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17. The house had been abandoned so the family would not be troubled by Coyote's ghost.

18. By omitting *haik(y)a* from his speech and adding *-naavasuwī'i* to every phrase.

19. George Laird translated this word as "nests" and said it was formed by adding an animate plural to the root of *soni(y)avi*, the soft, fur-lined "nest" or den made, for example, by a rabbit—but the nest of a bird is *kani*, house.

20. All creatures of the myth might be divided into "the kind that talks" and "the kind that does not talk." However, the line between these categories is not always firmly drawn. For example, the bear appears as a pet incapable of speech; yet in the great saga of Wolf's and Coyote's departure, Coyote's aunt is Bear, member of a tribe of Bears who conduct themselves like other mythological "people." Only the deer and the mountain sheep (and perhaps the buffalo) never appear as personages. Even when Coyote's grandson is turned into a mountain sheep he does not speak, though he acts as a judas goat to entice other mountain sheep within range of Coyote's arrows.

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Seasonal Exploitation of Chione Clams on the Southern California Coast

CHRISTOPHER E. DROVER

The remains of shellfish of various species comprise a significant fraction of many coastal southern California middens. Analysis of the growth rings of certain species permits determination of the season in which the shellfish were collected for food, and hence the season in which the middens were occupied. These data are thus useful for clarifying certain aspects of settlement patterns. The present paper adds two species of *Chione* clam to the list of molluscs used as indicators of archaeological seasonality, and discusses the implications of these findings for understanding prehistoric settlement adaptations on the southern California coast.

The data presented below are derived from investigation of a recent shell midden (4-Ora-119), located on a bluff overlooking a former eastern extent of upper Newport Bay, near the campus of the University of California, Irvine, on property owned by the Irvine Ranch Company. Excavations revealed that the deposit contained artifacts generally attributed to the Late Horizon, including such items as mortars and pestles, steatite containers, numerous small triangular projectile points, several types of shell beads, and Tizon Brown Ware sherds.

Shell represents a major constituent of the midden deposit. Recent studies (Weide 1969) indicate that it is possible to determine the season of collection of Pismo clams (*Tivela stultorum* [Mawe]) in coastal shell middens with some accuracy through a study of the growth rings of the shells. Since the Pismo clam was represented by only a single fragment in the shell collected from the site,



consideration was given to the possibility that other clams from similar environments may have also experienced the necessary growth conditions resulting in the formation of rings which would reveal the season in which they were collected. Upon examination it was found that two species of *Chione* present in the deposit, wavy chione (*C. undatella* [Sow.]) and smooth chione (*C. fluctifraga* [Sow.]), have diagnostic grooves or growth rings which seem to occur in a non-random pattern. In order to determine whether such grooves actually represent seasonal growth rings, and to determine which rings represent which seasons, it is necessary to study the ring patterns of clams grown under controlled conditions. Fortunately, extensive studies of growth periodicity in clams of the genus *Chione* by Barker (1970) and Berry (1972) are available, and these formed the basis of the present analysis. Coutts and Higham (1971) have utilized another species of the genus *Chione* to determine seasonality of coastal sites in New Zealand.

BIOLOGICAL FACTORS

Wavy chione is the most common chione of California beaches, and occurs from San Pedro to South America in shallow waters with muddy bottoms. Smooth chione occurs from San Pedro south to the Gulf of California in muddy substrates just below the low water line (McClellan 1969; Morris 1966:27-28). Both of these species have a wider distribution than the Pismo clam, and studies of their seasonal growth should therefore have more widespread application in archaeology. A comprehensive list of shellfish species which display seasonal growth, and may prove useful in archaeological studies, has been compiled by Barker (1970:8).

The addition of concentric growth rings to the valves of shellfish is a complex process, differing slightly from species to species. In

general, there are three types of growth increments which various shellfish undergo. To illustrate these we may consider the wavy chione (Fig. 1).

Daily Periodicity

Daily growth increments are more or less visible in various shellfish, and these laminae have never been found to exceed 365 within a major (yearly) increment (Barker 1970:42). Daily growth is thought to take place during feeding, when the valves are open, usually during a full tide. Periods of closure due to inactivity, elimination, or depredation produce no recognizable growth and account for yearly growth laminae numbering less than 365.

Fortnightly Periodicity (Fig. 1)

Barker (1970:64) has shown that wavy chione regularly produces 14 to 15 laminae between each ridge formation. These ridges are distinct from annual grooves and are thought to coincide with tidal disturbances. Annual growth increments become progressively smaller due to lengthening of winter hiatus in old age, resulting in a decreasing number of fortnightly rings being produced between annual grooves.

