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### Authors

Koerper, Henry C  
Prior, Christine  
Taylor, R E  
et al.

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## Additional Accelerator Mass Spectrometer (AMS) Radiocarbon Assays on *Haliotis* Fishhooks From CA-ORA-378

**HENRY C. KOERPER**

Dept. of Anthropology, Cypress College, Cypress, CA 90630.

**CHRISTINE PRIOR**

Radiocarbon Laboratory, Univ. of California, Riverside, CA 92521.

**R. E. TAYLOR**

Dept. of Anthropology, Univ. of California, Riverside, CA 92521.

**ROBERT O. GIBSON**

Gibson's Archaeological Consulting, Paso Robles, CA 93447.

*AMS radiocarbon assays confirm that shell fishhook and line fishing was a feature of early Late Holocene and Intermediate Cultures period subsistence technology in coastal Orange County. Other data support a similar development of coastal line fishing in southern and central California beginning no earlier than the third millenium B.P. However, limited data from San Clemente Island suggest shell fishhooks were employed prior to that time. We suggest that AMS dating be applied to San Clemente Island fishhooks to help clarify the relationship of the island data with established fishhook sequences for Orange County and other parts of California.*

**SIMPLE** shell fishhooks represent a technological advance over fish gorges (Salls 1989:194). If this innovation is causally linked to marked intensification of fish procurement for the maritime societies of southern California (Salls 1988, 1990; Raab et al. 1995), then temporal placement of such fishing gear could help establish minimal dates for the beginnings of an important shift in subsistence behavior.

Several shell fishhooks have been recovered from CA-ORA-378 (Christ College site), Irvine (Fig. 1), a settlement whose major occupation



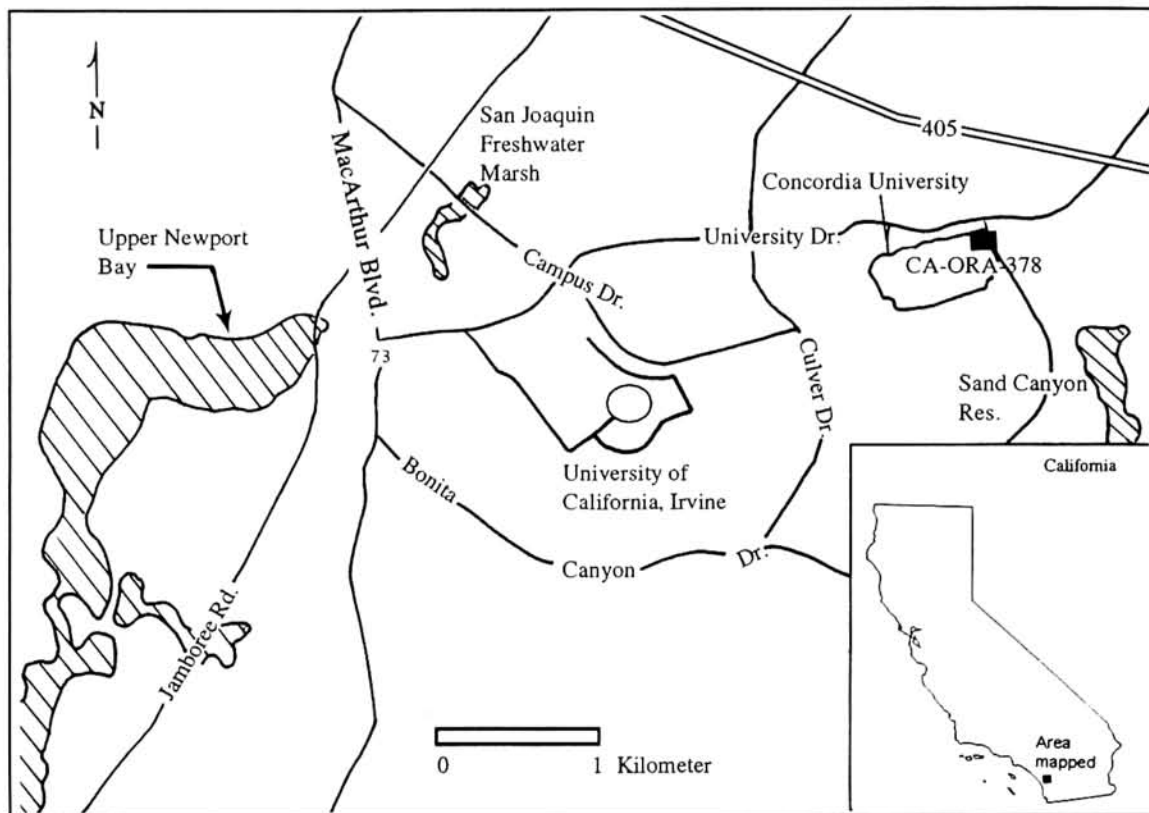


Fig. 1. Location of CA-ORA-378.

