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**SHELLMOUNDS OF THE SAN FRANCISCO
BAY REGION.**

BY
N. C. NELSON

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INTRODUCTION.

During the season of 1908 the writer completed a somewhat detailed survey of the evidences of prehistoric man in the San Francisco Bay region. The work, which had been under way for some time, was finished probably none too soon, because the obliterating agencies of nature have been strongly reinforced in the last four or five decades by the hands of modern man, and the ultimate destruction of every suggestion of former savage life seems not far off. Professor John C. Merriam, who directed the investigation, had himself for some years been collecting data on the subject, and a comparison of his results with our present knowledge shows only too plainly how rapidly the monuments and relics of primitive times are disappearing from the bay shores.

The field work connected with the present study represents a review of Professor Merriam's data, with the addition of much information that is new. In the course of three months, the writer traversed the entire country bordering San Francisco, San Pablo, and Suisun bays; including the tide-water districts of the entering streams and also a short strip of the Pacific Coast adjacent to the Golden Gate. The ancient remains discovered or re-examined include shell heaps, earth mounds, and a few minor localities that cannot perhaps be termed anything but temporary camp sites. Of the two most numerous forms, the earth mounds are nearly all located by the entering streams, close to the upper reaches of the tide-waters; and their number could be increased indefinitely by searching these stream valleys toward their sources. But as those rather common and widely spread accumulations appear, in many cases, to be of relatively recent origin and possibly representative of distinct cultures, the present paper is restricted to a consideration of the shell heaps.¹ These fairly numerous deposits, with a few exceptions, are situated close to the open bay and may, geographically at least, be regarded as a distinct group.

¹ The earth mounds of Central California have been considered briefly by W. K. Moorehead in his *Primitive Implements*, p. 258; and by W. H. Holmes, *Smithsonian Report*, 1900, p. 176.

Thus far only three of the four hundred and twenty-five shell heaps composing the group have been carefully excavated, and those three were unfortunately on the same side of the bay and not very far apart.² Nevertheless, guided by this limited amount of intensive work, the rather more than superficial examination of all the remaining mounds, supplemented by such sifted information as could be obtained from owners and local residents, may allow some safe generalizations for the group. The purpose of this paper is, therefore, to show by a map the actual location of all the ancient middens known, to consider the broader facts apparent in the relation of the mound distribution to the local topography, and, finally, so far as is warranted by available knowledge, to make some comparisons of the mound group and its culture with that of similar occurrences in other parts of the world. The paper should be considered only a general or preliminary report which it is hoped may be expanded from time to time as further systematic investigation shall be made possible.

The support of the field work has been generously furnished by Mrs. Phoebe A. Hearst, through the Department of Anthropology. The study as a whole has been pursued as graduate work at the University of California, under the immediate direction of Professor Merriam, who has also kindly revised the manuscript and read the proofs.

THE SAN FRANCISCO BAY REGION, AS ADAPTED FOR
PRIMITIVE HABITATION.

With the present tendency of historical research apology is scarcely required for devoting some attention to geography as in part the underlying basis of ethnic conditions. At the same time, science may doubtless easily overreach itself in the attempt to account all phases of human culture the product merely of external conditions, and the consideration of environment is not taken up here solely in order to explain archaeological facts, but is made necessary by the established relation between some of the shell heaps and certain events in the history of the local topography. That material conditions do play a fundamental

² See report on the Emeryville Shellmound by Dr. Max Uhle in Vol. 7 of the present series. Reports on the other mounds are awaiting publication.

part in human development is not to be questioned. Indeed it would seem as if environment had so particularly favored primitive human life in California that it must in the end be accepted as one of the chief factors in explaining the presence of the unusually numerous linguistic stocks, and the fact that they managed to exist within these narrow territorial limits without losing their identity.

GEOGRAPHICAL POSITION.

The relation of the region to be considered to the city of San Francisco makes its geographical situation a matter of common knowledge. Definitely fixed, the particular area concerning us is included between $121^{\circ} 56'$ and $122^{\circ} 42'$ west longitude and between $37^{\circ} 23'$ and $38^{\circ} 18'$ north latitude. In more general terms, the territory extends from the cities of Napa and Petaluma on the north to San Jose on the south and from the Pacific Coast eastward to the Great Valley, the respective distances being about sixty-five and forty-five miles. The bay itself, with its flood lands, covers approximately 120 square miles and is bounded by more than 300 miles of shore line.