Annual Periodicity

In both wavy chione and smooth chione, periods of winter inactivity are marked by a contraction of the mantle which stops secretion of calcium carbonate, and hence shell formation. This results in a semi-opaque concentric annual groove which is visible externally on the shell (Fig. 1), and is evidently a result of temperature reduction (Barker 1970:159-161; Fitch 1950:292). The period of winter inactivity also varies with latitude and its effect on length and severity of the winter season.

PROCEDURE

The following analysis of wavy chione

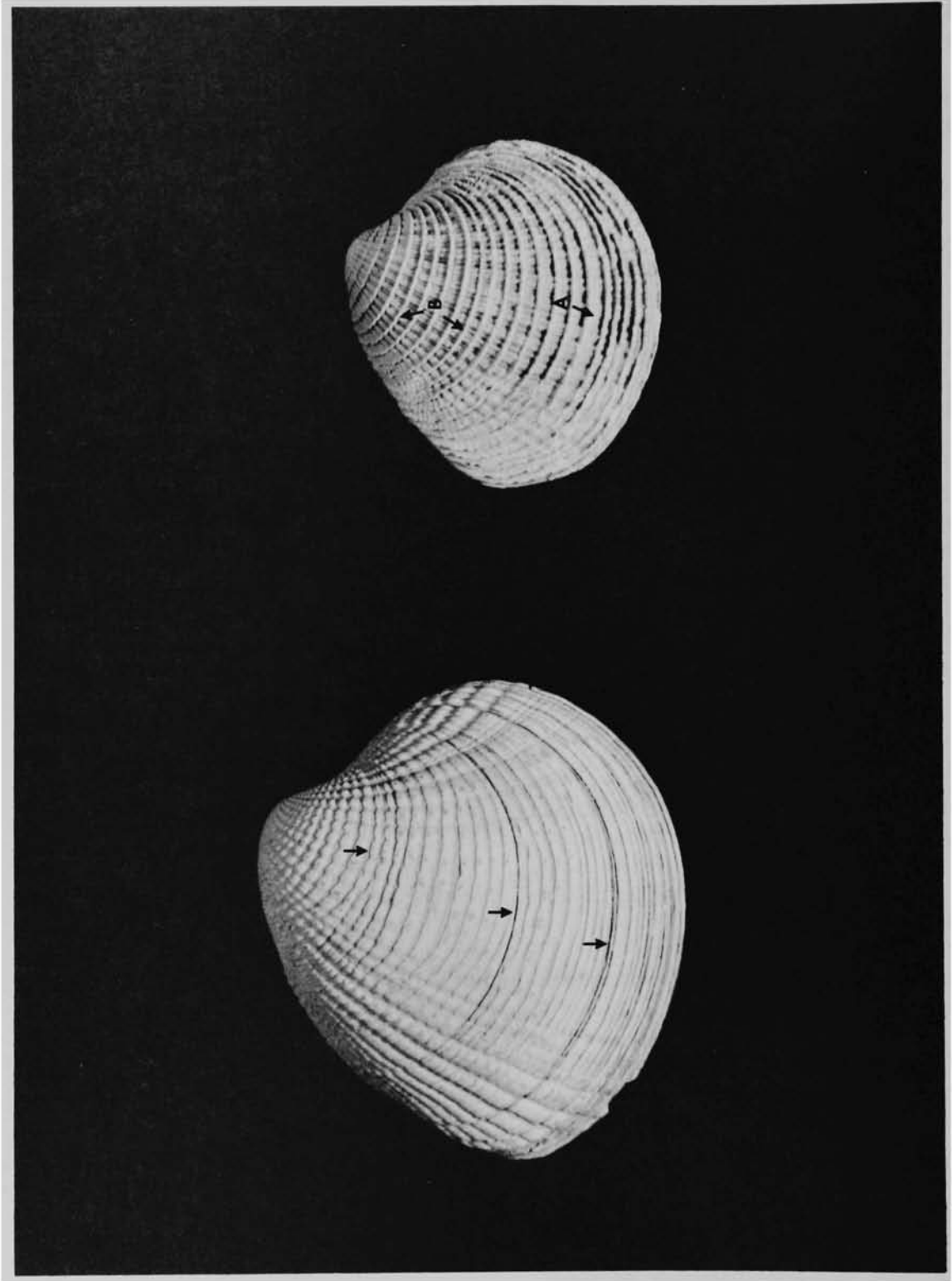


Fig. 1. Smooth chione (*C. flucifraga*), left, with annual winter grooves indicated by arrows. Wavy chione (*C. undarella*), right, with winter groove (A), and fortnightly rings (B) indicated. The specimen at the left is 6.4 cm. long. Items have been coated with ammonium chloride vapor.

follows essentially the procedure of Barker (1970). An adaptation of that procedure is then applied to the smooth chione.

