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## AMS Radiocarbon Dating of Shell Beads and Ornaments from CA-ORA-378

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*Accelerator mass spectrometry (AMS) dates for nine shell beads and two shell ornaments are used to test the application to Orange County of a temporal sequence devel-*

*oped for the Santa Barbara Channel region. Olivella cupped, Olivella oblique spire-removed, Olivella end-removed, Mytilus disc, and Megathura small square ring and Megathura oval ring beads/ornaments fell within time ranges predicted by the bead/ornament chronology developed by Chester King (1981, 1990) for the Chumash area. Olivella biplacata barrels and caps seem not to have been occurrences of King's Late Middle or Late periods in Orange County, but rather there appears to have been a switch to Gulf of California Olivella dama shells for local barrel and cap manufacture.*

**SYSTEMATIC** bead research in southern California began in the late 1960s when King et al. (1968:75) organized bead types from the Century Ranch Project, Los Angeles, into time periods, and published a bead chart for Chumash territory. Later, by seriating grave lots from sites mostly in the Santa Barbara Channel region, King (1981, 1990) organized bead and ornament types into a chronology that he divided into three periods—Early (E), Middle (M), and Late (L)—each of which was partitioned into subphases. The sequences were developed using radiocarbon dates from both mortuary and nonmortuary contexts and by cross-dating with the general Southwest Anasazi pottery sequence (Kidder 1927; Woodbury 1979:28-29; King 1990, 1996).

After King recognized that the central California bead typology was applicable to that of the Chumash area, he hypothesized that correspondences continued southward into the coastal zone occupied historically by speakers of Takic languages. Gibson and King's (1991) analysis of about 1,400 shell, stone, and bone artifacts from 25 Orange County archaeological sites within the Newport Coast Archaeology Project (NCAP) addressed this question. Their research drew on a previous Orange County bead study (King 1986).

Application of the King (1981, 1990; also see Gibson 1992) and Bennyhoff and Hughes (1987) schemes to the NCAP bead and ornament data was attempted first without benefit of radiocar-

bon dates from any of these 25 sites. Using the bead classification and chronology established for the Santa Barbara Channel region (King 1981, 1990; Gibson 1992), periods of occupation were defined for each NCAP village or camp. Next, the results of nearly 300 radiocarbon dates from the NCAP were compared against results of that bead and ornament study, which indicated that no significant temporal adjustments were required for the estimated periods of occupation. Some bead types reflected the existence of occupations not sampled by radiometric assay. Most of the shell beads and their temporal occurrences provided matches with the King (1990) and Bennyhoff and Hughes (1987) schemes, although local variant types were recognized for Orange County (Gibson and King 1991).

### RESEARCH QUESTIONS

The present study attempts further refinement of the Chumash sequence for Orange County through the application of accelerator mass spectrometry (AMS) technology to directly radiocarbon date nine shell beads and two shell ornaments (Fig. 1) from CA-ORA-378, or the Christ College site, located just 200 meters east of the campus of Concordia University (Turtle Rock area), Irvine (Fig. 2) (see Koerper 1995). The CA-ORA-378 site is within the territory of the historically known Gabrielino (Kroeber 1925), yet the area may have been multiethnic and multilingual through marriage ties between the Gabrielino and the Juaneño (Earle and O'Neil 1994).

The 11 shell artifacts represent types identified as time sensitive in Chumash territory. Descriptions of these beads and ornaments, discussions of temporal types, presentation of the results of AMS analysis, and inferential treatment of the data for chronology building and cross-dating are included in the six research questions presented below.

This study employs the alphanumeric type designations (e.g., K1, B2) of Bennyhoff and Hughes (1987). Such designations apply only to

*Olivella* beads, there being no alphanumeric characters to denote either *Mytilus* beads or *Megathura* ornaments. For all complete *Olivella* beads, subtypes based on maximum diameter of the complete shell are used. These include: (1) subtype a, small (3.00 to 6.50 mm.); (2) subtype b, medium (6.51 to 9.50 mm.); and (3) subtype c, large (9.51 to 14.00 mm.) (Bennyhoff and Hughes 1987:117). Specific nomenclature for types (e.g., *Olivella* spire-removed) follows King (1990).

### Type K1 *Olivella* Cupped Beads and *Mytilus* Disc Beads

Do *Olivella* Type K1 cupped beads and *Mytilus* disc beads serve as time markers for the Late Period in Orange County? Type K1 cupped beads were shaped from the callus portion of *Olivella biplicata* shells into relatively small forms of circular outline. Viewed in cross section, ventral sides are more convex than dorsal sides, accounting for the cup-like appearance.