PHYSIOGRAPHICAL AND GEOLOGICAL CONDITIONS.

The waters broadly designated by the term San Francisco Bay are confined to a series of connected depressions in the heart of the Coast Range. The mountain system referred to reaches its narrowest limits in this latitude, where its two or three main ranges have probably always been characterized by a general transverse sag, through which the interior basin of the state connected with the ocean. Since middle Tertiary times, the oscillating movements of the coast, amounting it seems to over 2,000 feet, have concentrated tidal and drainage currents on this pass until at the present time, when the land is relatively high, the enormous drainage of the interior basin reaches the ocean by way of an irregular line of deep gorges, cut through the three or four low barriers that still remain. Descending upon this transverse channel are some six or seven partly united and more or less directly opposable valleys, two from the south and the others

from the north; and it is these valleys which, after a partial re-submergence, have given rise to the present three divisions of San Francisco Bay.

The outermost and the largest of these divisions, that is San Francisco Bay proper, is an elliptical body of water about forty-five miles long and as much as twelve miles in width. It lies mostly south of the transverse channel and is flanked on the east by the Mt. Hamilton Range and on the west jointly by the Santa Cruz Range and the mountain block north of the inlet, of which Tamalpais is the culminating peak. At the present time its shores are generally low, marshy and unapproachable, except in certain places about the northern end. Here, especially on the west side, from San Bruno Point north, several secondary mountain features run out at an angle to the general trend of the shore line, producing an alternating series of inlets and headlands, the latter of which furnish easy approaches to the open bay. The resisting extremities of some of the most prominent of these headlands or peninsulas appear as islands in the bay; and one of these islands, the Potrero Hills, which was once a part of the western shore, has recently, by sedimentation, been linked to the opposite shore, while the originally insulating channel furnishes the only entrance to the second or central compartment of the estuary, namely San Pablo Bay.

San Pablo Bay is a roughly circular twelve-mile expanse, actually called Round Bay by the early Spanish explorers. It is walled in on the west by the same mountain block that separates the lower bay from the ocean but on the east by only a low and narrow strip of the Mt. Hamilton Range. On the north it sends three long tidal arms up the Napa, the Sonoma and the Petaluma valleys—now all choked with silt; while on the south it meets, somewhat abruptly, a broad section of the Mt. Hamilton Range. In other words, the basins of the two lower divisions of the estuary do not meet end to end but are roughly parallel and connect at present by a diagonal channel, the San Pablo Strait.

San Pablo Strait, like the Golden Gate below and Carquinez Strait above, appears to be the joint result of subsidence and wave erosion, completed perhaps within recent geological time, but still prior to the oldest records of the shellmound people in

the region. Probably the older channel, or at any rate the truly structural connection of the two basins, ran between the Potrero Hills and the Mt. Hamilton Range. This passage is now practically obstructed by the joint deltas of the San Pablo and Wildcat creeks, forming the plain on which the city of Richmond is building. The delta material, containing shell strata in places, is over 500 feet deep; and upon its surface are situated some of the largest and oldest of the shell heaps.

To the east of the remaining narrow portion of the Mt. Hamilton Range is the third and smallest of the estuary divisions, usually distinguished as Suisun Bay. The basin containing this body of water is now largely open to the Great Valley, subsidence and erosion having removed or obscured the dividing ridge. The result is that Suisun Bay, almost entirely silted up and reduced to tule marsh, appears to be topographically one with the adjacent floodlands of the Sacramento and San Joaquin rivers. These stretches of level floodlands, extending over a large area of the lower portion of the Great Valley, are marked by certain noteworthy features in the form of isolated sand dunes, rising like islands through the surrounding peat which often attains a depth of forty or fifty feet. We may leave the origin of these eminences for others to explain, but they are particularly interesting to the archaeologist by reason of the fact that they furnish evidence of having been more or less permanently occupied by the aborigines. (See pl. 35, fig. 2.)

