Appendix A

SHELLFISH

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Molluscan remains were an important constituent of all levels of the refuse deposit, though there was a noticeable decline in the proportion of shell as the bottom of the mound was approached. No attempt was made, of course, to collect all shell, but while the excavation was in progress two one foot column samples were obtained. One of these has been analyzed. In addition, all examples of rare or unusual shells were kept. The following species were represented:

Clams

*Clinocardium nuttallii* (Basket or Heart Cockle)
*Macoa nasuta* (Bent-nosed Clam)
*Pholas pacifica* (Pacific Piddock)
*Protothaca staminea* (Rock Clam)

Mussels

*Mytilus edulis* (Bay Mussel)
*Mytilus californianus* (Sea or California Mussel)

Oysters

*Ostrea lurida* (West Coast Oyster)

Snails

*Littorina scutulata* (Checkered Periwinkle)
*Odostomia* sp.
*Cerithidea californica* (California Horn Shell)
*Olivella biplicata* (Purple Olive)
*Thais lamellosa* (Wrinkled Thais)

Abalone

*Haliotis rufescens* (Red Abalone)
*Haliotis cracherodii* (Black Abalone)

Limpets

*Acmaea* sp.
Miscellaneous

_Balanus sp._ (Barnacle sp.)
Crab
Land snail

The column sample was analyzed primarily to determine the percentage of shell to other midden components. Interest in the significance of proportions of constituents in Californian shellmounds, especially mollusks, was first shown by E.W. Gifford, over 45 years ago (Gifford 1916). Among the soil samples analyzed at that time, eight came from West Berkeley. These had been collected years earlier by Furlong and Peterson.

Results of the 1916 analysis differ from those presented here, and an exposition of the sampling and analytical procedures will, in a large measure, explain the differences. The locality of the samples used by Gifford is not known; he states that they were not taken in the same vertical plane and that the depths ranged unevenly down to 12 feet from the surface. Those obtained in 1950 were all in the same vertical plane, and in successive one foot depths down to the bottom of the mound, 17 feet from the surface. In each case the sampling areas selected contained no unusual features and were regarded as "typical" of their respective sections of the midden. Wide variation in size of the 1916 samples must be noted, from 31.5 to 832.9 gm., with an average of 119.1 gm. For the present analysis, 500 gm. from each one foot level was sorted. The analysis techniques were essentially similar.

The 500 gm. sample from each level was washed through a 1/8 inch (2 mm.) screen and then air dried. Material held by the screen was next sorted into bone, stone, and shell, the last being subdivided according to species. Mostly it was soil that went through the sieve, together with very small bones and shell fragments, and this was considered residue. After each component and species had been segregated and dried, it was weighed. The total weight of components and species from each level (exclusive of residue) was subtracted from 500 gm. thus giving a figure for the residue. Five hundred grams was taken as 100 percent of each level sample and the weights of the components and species were converted into percentage proportions of that figure.

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1 Greengo (1951) presents a detailed discussion of the quantitative analyses of midden constituents and related problems.
Gifford found that his samples averaged 52.53 percent shell, 23.76 percent ash, 4.9 percent stone, and 18.51 percent residue (Gifford 1916:15). In the 1950 analysis, ash—what there was of it—was lumped with residue, and the following percentages were obtained: 23.1 percent shell, 7.8 percent stone, and 69.0 percent residue. (See Table 2). Due to the variables involved and lack of information on the earlier samples, it cannot be certain that the differences in proportions represent variability in mound composition or merely differences in sampling techniques. At any rate, the trends reflected by Gifford's analysis are of the same order as those presented here, a fact which serves to corroborate the results of the independent findings.

Of the 23.1 percent shell contents analyzed, only three species out of ten in the sample were represented in proportions large enough to be significant, the bay mussel (*Mytilus edulis*), the West Coast oyster (*Ostrea lurida*), and a mud clam (*Macoma nasuta*). Of the rest, a small species of barnacle (*Balanus* sp.) was the only kind exceeding one percent.