*Olivella* cups are believed to be chronological indicators of the Late Period throughout California (Bennyhoff and Hughes 1987:137; King 1990:155). Two subgroups of Type K1 add temporal precision, as the larger cups (3.8 mm. to 4.3 mm.) were prominent during Phase 1 of the Late Period (ca. A.D. 1150/1200 and A.D. 1500), while the smaller cups were more popular during Phase 2 of the Late Period (about A.D. 1500 to the start of the Mission Period) (King 1990:157). Cross-dating using Pueblo III evidence for an *Olivella* split punched bead from the Wupatki Pueblo (which predates the *Olivella* cupped type) and a standard charcoal radiocarbon date from Santa Barbara County for the transition between Phases M5c and L1a (Fig. 3) suggests that the Type K1 is an indicator for the Late Period beginning as late as A.D. 1200 (Gifford 1947:61; Arnold 1992; King 1996).

Circular in outline, flat in cross section, and varying in color from the blue black to creamy ivory coloring of California mussels (*Mytilus*

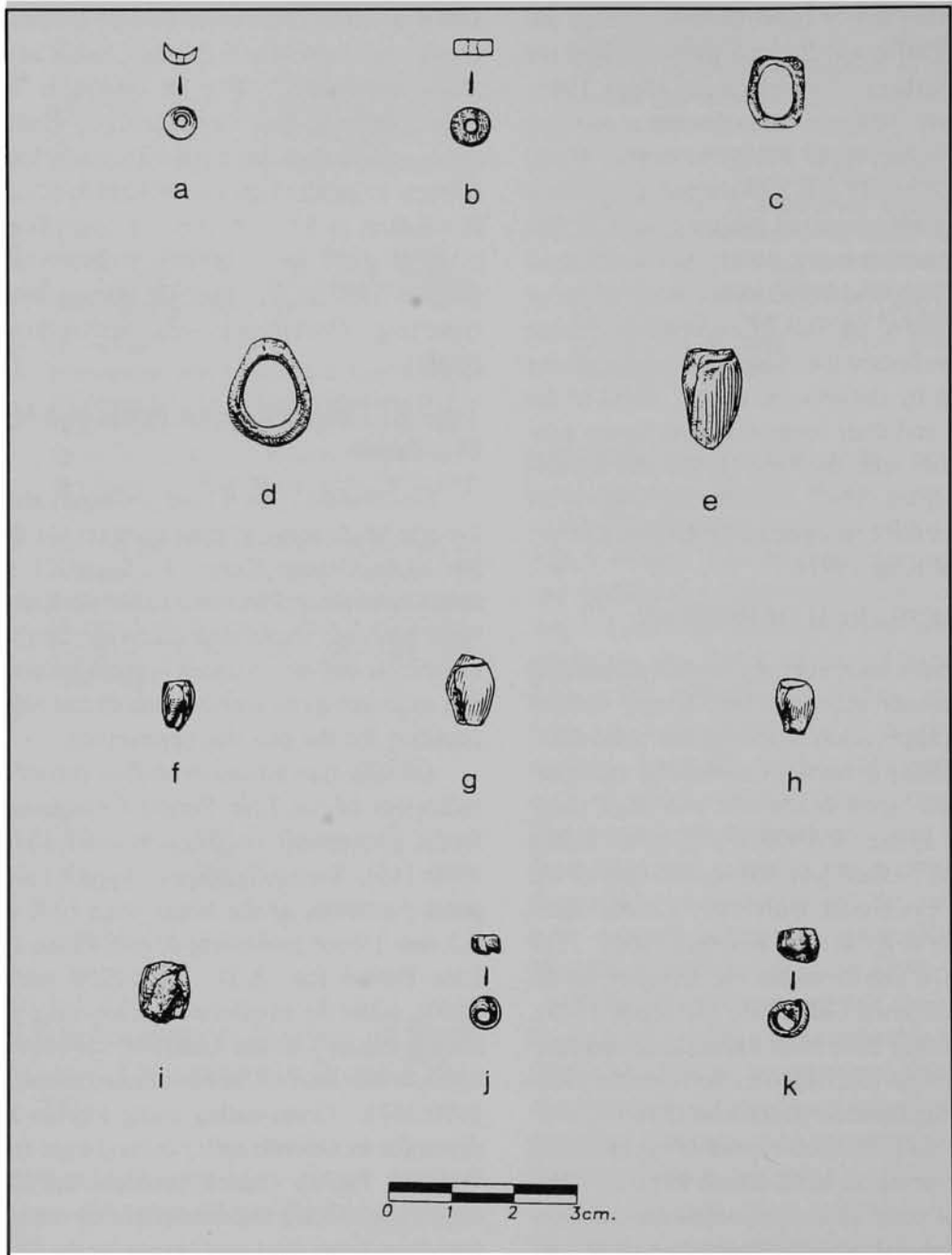


Fig. 1. Shell beads and ornaments from CA-ORA-378 used for AMS dating: (a) Type K1 *Olivella* cupped (Cat. No. 1983); (b) *Mytilus* disc (Cat. No. 1979); (c) *Megathura* small square ring (Cat. No. 616); (d) *Megathura* oval ring (Cat. No. 1442); (e) *Olivella* Type A1c spire-chipped (Cat. No. 3119); (f) Type A2a *Olivella* oblique spire-removed (Cat. No. 2938); (g) Type B2b *Olivella* end-removed (Cat. No. 2939); (h) Type B2b *Olivella* end-removed (Cat. No. 3867); (i) Type B3b *Olivella* barrel (Cat. No. 2950); (j) Type B4a *Olivella* cap (Cat. No. 3311); (k) Type B4b *Olivella* cap (Cat. No. 8001).