Whether Suisun Bay has been large enough or deep enough to admit the sea since prehistoric times seems doubtful. There are, on the one hand, several old beach marks along its shores, and the lowest of these is not many feet above the present water level; but, on the other hand, the very largest and perhaps the oldest of the shell heaps in the Suisun Bay basin, no. 250, near Concord, lies approximately at sea level and may therefore have been begun at a time when the bay was even smaller than to-day. To be sure, there are other shell heaps in the vicinity of Martinez and above Cordelia that lie on higher ground, but these are insignificant, in fact almost obliterated, and do not furnish any reliable tests. In view of these facts it will seem natural enough, therefore, that the remainder of this study should be restricted

almost entirely to conditions as they exist on the two lower divisions of the estuary.

The basins of San Pablo and San Francisco bays may, for our purposes, be considered as a unit and as physiographically distinct from the Great Valley, although receiving and transmitting the immense drainage of the latter. Being quite limited in extent, the watershed belonging to the basin is unable to develop any large streams. There are some sixty named and recognized water-courses, besides many more wet-weather gullies that descend from the surrounding hills; but of those named only the Guadalupe and the Coyote at the southern extremity and the Napa at the northern, are dignified by the doubtful term "river." Those three, together with the Sonoma and the Petaluma creeks, also on the north, are the only permanently flowing streams native to the basin. Of the remaining creeks, however, many, such as the Rodeo, the San Pablo, the San Leandro, the San Lorenzo, and the Alameda on the east side, and at least the San Francisquito and the San Mateo on the west, would under normal conditions, flow at all seasons of the year; and would, consequently, be lines of attraction for primitive populations. As it is, the water of nearly all the streams has been diverted in the foothills to satisfy the requirements of modern civilized life.

In connection with this preliminary statement of the physical features of the bay region it seems desirable also to call attention to the influence of the drainage entering or passing through the bay. The processes of erosion and of deposition are both in action at the same time and often in close proximity; but the wearing-down work is generally confined to the central section of the bay and the building-up process to the extremities. It is along the line of the great current from Carquinez Strait to the Golden Gate, and at a few other points on the lower bay, as far south as the latitude of San Mateo, that wave erosion is apparent. Wherever the projecting headlands reach the open waters high and steep cliffs are usually present. These cliffs have either been worked out since the last subsidence or are holding their own concomitantly with a slow sinking movement, of which it appears that at least the last eighteen or twenty feet have taken place since man's

occupation of the region. Either supposition indicates a considerable age for some of the shellmounds.

The most readily observable progress of erosion is of course confined to the recent formations, such as the soft conglomerates about Point Pinole and the gravels and clays of the alluvial slope bordering most of the lower bay. Perhaps the most notable wave work within historic times is that on the east shore, between Oakland and Richmond, where the marsh belt and the detrital slope have been eaten back for a considerable distance. The waves have here in all probability also cut away a number of the ancient shell heaps.

But the tearing down processes about the bay are more than counterbalanced by those that build up. In the first place, sub-aerial erosion in the flanking mountains has produced an alluvial slope extending from San Bruno Point around the south end of the bay and along the east side almost to Point Pinole. This slope, upon which are built some of the principal bay cities, varies from one-half mile to five or six miles in width, being most prominent off the points where the larger streams issue from the foothills. The deltas of the San Pablo, the San Francisquito and the Alameda creeks show even a fan-like contour; and the last named fan has thrown a dam across the mouth of a small lateral valley giving rise to several minor lagoons near the foothills, between the towns of Irvington and Niles. The shores of these fresh-water lagoons furnish distinct evidence of permanent settlements in former times, and the fact that the old San Jose Mission is located very near seems in a measure to warrant the opinion that the Spaniards found Indians living in that locality.

In the second place, there are the notable results of the deposition of the suspensible matter brought into the quiet waters of the bay by the streams. Almost the entire bay is fringed with a belt of tide-land, salicornia marsh, which attains a width of from three to five miles at the extremities and is absent only in the constricted central portion, chiefly about the heads of the more prominent peninsulas. Some vegetable matter enters into this marsh composition but it is made up chiefly of a very fine bluish silt. The sources of this silt and the rate of its deposition have probably been much altered in the last fifty years. There

can be no doubt, for example, that the supply has been at once appreciably reduced for the smaller streams and increased for the Sacramento and San Joaquin rivers, whose carrying powers have been much increased by the confinement of their channels. Whether or not this change has worked any rapid transformation in the upper bay is not known; but it is a fact that at the present time the open waters of the entire San Pablo Bay, excepting a broad channel across the southeastern half, average less than ten feet in depth at mean low tide.³ A similar condition is true also for San Francisco Bay below the latitude of San Bruno Point, save for a narrow, central channel which still maintains a depth of about forty feet. These facts regarding the deposition of silt are more or less relevant to the archaeological problem, because the continually widening marsh belt has left many of the shell heaps quite far from the open waters, suggesting that a large part of the depositional work was done since the middens were abandoned. Furthermore, several of the shell heaps situated on the tide lands are deeply imbedded in the silt itself.