occurred in a roughly 1,500-year time span through much of the Intermediate Cultures Period and the first third of the Late Prehistoric Period. The spatial distribution of 91 radiocarbon dates from the site, ranging across more than eight millennia, indicates significant stratigraphic mixing. This fact is also reflected in the distribution of bead types and other artifacts. Thus, little confidence would attach to placing the fishhooks in time based on cross-dating or the employment of radiocarbon association dates.

Koerper et al. (1988) reported that a C-shaped, rotating or incurved abalone (*Haliotis* sp.) shell fishhook (Cat. No. 378.1958, Fig. 2a, Table 1) from CA-ORA-378 was AMS dated to  $2,780 \pm 100$  RCYBP (assumed  $\delta^{13}\text{C}$  correction of 0.0 per mil<sup>1</sup>) (AA-1593), for a calibrated age range of 840 to 1,100 B.C. at one sigma. This

evidence placed hook-and-line fishing for the Newport Bay region at least as far back as the early Late Holocene (see Erlandson and Colten 1991:2), or around a proposed Intermediate Cultures-Millingstone Period interface (see Koerper and Drover 1983).

The calibrated age for the C-shaped hook does not reflect an upwelling correction due to still unresolved uncertainties in marine reservoir effects during the Holocene on the California coast. Previously published upwelling factors may require revision, depending on location along the coast. Studies currently under way will further define the ranges in marine reservoir values that are to be expected.

A second *Haliotis* fishhook (Cat. No. 378.140) illustrated by Koerper et al. (1988:49, Fig. 1a) was not then dated. That specimen is herein described and illustrated (Fig. 2b), and an

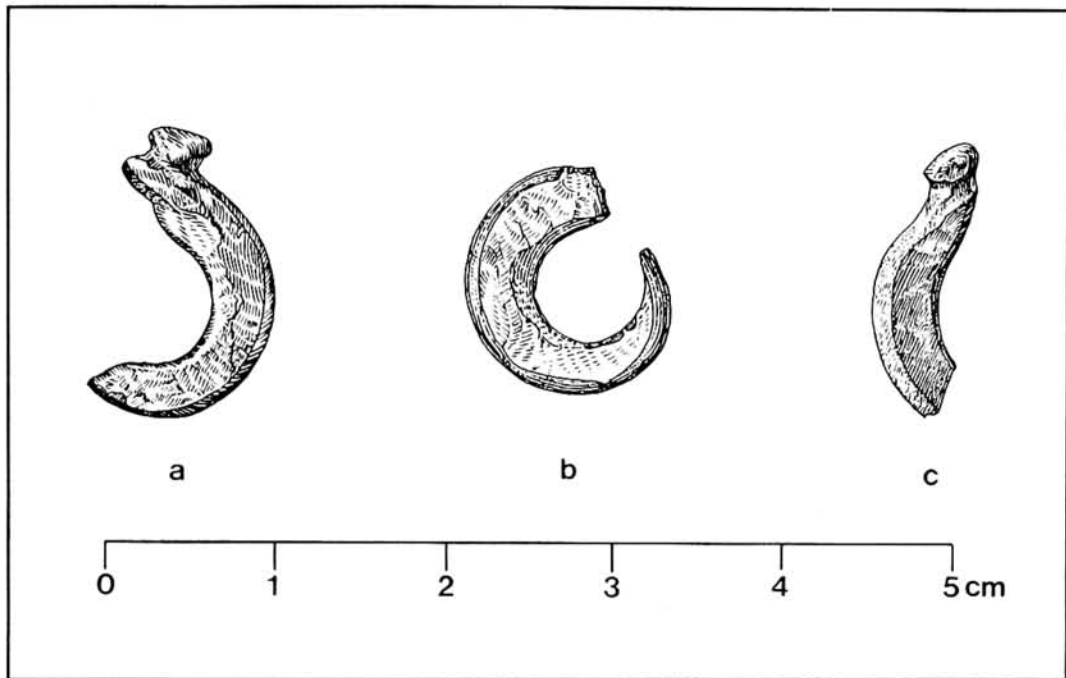


Fig. 2. *Haliotis* fishhooks from CA-ORA-378: (a) Cat. No. 378.1958; (b) Cat. No. 378.140; (c) Cat. No. 378.2251.