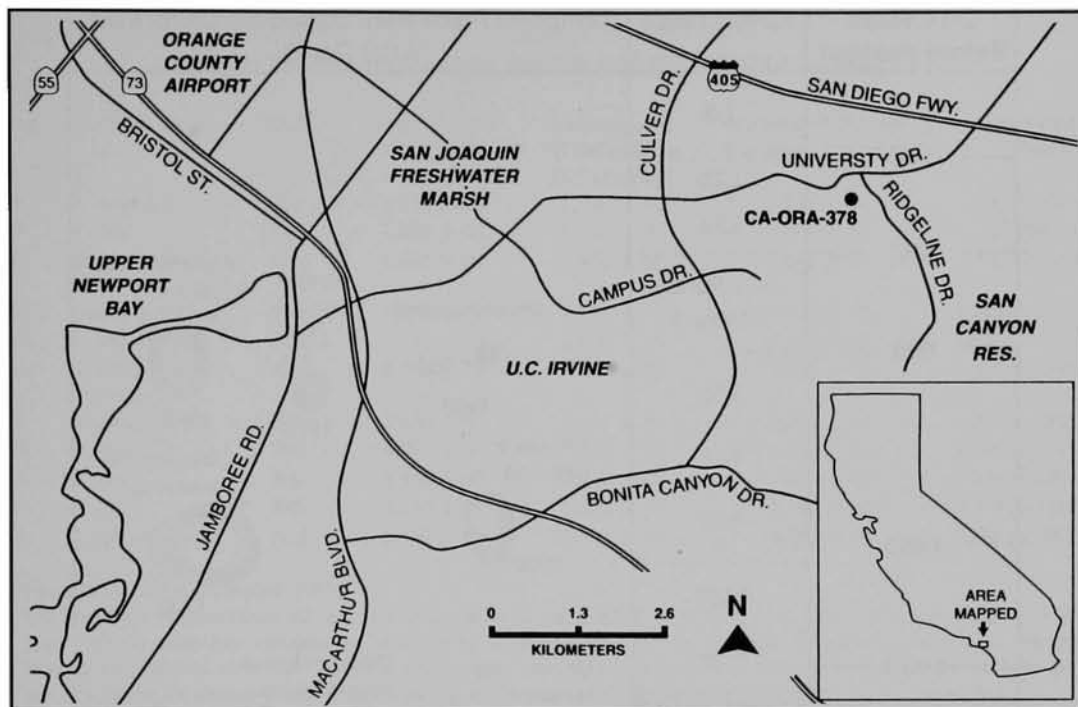


Fig. 2. Location map for CA-ORA-378.

*californianus*), *Mytilus* disc beads retain evidence of their natural curvature, even when their dorsal and ventral surfaces were ground, a common practice. In the Santa Barbara Channel region, *Mytilus* disc beads appear most frequently during Phase 5 of the Middle Period (ca. A.D. 950 to A.D. 1200) and during Phase 1 of the Late Period (ca. A.D. 1200 to A.D. 1500). The occurrence of these disc beads diminishes after A.D. 1400, yet persists even beyond A.D. 1782 (King 1990:148).

An *Olivella* cupped (Type K1) specimen (Fig. 1a) recovered at CA-ORA-378 from Unit 2N/OW at 60 to 70 cm. and a *Mytilus* disc (Fig. 1b) from the 50 to 60 cm. level of the same unit were selected for AMS dating. The specimen depicted in Figure 1a measures 4.8 by 5.0 mm. in overall diameter, is 2.1 mm. thick, and has a 1.2 mm. conical hole on the ventral side. External diameter of the *Mytilus* disc bead is 6.0 to 6.1 mm., and it is 2.6 mm. thick. Minimum diameter of the biconical hole is 1.7 mm.

Unit 2N/OW, which was 90 cm. deep, provides evidence of at least two time periods, Middle Period Phase 1 to 2 (M1-2) and Late Period Phase 1 (L1). Five of the presumed M1-2 bead types are from the 30 to 40 cm. level, and the other is from the 80 to 90 cm. level. The 60 to 70 cm. level produced three *Mytilus* discs and one *Olivella* cupped (Type K1). These four beads indicate a Middle Period Phase 5 to Late Period Phase 1 (A.D. 950 to A.D. 1500) event. Reversal of the temporal types between the fourth and seventh levels suggests more than simple bioturbation, such as the possibility of some amount of mechanical displacement.

