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Archaeological Evidence for Stages of Manufacture of *Olivella* Shell Beads in California

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WITH few exceptions, archaeologists in California and the Great Basin have overlooked a useful source of information available through the analysis of shell bead production refuse at prehistoric sites. It is analogous to earlier treatments of lithic debitage that saw little value in detailed studies of waste accumulated during tool manufacture. The detailed study of shell bead production refuse enhances the ability of archaeologists to determine when and where particular bead types were manufactured. As discussed below, since the dating of bead and ornament types is far from conclusive, such studies will help refine the chronology. Furthermore, analysis of shell detritus from archaeological contexts greatly expands on the few ethnographic cases and replication studies available that describe shell bead and ornament manufacture techniques (Merriam MS; Barrett and Gifford 1933; Barrett 1952; Hampson 1975; King 1978; Macko 1984).

The excavation of the Davis site (CA-Nap-539), an inland site excavated in 1980 by the University of California, Davis, yielded a large quantity of coastal shell species, the nearest sources of which are the Bolinas and Bodega bays (McLean 1978). The project was directed by Charles Slaymaker. Although the site contains multiple components, predominately it represents an early Phase I Late Period occupation (approximately A.D. 700-1000). The diverse shell assemblage from the Davis site includes whole *Olivella biplicata* shell; finished bead forms of *Olivella*, *Saxidomus*, and *Tressus*; broken *Haliotis* shell fragments; and a small number of incomplete, partially drilled shell beads. The following analysis of shell refuse from the Davis site reconstructs a method for bead manufacture not recorded in the ethnographic literature.

SHELL BEAD DATING

Classification of shell beads into categories by shape, size, and style has been and continues to be a common analytical technique used by California and Great Basin archaeologists. The seminal description of this classification was Lillard, Heizer, and Fenenga's (1939) *Olivella* shell bead typology. Subsequent studies essentially expanded and modified this basic morphological typology.

Initially, each bead type was dated relatively by crude burial lot seriations or associations (Gifford 1947; Beardsley 1948; Bennyhoff and Heizer 1958). During the late 1950s R. F. Heizer organized projects to retrieve carbon samples from previously excavated burial locations that had formed the basis of the established seriations. According to J. A. Bennyhoff (personal communication 1990), Heizer attempted to correlate the radiocarbon dates obtained from these samples with specific burials and/or associated artifactual assemblages. In this way, Heizer sought to date the occupation of each site or burial location to check the earlier seriations. Given the methods, as described by Bennyhoff (who was a participant on at least one of these radiocarbon sample-collection projects), it is appropriate to argue that the radiocarbon dates obtained from these sites must be applied with caution.

Recently, Bennyhoff and Hughes (1987) compiled the most comprehensive *Olivella* bead typology yet in their publication "Shell Bead and Ornament Exchange Networks Between California and the Western Great Basin." They distinguished and classified bead and ornament types on the basis of critical measurements as well as on gross shape and more precise stylistic criteria. The basic premise is that, by using metric criteria to distinguish types, researchers should be able to assign shell beads and ornaments to a chronological series in a replicable and objective manner, thus reducing the subjective assessments so rampant in the past. Where possible, Bennyhoff and Hughes (1987) incorporated radiocarbon dates to establish the temporal duration of specific bead types. Unfortunately, few reliable dates are available, leaving the temporal significance of many of the bead types poorly substantiated, and pointing to the need for studies well beyond analyses of finished beads in burial contexts.

SITE DESCRIPTION

The Davis site is located approximately 50 miles inland from the Pacific coast (Fig. 1). The site is situated adjacent to Rattlesnake Creek, a small stream whose watershed drains into the northern end of Berryessa Valley. Large ethnohistoric Patwin villages were recorded by Kroeber (1932) throughout Berryessa Valley, principally along the major watercourses of Putah Creek and Eticuera Creek.

The Davis site consists of a large midden deposit with an extent of over 32 x 40 m. and a maximum depth of approximately 2 m. (Fig. 2). Of the 10 1 x 2-m. units excavated, five were centrally located on the main rise of the midden (Fig. 2). Units were excavated in arbitrary 10-cm. levels with extensive recording of artifacts and features *in situ*.