AMS date is provided. Three, and possibly four, additional abalone fishhook fragments have been recovered from the Christ College site. A fragment of a *Mytilus* shell fishhook was also recovered. The most complete of these subsequent finds (Cat. No. 378.2251, Fig. 2c) was also AMS dated and is described in this report.

### THE ARTIFACTS

Specimen 378.140 (Fig. 2b) was excavated from the 30 to 40-cm. level of Unit 0N/8E, while Specimen 378.2251 (Fig. 2c) was recovered from the 20 to 30-cm. level of Unit 3S/5.5E. On each, the shanks are short-knobbed rather than grooved or notched (long-knobbed). They fall into the Type 1 category of Heizer (1949) or the Type 1b category of Strudwick (1985). Short-knobbed hooks are rare north of Malibu, Los Angeles County, but on the mainland south of Palos Verdes nearly every complete shell fishhook is a Type 1b (Strudwick 1986). The only Type 1a fishhook from Orange

County was from CA-ORA-662 (Cat. No. 33847) (Gibson 1993:202).

Both of the specimens are "left handed" hooks, meaning that when viewed with their points facing up and the shell cortex toward the viewer, the points are to the left of the shank (Strudwick 1985:40). With the points missing on both, calculation of angle of penetration was not possible (see Strudwick 1985:52-54). Both were more probably J-shaped rather than C-shaped hooks (see Strudwick 1985:53-54). Figure 2b has a growth line angle of  $10.5^\circ$  (see Strudwick 1985:42), a height (knob to bottom near break) of 16.6 mm., a maximum thickness of 3.2 mm., and a weight of 0.2 g. Multiple scrapes on the cortex of Figure 2c precluded assessment of growth line angle of this fragment, which weighs 0.1 g. and has a maximum thickness of 2.5 mm.

### SAMPLE PREPARATION AND ANALYSIS

Small fragments of shell for radiocarbon and stable isotope analysis were removed from the

**Table 1**  
**AMS RADIOCARBON DATES FOR THREE *HALIOTIS* FISHHOOKS FROM CA-ORA-378**

Cat. No.	Lab No.	Unit and Level	Radiocarbon Age <sup>a</sup>	$\delta^{13}\text{C}$
378.1958	AA-1593	10S/18E, 40 cm.	2,780 $\pm$ 100	0.0 o/oo <sup>b</sup>
378.140	UCR-3257; CAMS No. 12351	0N/8E, 30 to 40 cm.	1,770 $\pm$ 60	+2.8 o/oo
378.2251	UCR-3256; CAMS No. 12350	3S/5.5E, 20 to 30 cm.	2,200 $\pm$ 70	+1.0 o/oo

<sup>a</sup> Normalized for  $^{13}\text{C}/^{12}\text{C}$  ratio.

<sup>b</sup> Assumed value.

broken "point" end of each fishhook, leaving the knob end intact. The samples were cleaned by etching in 2N hydrochloric acid to remove surface contamination, then rinsing in distilled H<sub>2</sub>O. After drying, the shell carbonates were converted to CO<sub>2</sub> by reaction under vacuum with 85% phosphoric acid. After collection and purification, an aliquot of the CO<sub>2</sub> was reserved for stable isotope analysis ( $\delta^{13}\text{C}$ ) and the rest converted to graphite under hydrogen using a cobalt catalyst in a method described by Vogel et al. (1987a). When the reaction was complete, the graphite powder was tamped into aluminum target holders and sent to the Center for Accelerator Mass Spectrometry (CAMS) at the University of California Lawrence Livermore National Laboratory (LLNL) for counting. Details of the operation of the accelerator at LLNL may be found in Vogel et al. (1987a, 1987b).

## RESULTS AND DISCUSSION

The specimen shown in Figure 2b was dated to 1,770  $\pm$  60 RCYBP (UCR-3257; CAMS No. 12351). Figure 2c was dated to 2,200  $\pm$  70 RCYBP (UCR-3256; CAMS No. 12350). Both values are adjusted for the  $^{13}\text{C}/^{12}\text{C}$  ratio, but no upwelling correction was applied (Table 1). These data support the hypothesis that hook-and-line fishing was a feature of early Late Holocene and Intermediate Cultures Period subsistence technology in the Newport Bay area. Locally, shell fishhooks may have been introduced during the early Late Holocene.