AMS assays (Table 1, Fig. 3) yielded calibrated dates<sup>1</sup> of  $865 \pm 60$  B.P., for specimens illustrated in Figure 1a (Beta-73492) and Figure 1b (Beta-73491), offering support for the hypothesis that each of these types in Orange County co-occurs with these two kinds of artifacts from middens in Chumash territory. The 5.0-mm. diameter for the cup predicts a Late Phase 1 rather

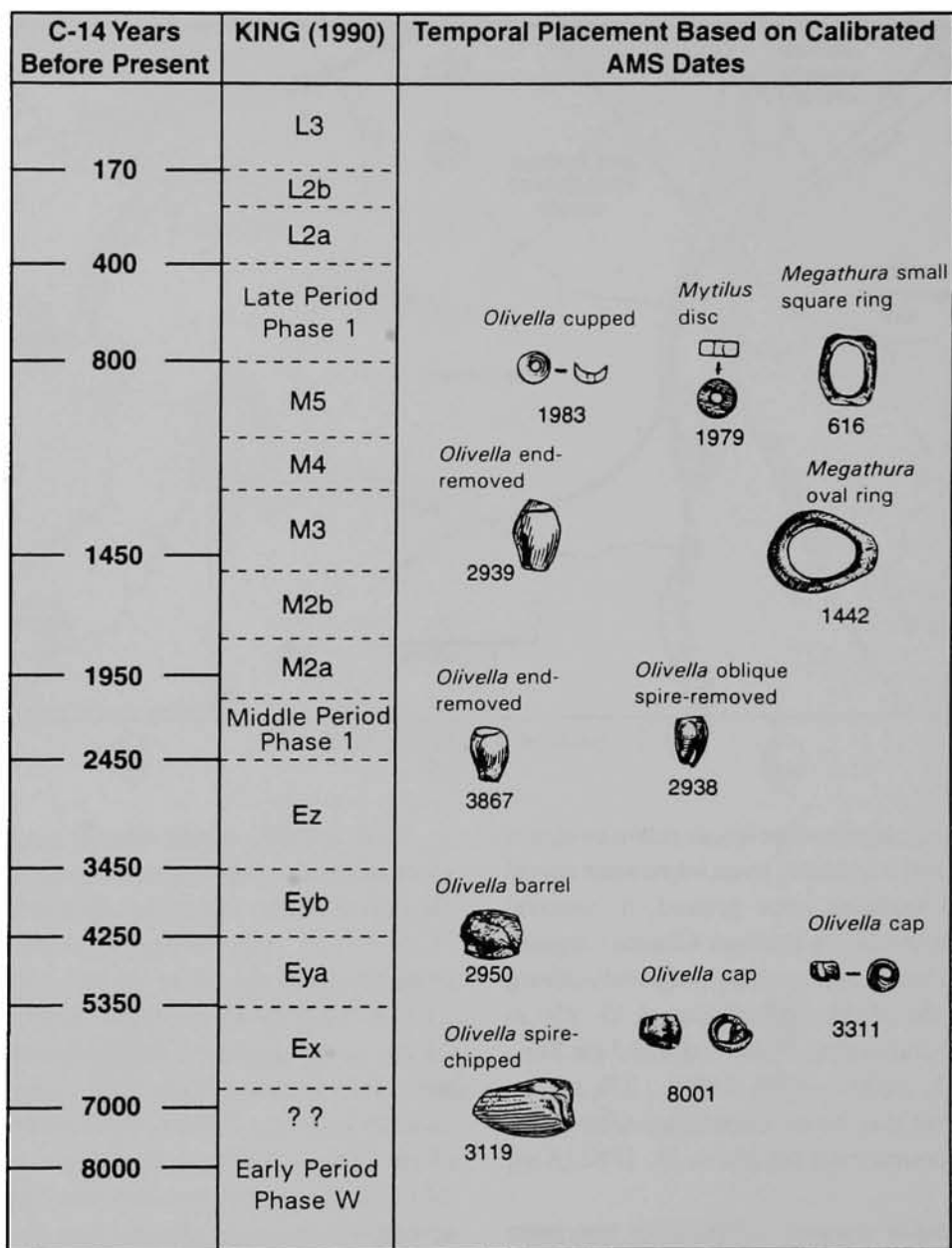


Fig. 3. Temporal placement of AMS dated shell beads and ornaments from CA-ORA-378.<sup>2</sup>

than a Phase 2 occurrence; the radiocarbon determination supports the above-noted association of temporal placement and size that applies to the Santa Barbara Channel region.

### *Megathura* Ring Ornaments

In the Santa Barbara Channel bead and ornament chronology, the floruit of the *Megathura*

oval ring type precedes the floruit of the *Megathura* small square ring artifacts for the Middle Period. Is the sequential pattern duplicated by the Orange County evidence?