The California shellmound dwellers apparently exploited the shores near their village sites to the fullest possible extent, ignoring no species occurring in sufficient size and quantity. The middens, then, fairly accurately reflect the molluscan population of adjacent waters. This does not necessarily mean that all species represented in the sites were eaten. For example, the small barnacle, constituting 4 percent of the 1950 samples and 2 percent of Gifford's samples, was probably carried in fortuitously with larger shellfish. It was almost certainly not economically feasible to pick out the small crustaceans when other forms of food were available.

Both the present data and Gifford's indicate that a shift took place in species content from bottom to top in the West Berkeley mound. Involved were two species, *Macoma nasuta*, a mud-flat inhabitant, and *Ostrea lurida*, an oyster favoring a gravel bottom or a bed of its own shells. The environmental niches of these two invertebrates are all but mutually exclusive. That is not to say, however, that an oyster bar and a mud flat cannot be found in close proximity to one another.

In the lower portion of the midden *Ostrea* constituted almost one-half of the shell content, to the virtual exclusion of *Macoma*. At the top, however, the latter exceeded *Ostrea* by over 26 percent. This is interpreted to mean that ecological conditions of the nearby shore were seriously modified during the shellmound's occupation. While the first 11 feet of midden was accumulating, gravelly bottom conditions are indicated, and this agrees with the fact that the site rests on alluvial outwash from the Berkeley Hills. On the other hand, from the top to a depth of six feet the predominance of *Macoma* over the oyster points to mud flats. Again, this is in line with observable conditions in the vicinity of the mouth of Strawberry Creek (Louderback 1939:788).
One additional fact should be brought out. *Mytilus* varies relatively less than the other two species, and maintains a constantly high proportion. It is well known that this mussel requires a gravel or rock bottom, a fact which would seem to conflict with the muddy condition indicated by the predominance of *Macoma* in the upper six feet. It can be deduced that, although *Mytilus* was undoubtedly covered by the apparently sudden sedimentation of silt which drastically reduced the oyster beds, mussels were sufficiently vigorous to recover, whereas the more delicately adjusted oysters were destroyed. The sedimentary history of the bay apparently fluctuated between relatively greater accumulations of silt brought down from the Interior Valley drainage system and the heavier gravel alluvium from the slopes bordering the bay (Louderback 1939; Sumner et al. 1914). At West Berkeley the supply of gravel supposedly remained constant enough and the reproductive capacity of mussels great enough for them to maintain a dominant position during the entire period of occupation. The mussels may have been attached to rocks or rock ledges, not covered by sediment.

A comparison with two other sites, Emeryville and Ellis Landing, is pertinent here. Gifford's analysis of the constituents of the Emeryville shellmound shows that shell represented almost 60 percent of the samples obtained. This figure may be somewhat high, for it is very similar to his shell proportion for West Berkeley (52.53 percent) as against the mere 23.1 percent found in later samples. The Emeryville findings also point to a shift in the molluscan complex, similar to that at West Berkeley. Again this variation occurs between oysters and clams, this time at a depth of 19.5 feet. Mussels remain relatively constant. Thus on the basis of analysis of shell remains it is possible to postulate contemporaneity of the upper six feet of the West Berkeley mound with the topmost 19.5 feet at Emeryville.

For Ellis Landing, Gifford found the shell content to be 69.43 percent. Of this, *Mytilus edulis* averaged 35 percent and *Macoma nasuta* 36 percent. However, concentrations of these two species varied considerably with depth. The site was 29 feet deep, but soil samples were obtained from the upper 17 feet only. Gifford's data show that below 10 feet *Macoma* occurred in minor proportions, whereas above that mark it attained a much higher percentage, exceeding that of *Mytilus* in three samples. Here, *Ostrea lurida* did not occur in significant quantities and the variability is expressed between mussels and clams. Although no exact figures exist for the lowermost levels of the midden, a good bit of which lay below the high tide line, Nelson states that it was composed almost exclusively of mussel shells, "and it is only in the upper eight feet that the clam shells become at all plentiful" (Nelson 1910:376). This agrees substantially with Gifford's findings.

At all three middens, variations of the molluscan fauna seem to reflect a shift from a gravel-bottom species to a mud clam during the accumulation of the refuse. Certainly these data indicate silting in of the bay, but they need not necessarily mean that this impact
was felt everywhere at the same time. Fluctuations in the rate of sedimentation are known to exist.

Bibliography


