that within raw material classes, more heavily reworked points retain most properties of stem morphology and suffer attrition mainly in attributes related to blade configuration (length and width). There is, of course, little doubt that Elko morphologies can be altered into Pinto (or equivalent split-stem) forms in the manner proposed by Flenniken, Wilke, and others, but data from the northern Mojave Desert suggest that this simply did not happen very often. Some elements of dart point form do, in fact, change with artifact use, but not those that are most typologically sensitive.

CONCLUSIONS

There is clearly a number of important issues that were not addressed in this study. Among others, these include the morphological/temporal segregation of bifurcate-stemmed and (evidently antecedent) Great Basin Stemmed series forms and the chronological characterization of post-Pinto dart points in the southwestern Great Basin. Effective consideration of such questions is impossible here due to obvious limitations of space and the complexities involved with evaluating an increasingly diverse and voluminous attribute data base. Resolution of these issues, which will establish fundamental levels of spatiotemporal control, remains a critical prerequisite to understanding evolutionary trends in prehistoric adaptation within the greater region.

Nevertheless, several conclusions have emerged from the foregoing analyses. Two major series of bifurcate-stemmed dart points exist in the western Great Basin, a northern Gatecliff (Split-stem) and southern Pinto series. Varying age estimates have been proffered for the latter group, but they clearly predate the more gracile Gatecliff forms. Levels of morphological/temporal convergence in point samples from localities in the southwestern Great Basin are consistent with a single, Pinto series, repudiating the claim that Stahl site variants are somehow different than artifacts from the deeper desert. Still sketchy data further suggest that bifurcate-stemmed points from at least some eastern Great Basin localities show stronger formal/chronological affinities to the Pinto than to the Gatecliff series. In addition, Fort Irwin assemblages are inconsistent with tenets of the Flenniken/Wilke recycling model, as material profiles of supposed antecedent/derivative forms differ significantly and empirical results indicate that stem morphology is more stable than predicted. Finally, use-related alteration affects blade form more profoundly than stem/shoulder characteristics, the latter retaining features that still permit reliable type assignment.

Although the material-specific data reviewed here relate to just one kind of dart point within a single region, results may have general implications. Projectile point form surely varies in response to levels of raw material availability and toolstone working qualities, but this does not jeopardize the utility of such artifacts as historical types.

NOTES

1. A somewhat puzzling conclusion, even at the time, inasmuch as Pinto and Gypsum points had divergent distributions at the one buried site Rogers investigated. Rogers (1939:47-48) reported that Pinto points were missing from the intact Gypsum component in Salt Springs Basin, although both point forms co-occurred on deflated surfaces "two to four feet below the Gypsum cultural stratum." Hints of slight temporal overlap between Pinto and Gypsum point forms exist in certain situations in the southwestern Great Basin, but it is apparent that the latter are usually found in more recent contexts and co-occur most frequently with the Elko series (cf. Amargosa) artifacts (Warren 1984; Gilreath et al. 1988; Hall 1993; Hall and Basgall 1994).

2. Green (1975) was not altogether consistent in his use of the Little Lake series, at times appearing to combine Pinto/Humboldt series points and elsewhere referring to the Humboldt and Little Lake series as independent entities (the latter presumably referring strictly to Pinto-like forms).

3. It is somewhat unfortunate that Thomas (1981, 1983) chose to collapse split- and contracting-stem points into a single series. Despite the fact that his rationale was clear and stratigraphic profiles at Gatecliff Shelter showed commensurate depositional ranges, obsidian hydration data and component associations in much of the western and southwestern Great Basin imply that contracting-stem variants typically occur later in time, being coeval with the broader Elko series (Hall 1983; Gilreath et al. 1988; Hall and Jackson 1989; Hall 1993; Basgall and Giambastiani 1995). Although the Monitor Valley typology was, of course, developed and intended for use in central Nevada, confusion might be minimized were the "Gatecliff series" reserved for split- or bifurcate-stemmed forms. In general, little seems gained by combining morphologically distinct point forms that could express important spatial or temporal variation within specific regions; there is certainly little chance of type-name inflation.

4. It is the case that several small, "pocket" obsidian sources occur in the vicinity of Fort Irwin (Basgall and Hall 1993; Hall 1993). However, these are characterized by very small nodules, poorly suited to production of large artifacts, and geochemical analyses demonstrate only a trace presence in Early and Middle

Holocene archaeological deposits; instead, nearly all obsidian Pinto points found at the fort originated in the Coso Volcanic Field or more distant quarry localities further to the north.

5. These artifacts had not undergone geochemical provenance determination when Meighan (1981) and Jenkins and Warren (1984) conducted their studies; however, subsequent X-ray fluorescence analyses by R. E. Hughes (Schroth 1994; D. H. Thomas, unpublished data) corroborated the presumption of a Coso obsidian source origin.

6. Long-term climatic data for Little Lake and Fort Irwin (extrapolated from records for Haiwee Reservoir [just north of Stahl] and Barstow [just south of Fort Irwin]) suggest that EHT derivations (cf. Lee 1969) differ by a factor of 1.54°C. With a 6% adjustment per degree (Trembour and Friedman 1984; Origer 1989), this means that a hydration value of 10.0 microns at Stahl is equivalent to 10.9 microns at Fort Irwin (Basgall n.d.b, 1990).

7. The chronometric data employed in deriving this rate ($y = 659.21 - 516.04x + 155.02x^2 - 4.56x^3$ [$r^2 = 0.99$], where y = uncorrected radiocarbon years B.P. and x = hydration value in microns) involved 15 pairings of 21 radiocarbon dates and 190 hydration measurements (for Coso obsidian artifacts) from seven sites (cf. Basgall n.d.b, 1990). These correlations relate to well-controlled feature contexts, primarily house floors.

8. Rejection of the Little Lake concept poses more serious problems for culture-historical treatments in much of the western Great Basin. Because Bettinger and Taylor (1974) also employed this term as a label for one of their periods, and posited an age range that is now clearly incorrect, regional syntheses will have to be reconsidered and a gap in the sequence filled.

9. O'Connell and Inoway (1994) made an important point here. The relative extent of tool recycling should be directly related to the costs of tool replacement, such as projectile points whose recycling/replacement is mainly determined by toolstone access/availability. This is, in fact, what material-specific morphological variation in the Fort Irwin samples implies.

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