Oval rings and small square rings were both manufactured from the large limpet, *Megathura crenulata*. The oval rings took shape as the shell around the callus opening was first chipped and

Table 1  
RESULTS OF AMS RADIOCARBON DATING FROM CA-ORA-378

| Catalog No. | Artifact Type                   | Type <sup>a</sup> | Raw <sup>14</sup> C Date Years B.P. | Conventional <sup>14</sup> C Date (Delta-13 Corrected) | Calibrated <sup>14</sup> C Age <sup>b</sup> (Upwelling Corrected) | Calibrated Age Range |
|-------------|---------------------------------|-------------------|-------------------------------------|--|---|----------------------|
| 1983        | <i>O.</i> cupped                | K1                | 1,040 ± 60                          | 1,470 ± 60   | 865 ± 60  | 917 (865) 765        |
| 1979        | <i>M.</i> disc                  | none              | 1,050 ± 60                          | 1,470 ± 60   | 865 ± 60  | 917 (865) 765        |
| 616         | Limpet small square ring        | none              | 1,040 ± 60                          | 1,470 ± 60   | 865 ± 60  | 917 (865) 765        |
| 1442        | Limpet oval ring                | none              | 1,630 ± 70                          | 2,050 ± 70   | 1,413 ± 70  | 1,513 (1,413) 1,333  |
| 2939        | <i>O.</i> end-removed           | B2b               | 1,640 ± 80                          | 2,050 ± 80   | 1,413 ± 80  | 1,520 (1,413) 1,324  |
| 2938        | <i>O.</i> oblique spire-removed | A2a               | 2,390 ± 70                          | 2,830 ± 70   | 2,334 ± 70  | 2,431 (2,334) 2,294  |
| 3867        | <i>O.</i> end-removed           | B2b               | 2,460 ± 60                          | 2,890 ± 60   | 2,395 ± 60  | 2,506 (2,395) 2,331  |
| 2950        | <i>O.</i> barrel                | B3b               | 4,070 ± 50                          | 4,510 ± 50   | 4,483 ± 50  | 4,543 (4,483) 4,410  |
| 3311        | <i>O.</i> cap                   | B4a               | 4,540 ± 60                          | 4,970 ± 60   | 5,050 ± 60  | 5,230 (5,050) 4,973  |
| 8001        | <i>O.</i> cap                   | B4b               | 5,640 ± 60                          | 6,070 ± 60   | 6,310 ± 60  | 6,399 (6,310) 6,273  |
| 3119        | <i>O.</i> spire-chipped         | A1c               | 6,140 ± 60                          | 6,580 ± 60   | 6,887 ± 60  | 6,986 (6,887) 6,820  |

<sup>a</sup> From Bennyhoff and Hughes (1987).

<sup>b</sup> Calibrated age obtained from 20-year marine model to ca. cal 8,500 B.P. (Stuiver et al. 1986). The one-sigma value reported for the calibrated age does not factor in the standard deviation from the Delta-R applied to these dates; the age range is assymetrical about the <sup>14</sup>C age determination. The Delta-R used in these calibrations is consistent with the figure established for coastal Orange County during the Newport Coast Archaeological Project (Southon et al. MS).

subsequently ground away to a tear drop or oval form. The final product usually lacked any crenulata. The square ring forms were produced in much the same manner, with the crenulata effaced completely (or nearly so), but with the ends squared and the ornament invariably thinner. Flat grinding characterized the ends of these rings.

The oval rings originated at the start of the Middle Period and flourished in relatively high frequency in Middle Period Phases 2 and 3 (200 B.C. to A.D. 700). Their frequency in Phase L1 is low, and they are absent from contexts beyond early Phase L2 (King 1990:127). King (1990:127) observed that *M. crenulata* ornaments, together with *O. biplicata* discs (saucer beads), helped characterize a trade network that spread from the San Joaquin River to southern Orange County and from the Pacific coast across much of the Mojave Desert.

King (1996:15) placed the small, squared *Megathura* forms in Middle Period Phase 4 to 5a, noting that the square rings manufactured during Phase M5a retained more of their original

shell than those of Phase M4. This later variety was ground flat on both concave and convex faces. Gifford (1947:61) dated identical flat-ended *Megathura* rings (H2aIII) at a Pueblo II site between A.D. 900 and A.D. 1100.