In descending order of abundance, the coastal shell present at the site consisted of *Olivella biplicata*, *Saxidomus*, *Tressus*, and *Haliotis*. *Olivella* shell fragments were found throughout all excavated units and were highly visible during the initial surface collection of the site as well. The bulk of the shell detritus (2,165 fragments) is of *Olivella* (Table 1). The term detritus is used here to mean fragments of shell with no evidence of shaping, incising, and/or drilling; it is the material that was discarded during bead production. Two coastal saltwater clam species, *Tressus nuttali* and *Saxidomus nuttali*, also are present in the assemblage as beads (n = 30), bead fragments (n = 17), and bead blanks (n = 3), totaling 50 identifiable specimens. Clam disk beads were concentrated in the upper 20 to 30-cm. level. In contrast, only seven *Haliotis* beads and pendants were recovered from units 1, 3, and 30, and ranged in depth from 100 to 170 cm., inclusive. No *Haliotis* manufacturing detritus was identified. The following discussion focuses on the manufacture of *Olivella* beads as documented by the abundance of *Olivella* detritus at the site.

ANALYSIS OF *OLIVELLA* REMAINS

The distribution and concentration of all *Olivella* shell beads and refuse indicate both vertical and horizontal stratification (Table 1). Eighty-six percent of the *Olivella* shell bead production detritus was recovered from the southern portion of the site in units 1, 30, and 31 (Table 1 and Fig. 2).

Bead types were identified using metric and morphological criteria defined by Bennyhoff and Hughes (1987). That is, beads were oriented according to their designation of "standard orientation" with "spire up and the canal down" (Bennyhoff and Hughes 1987:87). Measurements were taken on diameter, length, width, thickness, curvature, and perforation diameter, depending on the overall shape of the object. Beads were assigned to a type if they met the