All measurements and observations were made on the exterior of the shells (valves) without prior preparation other than washing. Weight, height, and age measurements were taken of each valve. Height (or growth) increment measurements were taken for each year and for the total height of the shell. These measurements were made with a calipers at the widest extent of each growth ring.¹

The sample of wavy chione consisted of 58 valves, all of that species represented in an excavation unit 2 m. square and 0.8 m. deep, the fill of which was removed in 20 cm. levels. The sample of smooth chione consisted of 53 valves from level 1 of the same unit. Smooth chione was more abundantly represented throughout the deposit by a ratio of 9:1. As noted above, wavy chione is usually much more common than smooth chione on southern California beaches; but it is not known at this time whether the high incidence of the latter is due to selection on the part of the aboriginal shellfishers or to special micro-environmental conditions.

Information on seasonality is derived from examination of the ventral margin of the valves. Winter death is marked by the presence of a readily discernable incipient annual groove comprised of extremely thin daily growth laminae. In wavy chione, this groove is often accompanied by an absence of fortnightly ring formation. Thus winter death is readily determinable; but fixing the time of death in other seasons requires examination of the growth rings between annual winter grooves.

In both smooth and wavy chione, the relationship between age and growth is not a linear function; growth decreases with age due to longer periods of winter inactivity. Essentially, all shell growth occurs from spring through fall, but with increasing age the

addition of major growth increments begins later in the spring and ends earlier in the fall. This means that with each year of life fewer major growth increments will be added between annual grooves. In wavy chione, Barker (1970:178) found that in the first year of growth an average of 16.9 fortnightly growth ridges were added. Thereafter, the number of such ridges decreased to 8.8 in the second year, 4.5 in the third year, and only 4.0 in the fourth year of life. By dividing each of these values by three, the resulting number should be an adequate approximation of growth during a single season, such as summer. This, of course, implies a linear growth rate during the three seasons of activity, which is not entirely correct since with increasing age the winter hiatus is longer and more growth probably occurs in the summer than in the spring or fall. Determination of exactly how sharply growth falls off in the spring and fall in older specimens will ultimately have to be derived from controlled growth studies. However, winter death is easily determinable by the presence of an annual groove at the ventral margin; and the number of concentric ridges added since the last annual groove was formed can in general be transposed into the season of death of the shellfish. A high incidence of death in a single season indicates the period of most intensive shellfish collecting and site occupation. As shown in Fig. 2, the most intensive period of collection of wavy chione was during the winter and spring. A preponderance of older individuals (Fig. 3) may reflect the relative ease of locating and collecting these larger specimens, as suggested by Cooley (1971).

The analysis of smooth chione is more difficult because the sharp concentric fortnightly ridges characteristic of wavy chione are absent and therefore could not be counted. The mean annual growth was determined by height measurements taken with a sliding calipers. The annual growth measure-