The limpet oval ring ornament (Fig. 1d) was recovered from the 40 to 50 cm. level of Unit 5N/1E. Its length and width were 13.5 mm. and 7.1 mm., respectively. This burned specimen was 2.5 mm. thick, with all surfaces ground and lacking crenulata. The limpet small square ring (Fig. 1c) was found at the 30 to 40 cm. level of Unit 3N/3E. It measured 11.5 mm. by 8.8 mm. and was 2.0 mm. thick. The hypothesized sequential pattern finds support with the oval ring (Fig. 1d) that was AMS dated (calibrated age) to 1,413 ± 70 B.P. (Beta-73490), as well as the small square ring (Fig. 1c) that produced a calibrated age of 865 ± 60 B.P. (Beta-73489) (Table 1, Fig. 3). Parenthetically, production of *Megathura* ring ornaments has been documented at several Orange County sites in the Newport Coast area during the Middle Period (Gibson and King 1991:10).

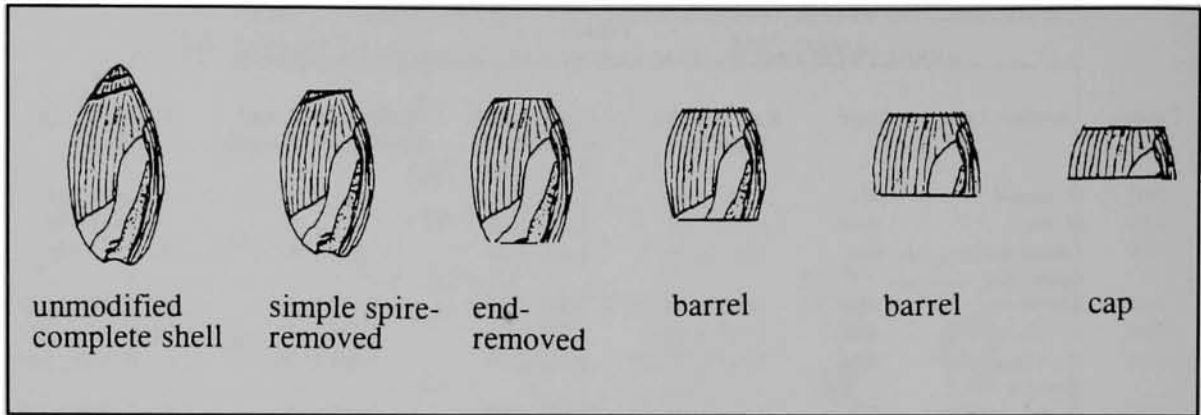


Fig. 4. Idealized types of *Olivella* beads with modifications to spires and bases.

### *Olivella* End-Removed (Type B2b) Beads

Are occurrences of *O. biplicata* end-removed beads (Type B2) in the Santa Barbara Channel region and in Orange County synchronous events? A continuum of basal removal by chipping and grinding accounts for the several types of beads in the B series (Fig. 4). Typically, beads with diameters less than 6.5 mm. were spire-altered but not basally modified. However, medium and large *O. biplicata* beads with spires ground at right angles to the long axis were also usually ground on the base end at right angles to the long axis.

In territory historically occupied by the Chumash, Type B2 beads are most common in the Early Period but persist through the end of the Middle Period (M5) and continue into Phase 1 of the Late Period (Bennyhoff and Hughes 1987: 121; King 1990:135). In Orange County, end-removed (Type B2) beads are often associated with site components having barrel types and/or oblique spire-removed types, an observation consistent with the hypothesis that B2 types are pre-Late Period artifacts.

The two *Olivella* end-removed beads from CA-ORA-378 chosen for AMS analysis (Figs. 1g-h) had basal grinding that had removed all of the canal notch and part or all of the folds, attributes assigning them more specifically to the

Type B2b category. Maximum diameter remains toward the spire. Figure 1g, which was recovered from Unit 20S/3E at the 70 to 80 cm. level, was 8.0 mm. in diameter with a length of 11.2 mm. Its ground spire was 2.6 mm. in diameter. Unit 20S/3E yielded both Early Middle and Late period beads. A Late Period *Mytilus* disc appeared in the upper 40 cm., while an oblique spire-removed bead occurred below 40 cm.

The bead shown in Figure 1h was 8.3 mm. long and 6.6 mm. in diameter. The ground spire diameter was 1.7 mm. The bead was recovered from the 0 to 10 cm. level of Unit 45N/8E. Two Late Period beads, a *Mytilus* disc and an *Olivella* cupped, also occurred in the unit.

Although both units contained Late Period beads, neither *Olivella* end-removed bead dated after the Middle Period. Figure 1h yielded a calibrated date of  $2,395 \pm 60$  B.P. (Beta-73498), and Figure 1g dated to  $1,413 \pm 80$  B.P. (Beta-73494). The former is then placed into the Middle Period Phase 1 and the latter into the Middle Period Phase 3 (Table 1; Fig. 3). This is consistent with the Chumash sequence.

### *Olivella* Oblique Spire-Removed (Type A2a) Beads

Do oblique spire-removed Type A2a beads from Orange County date within the temporal range established for the Santa Barbara Channel



bead sequence? Such beads are manufactured from *O. biplicata* shells and are similar to the previously discussed spire-removed types, except that the spire has been ground at an angle oblique to the long axis of the shell. Measured oblique angles cluster around 45° (Bennyhoff and Hughes 1987:119; King 1990:118).