This partial submergence of mounds in the tide-lands furnishes occasion for a final word with reference to the recent subsidence of the bay region. There is of course no question about the origin of San Francisco Bay. Its very setting is suggestive, and examination of the details of the shore line could not leave even the untrained observer in doubt. Nor should it have been necessary to investigate the shell heaps for evidence of recent subsidence. The manner in which the foothills descend directly to the marsh level, without any intervening alluvial slope, would seem sufficient proof. Similar suggestions are also furnished by the small islands scattered in the marsh along the western shore from Petaluma to San Mateo. And on the east side, well towards the southern extremity of the bay, the Coyote Hills, a narrow range several miles long, rise about three hundred feet out of the

³ In 1775, when José de Cañizares, pilot to Commander Ayala of the San Carlos, made the first reconnaissance of the bay region with copious soundings of the estuary, he found, at low tide, about five feet of water in San Pablo Bay outside the main channels. He also mentions two large harbors (now silted up) on the west shore and a large body of open water in what is now Petaluma Slough. See translation of Ayala's report by E. J. Molera, with photographic reproduction of the original map of San Francisco Bay, in *The March of Portolá*, published by the California Promotion Committee, San Francisco, 1909.

marsh,—a particularly striking example of the many outcropping remnants of the older drowned topography.

CLIMATE.

California is distinguished as perhaps the most unique of the world's thirty-four climatic provinces. No other territory covering an equal extent of latitude shows the same uniformly mild temperature. Certain sections of the west coasts of South America and of British India offer the nearest approach to California conditions, but in those places the mean annual temperature is 10° Fahr. higher than in California. This does not mean that extremes are wanting in specific localities in California. Far from it: the state not only reaches over a great extent of latitude but its altitude ranges from 400 to 500 feet below sea level, in Death Valley, to the horizons of continual snow in the mountain ranges. It is owing chiefly to the fortuitous combination of the warm ocean currents and the general arrangement of the broad features of relief that the really habitable portion of the state possesses an equable temperature which is highly favorable to vegetable and animal life. Broadly speaking, the climate is sub-tropical; and that of the San Francisco Bay region, tempered as it is by the prevailing ocean winds, may be characterized as insular.

Two seasons, a wet and a dry, are to be sharply distinguished. The rainy period may be said to last from October to April and is on the whole the pleasantest part of the year. The precipitation, which increases rapidly with the latitude, for San Francisco ranges from 23 to 28 inches. Snow is a rare sight and frost seldom touches the low country about the bay. The prevailing winds are from the southwest during the dry season and it is these that bring the fogs. Winds blowing from the opposite direction sometimes bring the heated air from the interior valleys and produce the only hot spells that may be experienced in the bay region. The mean summer temperature for San Francisco is about 60° and the mean winter temperature about 51° Fahr. The mean annual average for thirty-one years is 56° Fahr., while the extreme annual range is only about 60° Fahr.

FLORA AND FAUNA.

The particular configuration of the state, which in a large measure causes the remarkable uniformity of temperature in certain regions, introduces also the important element of variety. This whole phenomenon is perhaps best expressed in terms of the flora and fauna. The life zones range from arctic down to subtropical; and this fact, combined with the general geographic position of the region, has resulted in a remarkable diversification of the plant and animal life.

The San Francisco Bay region itself, while appearing to contain all of the more valuable economic plants of the state, could probably never have furnished the variety found in some other parts of this large political division. This specific section of the Coast Range is quite limited in extent as well as relatively low, and the general northwest-southeasterly trend of the relief gives only a small amount of favorable exposure. The hills on the east and north sides of the bay are therefore almost barren, except in the minor side canyons; but on the west, where the ranges are more thoroughly broken up, the vegetation is fairly luxuriant.