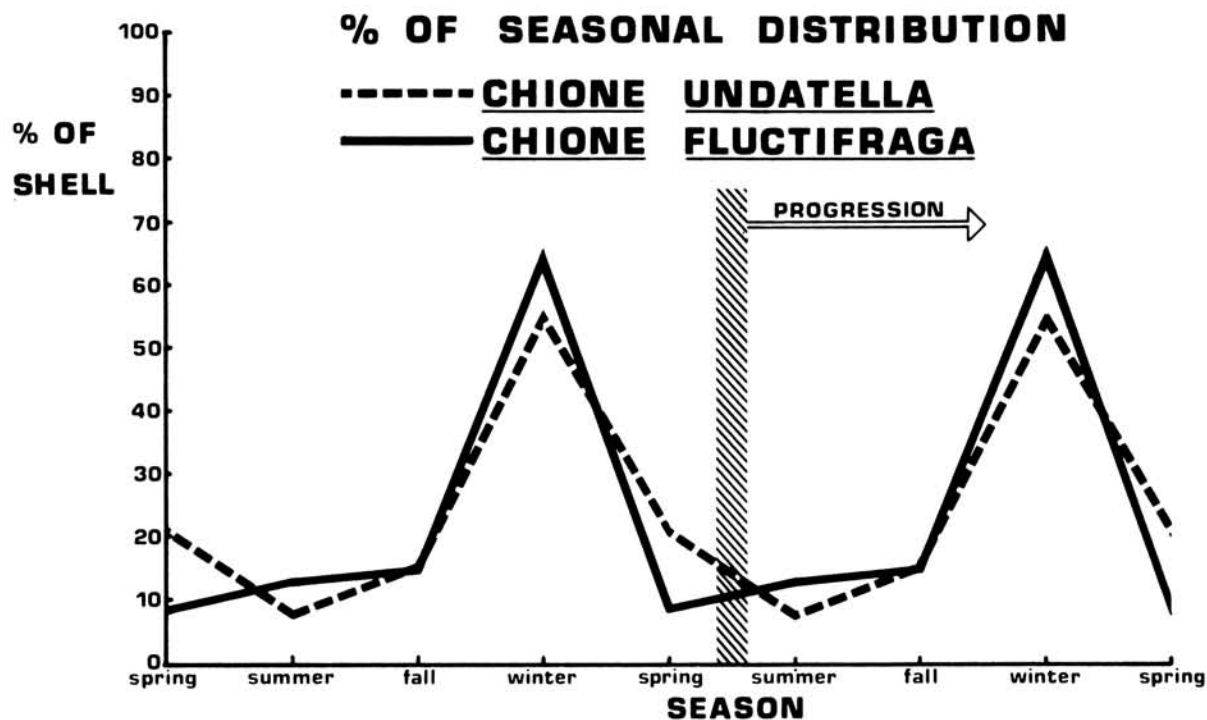


Fig. 2. Graph showing percentages of wavy and smooth chione collected at various seasons. The pattern of predominantly winter shellfishing is projected over a two year period.

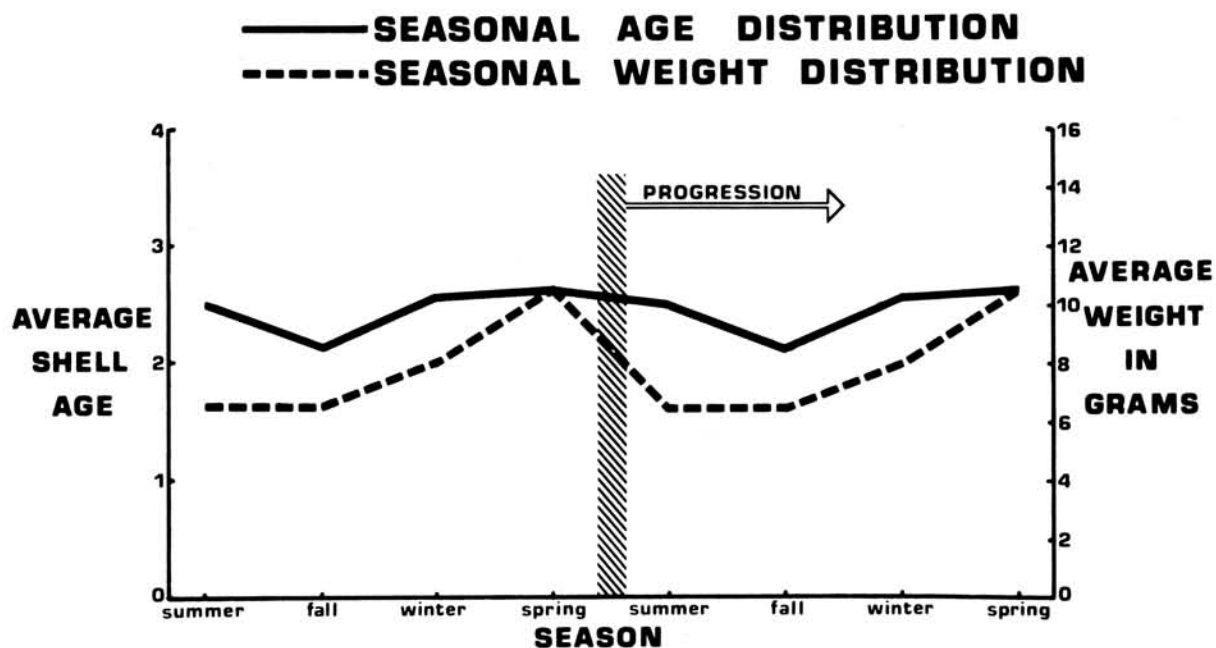


Fig. 3. Seasonal age and weight distribution of wavy chione.