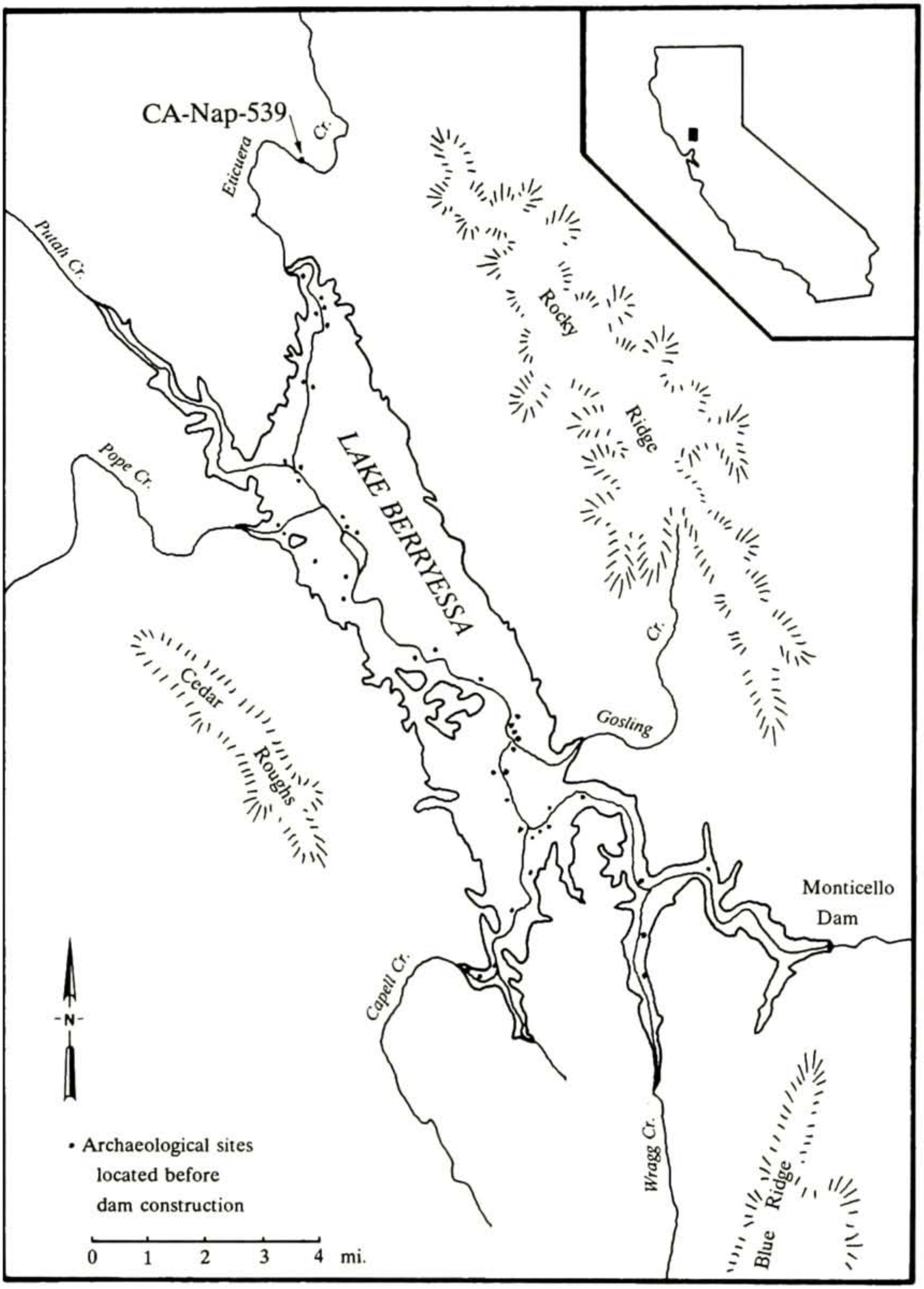

Fig. 1. Map showing location of the Davis site (CA-Nap-539) in relation to sites in Berryessa Valley.