In most of Chumash territory, in central California, and in the western Great Basin, this type was popular only during the latter part of the Early Period. However, in the Santa Barbara Channel region, the type was common during Phase 1 and Phase 2a of the Middle Period (ca. 600 B.C. to A.D. 200). Rarely are they encountered in site components dating to Phase 2b of the Middle Period or later (Gibson 1975:116; King 1990:119).

The specimen depicted in Figure 1f was also selected for AMS analysis. Its spire was ground at about 45° to the long axis of the shell, but it lacked basal grinding. Its length was 7.9 mm., and its diameter was 5.7 mm. The spire hole measured 2.2 mm. AMS assay of this artifact yielded a calibrated date of 2,334 ± 70 B.P. (Beta-73493), establishing it within Phase 1 of the Middle Period (Table 1; Fig. 3). Such time placement is consistent with the popularity of this type in the Santa Barbara Channel region.

### Large *Olivella* Spire-Chipped (A1c) Beads

Are large *O. biplicata* spire-chipped beads (Type A1c) confined within a limited time range? Such beads have diameters greater than 9.5 mm. Spire removal is accomplished with a vertical blow that drives the spire into the shell. The resulting hole is noticeably larger than those of large *Olivella* spire-ground beads, which are found in all time periods (Bennyhoff and Hughes 1987:116-118).

Six Type A1c beads were recovered in Monterey County at CA-MNT-108 in strata whose raw radiocarbon dates ranged between 2,400 and 2,700 B.P. (Gibson 1989). Only one unequivocal example of this type (Fig. 1e) was discovered

at CA-ORA-378, in Unit 15S/28E, at a depth of 40 to 50 cm. The diameter of the spire was 5.4 mm., the shell diameter measured 10.7 mm., and the length was 15.4 mm. Both the spire and the base were slightly worn or weathered. With a calibrated date of 6,887 ± 60 B.P. (Beta-73496) (Table 1, Fig. 3), this artifact was manufactured far earlier than the Monterey specimens, indicating a wide time range for A1c types. Parenthetically, two raw radiocarbon dates on marine shell from CA-LAN-267 (6,310 ± 100 B.P. and 6,870 ± 100 B.P.) may date two large *Olivella* spire-removed beads, one with a large punched spire (King 1967:Fig. 18h). Bennyhoff and Hughes' (1987) assertion that larger diameter spire-removed beads occur during all time periods is further supported.

### *Olivella* Barrels (Type B3) and Caps (Type B4)

Do the temporal occurrences of Orange County *O. biplicata* barrel (Type B3) and *O. biplicata* cap (Type B4) types coincide with those of the Santa Barbara Channel sequence? Barrels and caps grade into one another typologically, with modification of each involving grinding at the spire and at the base (Fig. 4). Barrels have their maximum diameter close to the midpoint along the length of the bead. Similar to the barrels, *Olivella* caps are distinguished first by their extreme basal grinding. Further, Bennyhoff and Hughes (1987:122) noted that "virtually all the aperture is removed to produce a caplike bead consisting of the upper one-third of the spire-lopped shell."

For Chumash territory, *O. biplicata* barrels and caps occasionally occur in the Late Middle and Late periods. Small barrels were most common in Phases M5b and M5c, and caps were most common during Phase L1a (King 1990:135). Research from NCAP suggested that barrels and caps were more likely to occur in the later portion of the Early Period or in Phases 1 and 2 of the Middle Period, since both of these types were absent at CA-ORA-339 and -340, two

predominantly Late Middle Period and Phase 1 Late Period sites (Gibson and King 1991). Parenthetically, in Orange County, the *Olivella dama* species may have been employed more often for the Late Period Barrels than *O. biplicata* (King 1986).

Three such beads, including one barrel (Type B3b; Fig. 1i) and two caps (Types B4a and B4b; Figs. 1j-k), were selected for AMS dating. The barrel specimen (Fig. 1i) had its maximum diameter about midway between the ground spire and the ground base. Basal chipping had removed all of the folds and much of the callus or columella area. It was 8.3 mm. in diameter and 9.0 mm. in length. The chipped spire was 4.0 mm. in diameter. The spire and base appeared to have resulted from percussion blows to remove the spire.

The barrel bead in Figure 1i was recovered at the 80 to 90 cm. level of Unit 20S/3E, a unit that contained a Late Period *Mytilus* disc and a Middle Period *Megathura* ring blank above the 40 cm. level. Early Middle Period types occur below the 40 cm. level. This *Olivella* barrel returned a calibrated date of  $4,483 \pm 50$  B.P. (Beta-73495) (Table 1, Fig. 3), a good fit with the established Chumash sequence. It also falls into King's Early Period Phase Eyb, which was given a revised time range, using raw radiocarbon dates, between  $3,970 \pm 70$  and  $4,260 \pm 80$  B.P. (King 1990:28).