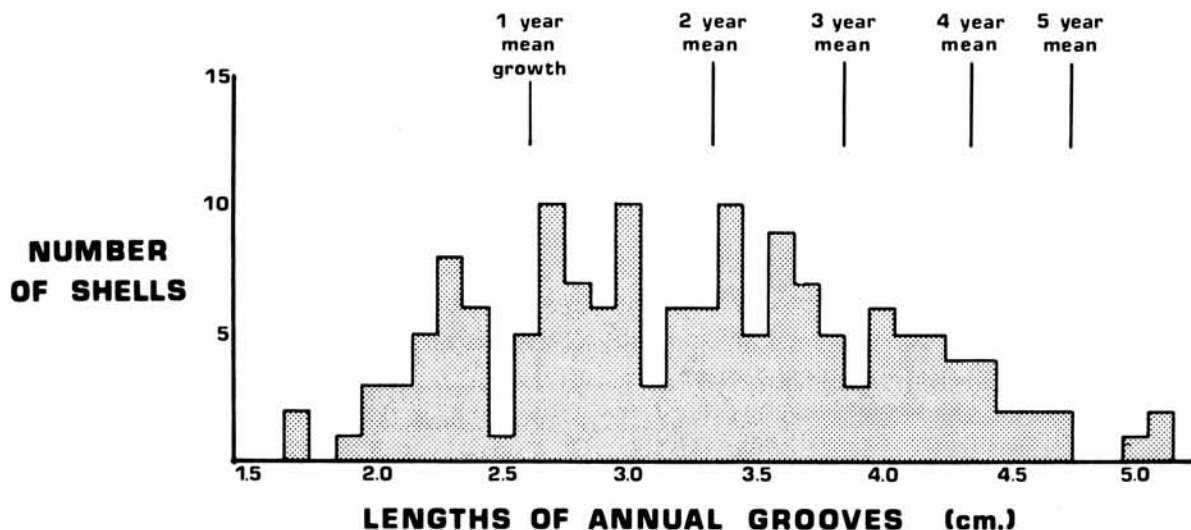


Fig. 4. Histogram showing size distribution of smooth chione valves occurring at site 4-Ora-119.

ment was then divided by three, resulting in an approximation of growth for a given season. The results are intended as preliminary, rather than diagnostic, but reveal a generally similar pattern of seasonal collection as that obtained for wavy chione (Fig. 2).

In order to determine whether the growth rings were correctly identified, statistical techniques were employed. One and two-year old individuals were the most numerous age sets represented in the sample, and measurements were taken for each year of growth on each valve. Calculations for one standard deviation were made for each set to demonstrate the degree of "randomness" in the occurrence of grooves observed as annual rings. Mean height at the formation of the first year groove was 2.40 ± 0.40 cm., and includes 76% of the population of one-year olds. For second year growth, mean height was 0.80 ± 0.30 cm., which represents 79.5% of the two-year old population (67% being considered significant) (Fig. 4). This suggests that identification of the grooves as annual growth increments is probably correct, but verification must await controlled growth studies. However, it does appear that smooth chione does exhibit a seasonal growth pattern that can be used for

determining archaeological seasonality. The seasonal growth periodicity of smooth chione is probably due to the same factors which regulate growth in wavy chione, e.g., variation in water temperature.

IMPLICATIONS

Analysis of the shellfish remains from 4-Ora-119 indicates predominant collection during the winter. There are a number of reasons why the aboriginal occupants of the Orange County coast were engaged in winter shellfishing, including the season of availability (or non-availability) of other resources in other biotic zones, and the availability of the shellfish themselves.

Hudson (1971) developed a model for predicting settlement patterns for the Gabriellino region based on techno-environmental factors, suggesting that:

The sites along the exposed coast from San Pedro southward to Newport Bay were used for secondary subsistence activity. These gathering camps were occupied by small family groups who exploited the available shellfish during lean winters. With the approach of spring, they probably moved inland to primary rancherias or villages, form-

ing into multiclans, and exploiting the adjacent areas for seeds, roots, and small game animals. Toward fall, the acorn harvest occurred, followed by the formation of small family units again for the lean winter. In areas which provided some coastal protection, such as Goff's Island and areas within the Newport Bay region, maritime activities were pursued as both the environment and technology permitted [Hudson 1971:70].