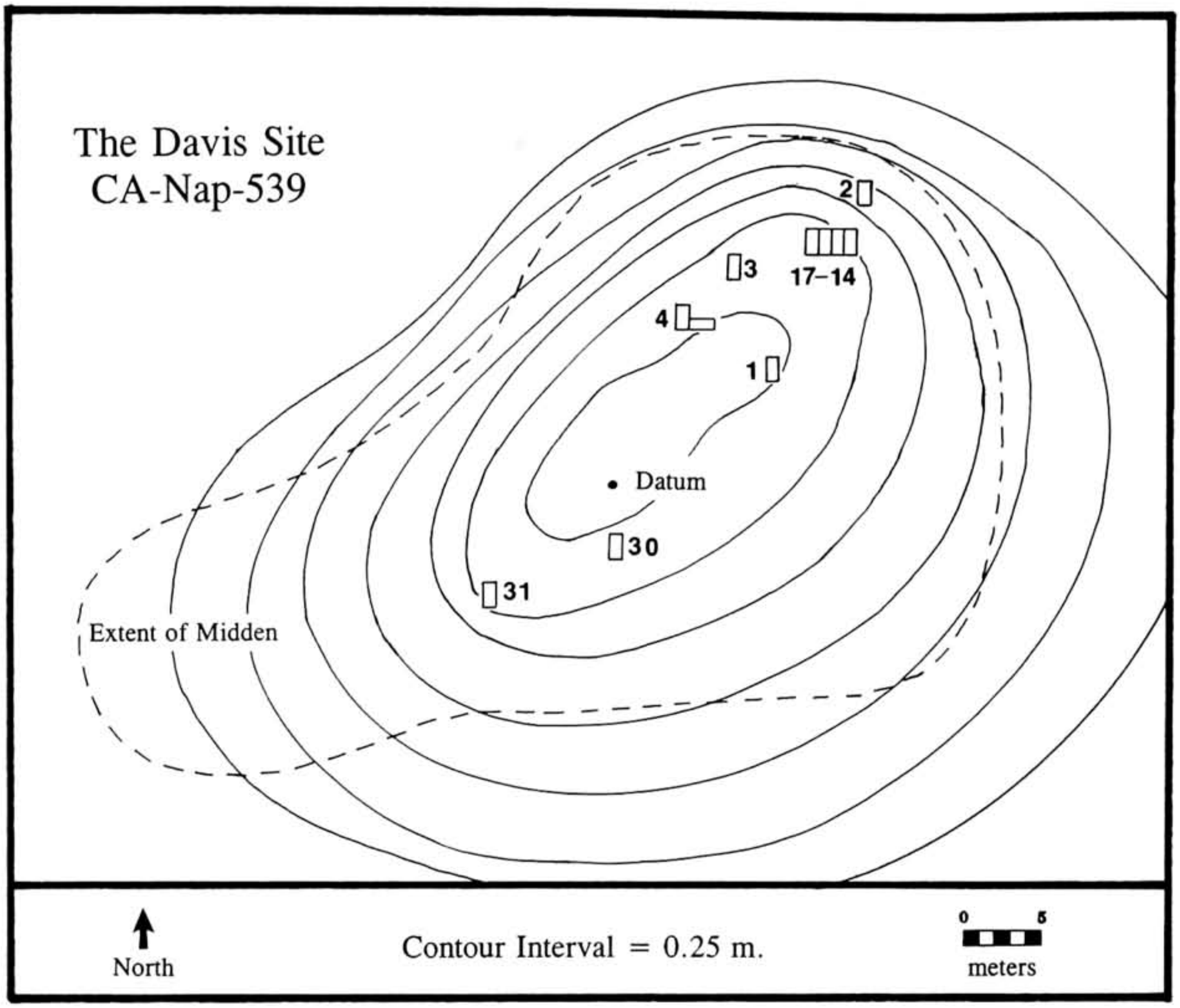

Fig. 2. Map of the Davis site with excavation units.

criteria listed in Bennyhoff and Hughes' (1987) typology for size (including all measurements listed above) and overall morphological characteristics. If the type did not match each of the key measurements, another type was sought until a match was made. For the most part, this was a straightforward process.

Following Bennyhoff and Hughes' (1987) typology, 13 *Olivella* bead types were identified at the Davis site representing late Middle Period (ca. 200 B.C. to A.D. 700) through Phase II (A.D. 1500 to ca. 1880) bead types. It was clear, however, that the majority of the beads (80%) are of a single type of *Olivella* bead (Table 2). The predominant bead type was identified as M1a Normal Sequin (Fig. 3). Bennyhoff and Hughes (1987:140) described these as rectangular beads with ventral face grinding and central perforation. They are considered to be a chronological marker for early Phase I between A.D. 700 and 1000.

Figure 4 illustrates both the ventral and dorsal view of the *Olivella biplicata* shell. The M1a Normal Sequin was removed from the dorsal section of the *Olivella* shell. Discarded shell fragments would consist of all other

Table 1
***OLIVELLA* DETRITUS FROM THE DAVIS SITE**

Depth (cm.)	Unit 1	Unit 30	Unit 31	Unit 3	Unit 4	Unit 29	Unit 2	Totals
0-10	3	18	10	2	2	3	1	39
10-20	9	15	6	13	20	21	0	84
20-30	1	25	3	19	12	15	2	77
30-40	23	26	1	14	1	21		86
40-50	20	20	10	14	10	17		91
50-60	36	43	3	9	4	16		111
60-70	31	85	13	10	12	16		167
70-80	35	80	97	8	9			229
80-90	28	115	16	4	3			166
90-100	40	54		5	3			102
100-110	48	184		11	1			244
110-120	60	121		3				184
120-130	103	129		5				237
130-140	86	106						192
140-150	48	23						71
150-160	57	9						66
160-170	18							18
No loc.	1							1
Totals	**647**	**1,053**	**159**	**117**	**77**	**109**	**3**	**2,165**

Table 2
***OLIVELLA* ORNAMENTS FROM THE DAVIS SITE**

Chronology[a]	Temporal periods[a]	Class[a]	Bead name	Number
	Any period	A1/B2	Spire-lopped/End Ground	27
		G1	Tiny Saucer	1
A.D. 1500-ca. 1880	Protohistoric-Historic	H1a	Ground Disk	1
		E2a	Full Lipped	4
		E1a	Round Thin Lipped	2
ca. A.D. 700-1500	Late Prehistoric	K1	Cupped	1
		M2c	Narrow Pendant	2
		M2a	Normal Pendant	4
		M1c	Narrow Sequin	6
		M1a	Normal Sequin	281
ca. 200 B.C.- A.D.700	Middle Prehistoric	F3a	Square Saddle	8
		F2a	Full Saddle	6
		G2a/b	Normal Saucer	7
Total				**350**

[a] From Bennyhoff and Hughes (1987).