King (1990:231) posited shell fishhooks as occurring generally after 200 B.C. in southern California. In their study of fishhooks from the Newport Coast Archaeological Project (NCAP), Gibson and King (1994:7) suggested that manufacture of large shell fishhooks, both knobbed shank and grooved shank varieties, probably occurred in the post A.D. 500 period. At least nine NCAP sites contained occupation strata earlier than 3,000 years B.P., yet none of these strata contained evidence of shell fishhooks. The most reliable evidence of circular shell hook manufacture and use occurred in strata radiocarbon dated between 370 and 1,300 years B.P. The largest sample from CA-ORA-662 contained 36 specimens from strata with 13 association dates ranging between 370 and 850 years B.P. (Gibson and King 1994). In the Santa Barbara Channel, short- and long-grooved shank fishhooks are believed to occur at the end of the Middle Period, continuing into Phase 2 of the Late Period (King 1990). Gibson and King (1994) found the data of one NCAP site, CA-ORA-929, problematic. No radiocarbon dates or time-sensitive shell beads indicated a Late Period, but two Type 1b fishhooks were recovered. There are Middle Period II and III dates for CA-ORA-929, but in light of the other NCAP data, as well as the Chumash data, Gibson (1991:156) was reluctant to associate the two hooks with a Middle Period occupation.

The earliest date King (1981:137) regarded as credible for small, circular, simple, "J"-shaped

hooks is based on a radiocarbon association date of  $2,510 \pm 80$  RCYBP (UCLA-918C) from CALAn-264, in Malibu. The style of short to long grooves on the proximal end of the hook (Strudwick [1985], Types 1a and 1b) is thought by King (1990:232) to date from A.D. 900 to 1650, or from the Middle Period into Phase 2 of the Late Period.

Strudwick (1986:272, 278) proposed that single-piece fishhooks were used before 2,500 B.C. along coastal California, and that the earliest hooks may have been used on the Santa Barbara Channel Islands or adjacent mainland, with diffusion of the circular hook to Orange County occurring before 1,500 B.C. The basis for this hypothetical scenario is association dates (Strudwick 1986), which can be problematic, a fact illustrated by the  $3,260 \pm 100$  B.C. association date given for Figure 2b (see Strudwick 1985: 58, 1986:267), which was subsequently AMS dated to  $1,770 \pm 60$  RCYBP (UCR-3257; CAMS No. 12351). Figure 2b and the aggregate radiocarbon shellfish sample used for the association date derived from the same unit level.

Strudwick (1985:56), citing personal communication with R. Rechtman, reported that several fishhooks from San Clemente Island might be as old as 4,000 B.C., and that AMS dating was planned for these specimens. To the authors' knowledge, no AMS assays have been run on these artifacts. However, conventional decay counting dates have been run directly on three hooks from Component B at the Eel Point site (CA-SCLI-43B) (Ghiradelli 1984; Goldberg and Titus 1986; Salls 1988:361, 371-372, 1990:65-66, 1991:66). A *Haliotis* specimen found at the 30 to 45-cm. level, and another discovered at a depth of 215 to 230 cm., yielded normalized dates of  $3,950 \pm 330$  RCYBP (UCLA-2573) and  $4,500 \pm 350$  RCYBP (UCLA-2574), respectively. A *Norrisia norrisii* fishhook from the 60 to 75-cm. level was dated to  $3,380 \pm 280$  RCYBP (UCLA-2578).

Also at the Eel Point site, a circular *Haliotis* fishhook from Stratum 10, Unit 2N/35E, at 3.4 to 3.5 m., was dated by association using a charcoal sample assay of  $3,320 \pm 10$  RCYBP (Beta-76151) (M. Raab, personal communication 1994). There appeared to be stratigraphic integrity, as indicated from the soil profile. Comparatively undisturbed stratigraphy on San Clemente Island is due to the lack of burrowing rodents (Salls 1991:63).

The San Clemente Island data that indicate shell hook-and-line fishing prior to the third millennium B.P. are at variance with the shell fishhook sequences established for Santa Barbara County (King 1990) and Orange County (e.g., Gibson and King 1994). It is possible that there are problems with the San Clemente data. If proximal and distal ends are not present, objects may not have been fishhooks, but rather circular ornaments. *Haliotis* ornaments appear in Middle Period sites, yet for San Clemente Island, there is no recorded tradition of disk or ring ornaments such as that known for the northern Channel Islands (Raab et al. 1995). Complete shell fishhooks weigh only about three to five grams; thus, their small size makes conventional radiocarbon dating difficult. Association dates may prove to be accurate, but human disturbance is always a possibility. The authors suggest that in future investigations, AMS dating be conducted on shell fishhooks from San Clemente Island to help clarify the relationship of the island data with the established sequences of Orange County and other parts of California.

#### NOTE

1. Erroneously reported in Koerper et al. (1988) as an assumed -3.8 per mil value.

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