Essentially, the proposed pattern is one of primary (village) sites occupied during the warmer months and located inland from the coast, and secondary (specialized exploitation) sites occupied during the colder months and including such sites and localities as coastal shellfishing stations and inland acorn gathering areas. There are several problems with this model, not the least of which would be the seeming advantage of living in larger groups than the extended family during the lean winter months in order to rely on others in case of a short food supply.² Hudson did note certain exceptions to this gross classification; and on the basis of the coexistence of both maintenance and extractive artifacts at the shell midden here under consideration, the taxonomy may be too restrictive. The artifact inventory suggests that 4-Ora-119 functioned as both a shellfishing station, and probably also as a [primary] occupation site. Given what we know concerning the size of territories exploited by !Kung bushmen from base camps (the site catchment concept, e.g., Lee 1968:35), there is no apparent reason why primary occupation sites could not have existed on Newport Bay and the occupants of them easily exploited the resources of the nearby San Joaquin Hills. Likewise, it is entirely reasonable to suggest that inland groups may have resorted to shellfishing in lean times, perhaps in the territories of kinsmen who occupied coastal territories such as Newport Bay. In the first instance, one could expect reasonably large populations occupying sites such as 4-Ora-119 and exploit-

ing shellfish during the winter as a supplement to stored foods. In the latter case, smaller groups may have made the journey to collect shellfish when other resources, such as stored acorns, were depleted.

Ethnographic information from northwestern California details the significance of the shellfishing industry, the general outlines of which might also be applicable in the Newport Bay region:

All these tribes [Pomo, Maidu, Wappo, Tolowa, Yurok, Wiyot, Chilula, Mattole, Sinkyone, Coast Yuki, Wintu, Kato] used the various shellfish available. Those living along the immediate coast line had an abundant supply at all times and dried them, not only for use in winter, but also as an article of barter with the people living farther back in the mountains. Frequent mention is made of this barter. The interior people also made trips to the coast where they were permitted to collect shellfish and other sea foods for themselves on the beaches and rocks of their friendly neighbors [Kroeber and Barrett 1960:110-111].

In addition to it being a season of slack resources, another factor which may have contributed to increased shellfishing in the winter is the presence of red tides which affect coastal waters from June through September, especially during July and August (Fitch 1953). Kroeber and Barrett (1960:111) have discussed the significance of these tides as they affected shellfishing on the north coast:

A paralyzing poison, occurring especially in mussels, is due to a dinoflagellate form of plankton, *Gonyaulax catenella* [polyhedra?]. When this species becomes disproportionately numerous, as indicated by redness or rustiness of the ocean water and luminescence at night in summer, the mussels, storing the poison in their livers, are not themselves harmed but can become lethal to warm-blooded animals eating them. The northwest coastal Indians were well aware of this poisoning . . . The California mussel is

the chief source of danger, clams appearing to be somewhat protected by living buried (though the razor and Pismo clam show some infection), and bay and estuary species by the fact that *Gonyaulax* does not flourish in these waters The Pomo . . . place sentries on watch for *Kal ko-o* (mussel poison). Luminescence of the waves, which appeared rarely and then only during very hot weather, caused shellfishing to be forbidden for two days; those eating shellfish caught at such times suffered sickness and death.

The effect red tides may have had on the seasonality of prehistoric shellfish gathering at Newport Bay would be difficult to ascertain, but the winter collecting of Pismo and chione clams may reflect avoidance of these resources during seasons of potential infection. Away from the bay, out along the open coast, it may have been a very significant factor in determining season of collection.

In terms of dietary preference, it is clear that older and therefore larger clams were collected. The average age of the wavy chione in the sample from 4-Ora-119 was 3.2 years. The unexpected high incidence of smooth chione in the sample would seem to indicate that this species was more palatable than wavy chione.³

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NOTES

1. Sometimes better growth ring definition can be obtained by washing the shells in dilute hydrochloric acid (HCl), but since the shells dissolve in acid, care must be taken to record length and weight beforehand.
2. The acuteness of the problem of short food supply in the event of a poor acorn harvest is exemplified by the study by Tainter (1971), who showed that for the Santa Ynez Valley, of 26 commonly utilized food resources only two, manzanita (*Arctostaphylos* sp.) and miner's lettuce (*Montia perfoliata*), are available for collection in winter. The availability of shellfish at such times would be very important.

3. I am indebted to Richard Ambro and Philip Wilke for their comments and editorial criticism, and to Theodore Cooley for his helpful suggestions based on prior experimentation. Site 4-Ora-119 was excavated with the help of students from Chapman College.

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