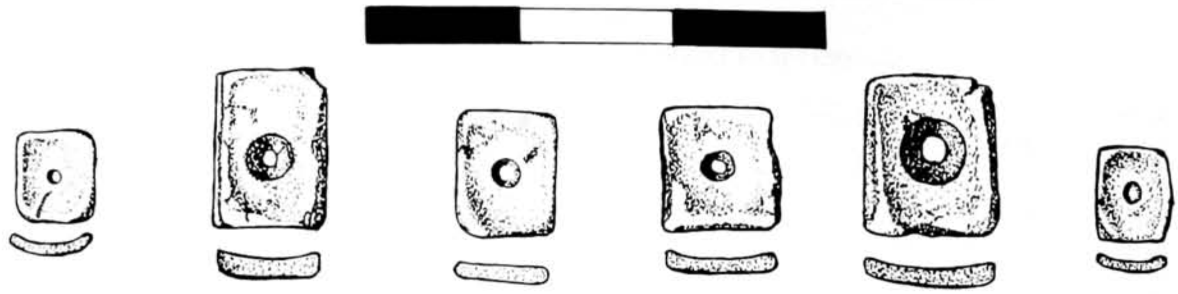

Fig. 3. M1a Normal Sequins (Cat. Nos. 265-2166; 265-144; 265-390; 265-1124; 265-3105; 265-2046). Centimeter scale.

sections of the shell except the area removed for bead manufacture.

An analysis of the shell detritus of the midden was necessary to support the hypothesis that the M1a Normal Sequin bead type was produced at the site and not one or more of the other 12 types identified as finished *Olivella* beads. The correlation between type M1a Normal Sequin and the *Olivella* production refuse was verified on two lines of evidence. First, both bead blanks and partially drilled blanks were examined to determine if they were exclusively type M1a Normal Sequin. Second, by examining which portions of the *Olivella* shell had been discarded, one can infer that the missing portions were used to produce the M1a Normal Sequin.

Olivella detritus recovered throughout the midden contained fragments from the apexes, spires, columellae, fascioles, canals, and body whorls of *Olivella* shells (Fig. 4). This is exactly the debris that would be expected if Class M beads were produced. Further supporting evidence is that only rectangular blanks and partially drilled rectangular blanks are present in the *Olivella* detritus, and no other *Olivella* bead forms in a preliminary stage of production were found.

Class M rectangular beads, blanks, and fragments were first identified and sorted into general categories; within these categories, the fragments were subdivided on the basis of direction of breakage, either longitudinal or latitudinal (Figs. 5 and 6, respectively). This distinction was necessary to preclude any confusion with the end-perforated rectangular bead, type M2a Normal Pendant (Bennyhoff and Hughes 1987). Initially, it could not be determined if the *Olivella* detritus was the result of the manufacture of both M1a Normal Sequins with central perforations and M2a Normal Pendants with end perforations, or of one of these types, given the presence of both forms in the assemblage (Table 2).

According to Bennyhoff and Hughes (1987), M2a Normal Pendant is a marker type for late Phase I of the Late Period (approximately A.D. 1000-1300). They remarked that its co-occurrence with M1a Normal Sequins is diagnostic of middle Phase I of the Late Period (1987:141). Thus, the relative dating of the manufacture of *Olivella* beads at this site could vary depending on whether both bead types were manufactured simultaneously and/or sequentially.