Figure 1j illustrates a Type B4a *Olivella* cap bead (Bennyhoff and Hughes 1987:122). The diameter measured 4.8 mm. and the length 3.3 mm. The spire had been ground perpendicular to the long axis, with the resulting hole being 2.4 mm. in diameter. It was retrieved from Unit 5N/18E at the 40 to 50 cm. level. In the 10 to 40 cm. level, two rough discs (ca. A.D. 1790), a *Mytilus* disc, and an *Olivella* cupped (L1 or L2) were recovered. An *Olivella* oblique spire-removed (Type A2a) bead occurred in the 40 to 50 cm. level, and it probably is of Middle Period Phase M1 or M2 age.

An *Olivella* cap (Type B4b) bead (Fig. 1k) measured 6.6 mm. in diameter with a length of 4.6 mm. Its spire was ground obliquely, leaving a 3.5-mm. diameter hole. It was recovered from the 60 to 70 cm. level of Unit 25S/18E. The unit also contained an *Olivella* oblique spire-removed bead (Type A2a), a type usually associated with the early Middle Period.

The cap beads in Figures 1j and 1k yielded calibrated dates of  $5,050 \pm 60$  B.P. (Beta-73497) and  $6,310 \pm 60$  B.P. (Beta-73499), respectively (Table 1, Fig. 3). Both caps, then, occur earlier than expected based on the Chumash sequence, where caps are most common in the Ez Period with some occurring in Eyb (King 1990:107). None is thought to have occurred in Eya or earlier. King (1990:30) has not yet established firm dates for the Ey subphases but estimated a range between  $2,600 \pm 200$  B.C. and 3,500 B.C.

#### SUMMARY AND CONCLUDING REMARKS

Eleven AMS radiocarbon dated shell beads and ornaments from CA-ORA-378 offer partial tests of the applicability to Orange County of the temporal sequence developed by Chester King (1981, 1990) for the Santa Barbara Channel region. Our results help support the general notion that most shell beads and ornament types recovered from Orange County middens may be used to cross-date local site components by employing identical artifacts whose time of manufacture and use are established for Chumash territory.

Specifically, certain CA-ORA-378 specimens, including the *Olivella* cupped, the *Mytilus* disc, the small square ring and oval ring limpet beads, and the *Olivella* spire-removed, oblique spire-removed, and end-removed beads, fall within expected time ranges. However, our research also indicates that *O. biplicata* barrels and caps were not occurrences of the Late Middle Period or Late Period in Orange County. Rather, it appears that at such times there was a switch to

Gulf of California *O. dama* shells for barrel and cap manufacture. These *O. dama* beads were probably produced locally. *O. biplicata* barrels and caps were salient types in Late Middle Period and Late Period contexts in the Chumash area. If spatiotemporal boundaries regarding *O. biplicata* versus *O. dama* barrels and caps could be established, and particularly if the geographic division coincided at least roughly with the historically recorded Gabrielino/Chumash interface, then there are implications for the enigma of coastward migration of Takic groups.

We anticipate that our research results will inspire Orange County archaeologists to utilize further application of AMS technology to selected beads and ornaments, with the obvious corollary that with reference to the Santa Barbara Channel region bead sequence, higher confidence statements should characterize the cross-dating of local beads/ornaments and their archaeological associations. Ultimately, a mere concatenation of high probability predictions will be transformed into an independently formulated Orange County bead/ornament chronology, thereby obviating dependence on a temporal scheme that was developed within another locality.

### NOTES

1. The calibrated ages (see Table 1) include a Delta-R adjustment for upwelling that was established for coastal Orange County during the NCAP (Southon et al. MS). This Delta-R may not be applicable to all of the 11 dated specimens if, as seems likely, most of these beads/ornaments had been manufactured in the Santa Barbara Channel area where the upwelling phenomenon could have been of a significantly different character.

2. King's (1981, 1990) chronologies are referenced in discussions of beads found in Orange County; otherwise, chronological frameworks normally employed are those evolved from Wallace (1955). Presently, we take the Late Prehistoric Period to begin locally at 1,350 B.P., around the time of the presumed introduction of the bow and arrow (Koerper et al. 1996), terminating at the Historic Period, the start of King's (1990) L3 period. The Late Prehistoric Period thus spans the latter third of King's (1990) Middle Period through his Late Period Phase 2b. The Late Pre-

historic Period divides into early (LP1) and late (LP2) at 650 B.P. (Mason and Peterson 1994). The Orange County Intermediate Period (3,350 B.P. to 1,350 B.P.) covers most of King's (1990) Early Period Phase Z (Ez) and the first two-thirds of his Middle Period (Koerper et al. 1998). The Milling Stone period in Orange County begins minimally four millennia prior to the proposed Intermediate Period start date.

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