In the valleys, and on the lower foothills bordering the bay, grow several species of oak, especially the Valley Oak, *Quercus lobata*, and two Live Oaks, *Quercus agrifolia* and *Quercus Wislizenii*. The willow, *Salix*, is also common along some of the streams crossing the border plain. Farther back, in the canyons and on the hillsides, flourish the Mountain Laurel or Bay tree, *Umbellularia californica*, and the Buckeye or Horse Chestnut, *Aesculus californica*; and close to these may be found two or three species of the manzanita, *Arctostaphylos*, and the hazel, *Corylus californica*. Finally, in the higher hills appear several conifers among which are the Douglas Spruce, *Pseudotsuga taxifolia*; the Hemlock, *Tsuga heterophylla*; the Yellow Pine, *Pinus ponderosa*; and the Digger Pine, *Pinus Sabiniana*. The Redwood, *Sequoia sempervirens*, is also quite abundant, especially on the sea side of the western range. Besides these larger trees, the products of most of which have been used in some way by the Indians of late times, there are two or three species of the wild cherry, *Cerasus*; a plum, *Prunus subcordata*; and a huckleberry,

Vaccinium ovatum. The Elderberry, *Sambucus racemosa*, and Wild Grape, *Vitis californica*, are also common. Finally, there are several of the common berries such as the Thimbleberry, *Rubus parviflorus*; the Blackberry, *Rubus vitifolius*; and several species of gooseberry and currant, *Ribes*; in fact the saxifrage family is well represented, though it is perhaps not as valuable here as elsewhere.

Of the smaller flora in the region many families are unusually well represented. Among the most common of these are the sunflower family, *Compositae*; the mustard family, *Cruciferae*; the crowfoot family, *Ranunculaceae*; the poppy family, *Papaveraceae*; the pea family, *Leguminosae*; and the lily family, *Liliaceae*. There are about thirty different species of lily bulbs and of these the famous Indian soaproot, *Chlorogalum pomeridianum*, is very abundant. Many other useful plants such as the Milkweed, *Asclepias mexicana*, and various grasses and sedges are also found.

No detailed study of the local flora has been attempted or deemed necessary in connection with this shellmound investigation inasmuch as it is not possible to determine to what extent the prehistoric inhabitants utilized vegetable products.⁴ It may be worth while, however, to cite the results of Mr. Chesnut's recent studies among the Indians of Mendocino County, which adjoins the bay country on the northwest.⁵ Mr. Chesnut lists and describes the various uses of no less than 212 plants in that region and shows how thoroughly versed primitive peoples may be in the botany of their respective habitats. It is not known just what the difference in geographical distribution may be, but certainly the majority of the economic plants of Mendocino County are to be found also in the vicinity of San Francisco Bay.

The indigenous fauna of California is now much depleted, but there can be no doubt that it once corresponded to the flora in richness. There are some three hundred and fifty species of birds in the state; and of these many of the game birds were until late years very plentiful in the bay region. Of the mammals the state contains fifty-three out of the sixty-six genera in North America,

⁴For a full account of the flora of the region consult Jepson, W. L., *Flora of Middle Western California*, 1901.

⁵Chesnut, V. K., *Plants used by the Indians of Mendocino County, California*. *The U. S. National Herbarium*, Vol. III, No. 3.

and the species number about two hundred and seventy-five.⁶ But several of these have been much thinned out, and some, like the antelope, *Antilocapra americana*, have disappeared entirely. All the more useful mammalian orders such as the cetaceans, the ungulates, and the rodents were once well represented in the bay region. The particular species hunted in prehistoric times will be enumerated later in the paper and need not be given here.

Fishes also, especially the salmon, were supposedly always plentiful; but it is difficult to determine whether or not the primitive inhabitants were able to fish successfully in so large a body of open water.⁷ The minor streams entering the bay afforded far more favorable opportunities; but these water-courses probably never contained more than a limited number of small species. It appears, however, that at the present time these streams are continually being restocked from the Sacramento and San Joaquin rivers, probably during the excessive spring floods.⁸ Finally, the shoaling bay was well stocked with molluscs, particularly the mussel, *Mytilus edulis*, and the clam, *Macoma nasuta*,—a fact which may have drawn the first settlement to its shores.