As it turned out, fragmentation of the rectangular sequins occurred as frequently along the length of the bead across the perforation (longitudinal fragmentation; 51 examples identified; Fig. 5) as across the width of the bead (latitudinal fragmentation; 53 examples identified; Fig. 6) through the perforation. Breakage along both dimensions, length and width, occurred less frequently (Fig. 7) with only 12 examples recovered. A total of 62 finished M1a Normal Sequins and 51 longitudinal fragments, all centrally perforated, were

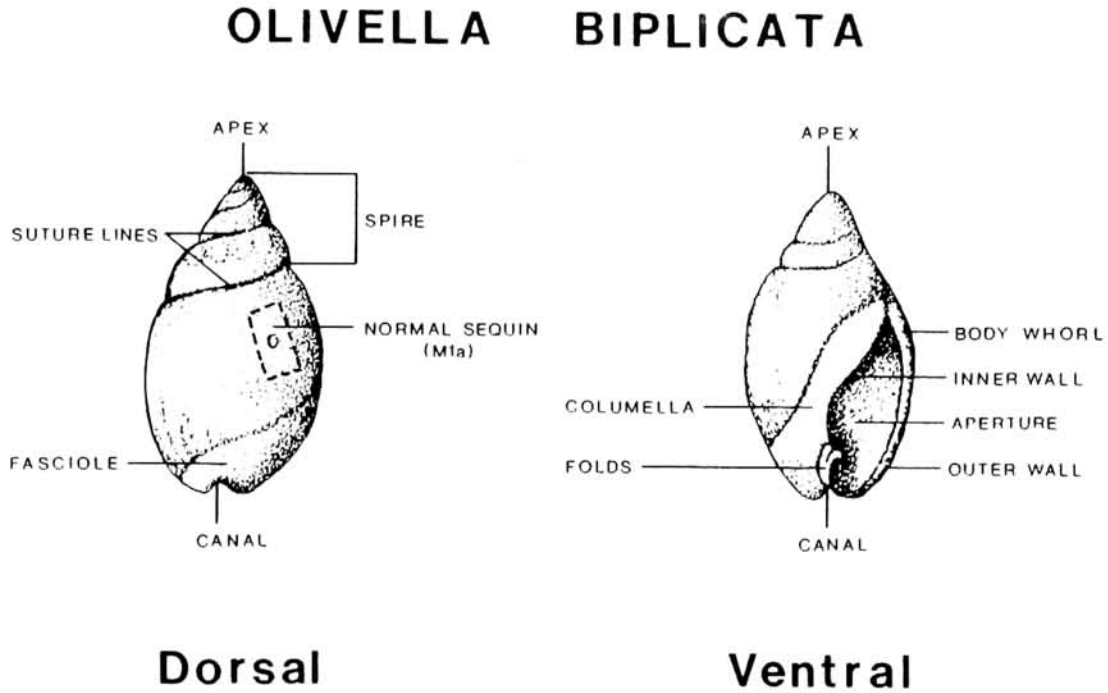

Fig. 4. *Olivella biplicata* shell morphology and nomenclature, showing location of material used for M1a Normal Sequin.

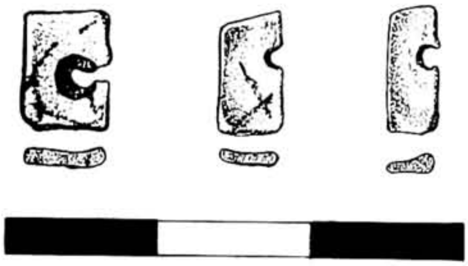

Fig. 5. M1a Normal Sequins broken longitudinally (Cat. Nos. 265-2261; 265-2482; 265-2650). Centimeter scale.

Fig. 6. M1a Normal Sequins broken latitudinally (Cat. Nos. 265-512; 265-2316; 265-3686). Centimeter scale.

identified, whereas only seven end-perforated M2a Normal Pendants were recovered. Therefore, it seems likely that all of the 53 latitudinal fragments represent type M1a Normal Sequin beads. As such, they are included in the sample.

The production sequence hypothesized for type M1a Normal Sequin is based, therefore, on characteristics observed in 61 bead blanks and fragments, 42 partially drilled blanks and fragments, 51 longitudinal fragments, 53 latitudinal fragments, 12 fragments broken in both directions across the perforation, and 62 finished beads, yielding a total sample of 281 beads (Table 3).

RECONSTRUCTED MANUFACTURING SEQUENCE

The suggested production sequence for the manufacture of M1a Normal Sequins is as follows.

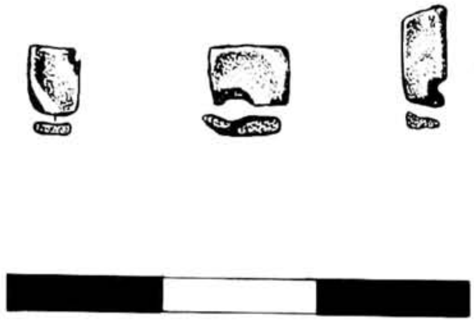

Fig. 7. M1a Normal Sequins broken in both directions (Cat. Nos. 265-2476B; 265-2342A; 265-7016). Centimeter scale.

Table 3
***OLIVELLA* M1a NORMAL SEQUINS FROM THE DAVIS SITE**

Description	Frequency
Bead blanks and blank fragments	61
Partially drilled blanks and fragments	42
Longitudinal fragments	51
Latitudinal fragments	53
Broken both directions	12
Complete finished beads	62
Total	**281**

Heat Treatment

Whole shells were first heat treated. This both whitens the shell and makes it easier to cut, grind, and drill. Barrett and Gifford (1933) recorded this procedure among the Miwok and similar results were observed in my own replication studies. In the midden, shells occurred in three broad categories: unmodified, showing the natural coloring (Fig. 8a); heat treated, which produces a uniformly white shell (Fig. 8b); and, excessively heated shells, which are gray-black in color with surface spalling (Fig. 8c). Archaeological evidence from the Davis site for the heat treatment of whole *Olivella* shells as the initial step in the manufacture of M1a Normal Sequins is supported by the fact that all finished beads and *Olivella* refuse are white, gray, or black from heat treatment. Were this not the case, purposely modified fragments should have been recovered with the natural *Olivella* coloring, assuming there has been no significant postdepositional burning. As it was, less than a dozen of the 41 whole *Olivella* shells were recovered with their natural coloring. In contrast, the *Olivella* detritus was either white throughout or had been burned severely to gray-black; natural coloring was not visible on any of this fractured detritus.

Shell Cutting

The second step in the manufacture of M1a Normal Sequins at the Davis site was to break or cut the shell into usable fragments. Although direct archaeological evidence for this procedure may be difficult to recognize, several alternative methods of breakage have been proposed. One procedure described in the ethnographic literature (Barrett and Gifford 1933) and replication studies (Macko 1984) is "spire-tapping." The shell is placed on its "foot" end with the apex up and tapped with a hard object, such as a rock. This splits the shell into a number of pieces, presumably along its growth lines, lengthwise (Macko 1984). Alternatively, the apex could have been ground or cut off. A wedge could then have been inserted down the center of the *Olivella* shell, forcing it to fracture along its weaker growth lines (Macko 1984).

A number of *Olivella* shell fragments recovered from the Davis site show distinctive cut marks (Fig. 9). Despite the fact that this procedure is not discussed in the literature, it clearly is evident in the *Olivella* bead production debris for M1a Normal Sequins at this site.

Edge Grinding

The third production step may be inferred strictly from archaeological evidence at the Davis site. This was to grind the edges smooth on each rough rectangular blank prior to per-

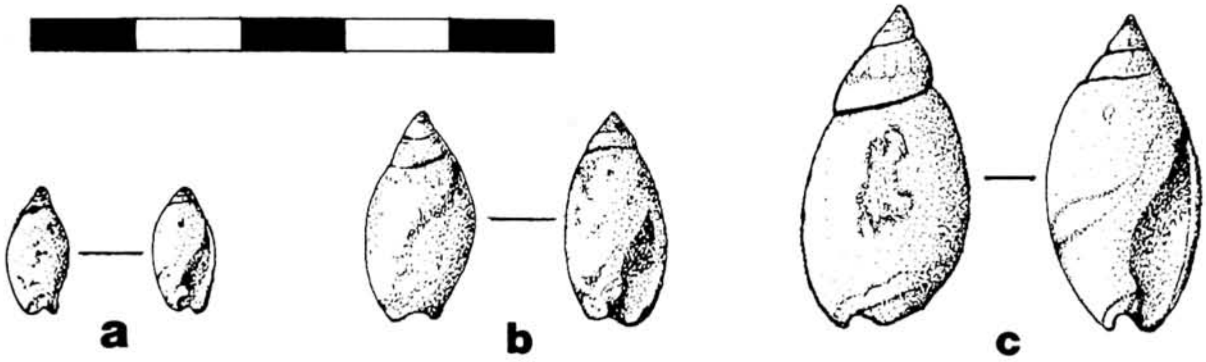

Fig. 8. *Olivella* shells showing natural appearance and effect of heat treatment: a, natural coloring (Cat. No. 265-272); b, uniformly white (Cat. No. 265-3539); c, excessively heated (Cat. No. 265-1552). Centimeter scale.

Fig. 9. *Olivella* shells with cut marks (Cat. Nos. 265-1665; 265-107; 265-84). Centimeter scale.

Fig. 10. M1a blanks with finished edges (Cat. Nos. 265-2611; 265-1538; 265-2005). Centimeter scale.

foration. As mentioned previously, 61 blanks and blank fragments were recovered (Fig. 10). Of these, 53 are smoothly finished, and eight have rough edges. No rough-edged blanks have drill marks. Furthermore, all 42 partially drilled blanks and fragments have finished edges (Fig. 11). Thus, the evidence from partially drilled blank fragments clearly shows that edges were finished prior to drilling.

Ventral Face Drilling

The fourth and final step in the proposed production sequence was then to centrally perforate the finished rectangular bead blank. Blanks were drilled from the ventral (or interior) face of the shell with only minor exterior retouch. Figure 12 illustrates two examples of blanks partially drilled from the ventral face.

DISCUSSION

To determine which *Olivella* bead type was manufactured at the Davis site, it was necessary to establish a correspondence between the 13 identified *Olivella* bead types and associated shell refuse. Evidence has been presented that suggests the shell refuse is consistent with debris associated exclusively with the production of *Olivella* bead type M1a Normal Sequins.

It is of interest to note that whole *Olivella* shells were present at this site in a variety of sizes. This suggests that shells were brought to the site as a "mixed bag" and not selected for any particular size class. While one might assume some size selection in any imported raw material, the size variability among *Olivella* may not have been significant to the manufacturer of this particular bead form. Furthermore, from

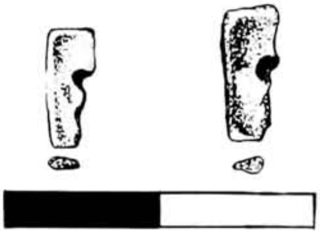

Fig. 11. M1a partially drilled blank fragments with finished edges (Cat. Nos. 265-1693; 265-3671). Centimeter scale.

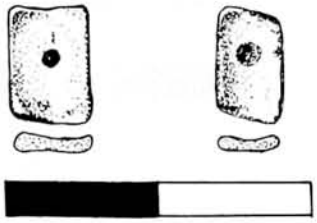

Fig. 12. M1a blanks partially drilled from the ventral face (Cat. Nos. 265-1002; 265-2459). Centimeter scale.

subjective observations it does not appear that manufacturing techniques sought to produce a maximum number of beads from each shell.

Through a detailed analysis of shell refuse, coupled with ethnographic models and replication studies, a clearer idea of the procedure used to manufacture this particular bead form has been achieved. Further studies of shell refuse from other manufacturing sites is necessary to expand on our knowledge of the technology used to produce a variety of other bead forms.

We have seen that by establishing a correspondence between finished bead forms and their manufacturing detritus, bead types can be more conclusively dated than through the traditional method of burial seriation studies. Unfortunately, radiocarbon samples associated with the M1a Normal Sequin manufacture refuse at the Davis site have yet to be analyzed. The results, when available, will provide comparative dates to those in Bennyhoff and Hughes' (1987) typology for M1a Normal Sequins.

Future research questions to be asked are: What was the relationship between coastal populations and interior groups with regard to access to raw materials used in bead and ornament manufacture? What social factors would affect control of access and/or production of shell resources? Beyond the scope of this particular study is the analysis and quantification of shell bead production detritus from other sites in the area which are needed to provide the comparative data necessary to address many of these questions more effectively.

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