We have then, to sum up the environmental conditions, a large body of water, favorably isolated and sheltered by encompassing mountains. The bay itself is extensive and broad enough to constitute a natural barrier for people without well developed means of navigation; and the border country, which is either partitioned by low mountain ranges or is suitable for habitation only along the widely separated streams, also tends to develop a certain degree of isolation and thus favors segregated community life. Under former normal conditions the hill slopes and the valleys of the region were tolerably well supplied with fresh water; while food products of all kinds were plentiful and near at hand. When we add to these characteristics a climate as

⁶ Stephens, F., *The Mammals of California*, 1906.

⁷ The pilot Cañizares, already referred to, found in 1775 an Indian rancharia near the west end of Carquinez Strait, where various kinds of fishes (among them salmon) were offered the explorers as presents. See *The March of Portolá*, p. 66.

⁸ J. O. Snyder, *Notes on the Fishes of the Streams Flowing into San Francisco Bay*. *Report of Bureau of Fisheries*, 1905; p. 329.

favorable as is known, it should be no cause for wonder if the human species early seized upon the region for permanent habitation.

DISTRIBUTION OF THE SHELLMOUNDS.

PRESENT NUMBER.

The group of shellmounds examined in the San Francisco Bay region and located on the accompanying map numbers 425 separate accumulations. It is not to be supposed, however, that this figure exhausts the evidences of aboriginal occupation to be found within the given territorial limits, because the shellmounds are confined to a narrow belt around the open waters of the bay and grade off landwards into earth mounds of a more or less artificial character. In fact, some of the deposits shown at the northern and southern extremities of the map, specifically those on Sonoma Creek and on the Napa and Guadalupe rivers, contain a larger percentage of earth and ashes than of shell. According to reports, moreover, earth mounds and "old Indian rancherias" are situated on the banks of the Alameda and San Francisquito creeks, above the alluvial plain in the foothills; and it is hardly to be doubted that sites of this character could be found in great numbers by following up any other of the minor streams. As it is, several more or less obliterated camp and village sites of late and ancient date are definitely known in the region, some of them even on the University Campus in Berkeley; and the publication of news items relating to discoveries here and there of relics and skeletal material is no uncommon occurrence.

The now known list of genuine refuse heaps certainly falls short also of the number that originally existed in the region. Many of the deposits appear to have been either obliterated or destroyed by natural causes. Thus there were discovered, quite by accident, four shell heaps of unknown lateral extent, but from one to three feet deep, that were completely covered by natural deposits, ranging in thickness from one to two and a half feet. Of these four, no. 6 lies at the bottom of Elk Canyon, northwest of Sausalito, and its covering is simply a light sandy alluvium; but nos. 4 and 15, below Mill Valley, lie on hillsides and the covering here is a hard clay or adobe that could have washed

from the slope above only very slowly. The last, no. 96, situated west of Point San Pedro, lies in the edge of a reclaimed salt marsh, and was discovered only through the presence of a ditch lately dug across the area containing the buried deposit.

Another point worthy of note is the fact that there are at the present time no less than thirty relatively large mounds so situated by the shores, central on the bay, that they are subject to wave action (pl. 34). Some of these mounds have their foundation below sea level while others are raised on high bluffs and cliffs; but they are all alike disappearing, though necessarily at very different rates. One such mound, no. 266, situated on the bay shore north of San Pablo Creek, has been washed away within the last three or four years, the only signs of its former presence being certain fragments of worked stone and a few human bones that lie scattered over the muddy beach.

The suggestion that some of the deposits examined have their bases below sea level is of special significance and will be considered in detail later; it will be enough to state here that the subsidence appears to have affected the entire San Francisco Bay region, and that it is of such magnitude as to make it seem probable that a large number of mounds may have sunk entirely out of sight.

In addition to these natural forces, acting in the capacity of destroyers, there are to be taken into account several artificial agencies. Thus agriculture has been practiced more or less intensively in the region for over one hundred and twenty-five years; and, judging from reports as well as from conditions at the present time, it is not improbable that many of the mounds have been either plowed down or literally removed. In a number of cases where mounds have evidently disappeared in recent years, reliable information was not to be obtained. The majority of the country population, especially around the northern end of the bay, are Portuguese ranchers, mostly of the first generation, who know little or nothing about the recent history of the region. A little experience made it evident that negative information was not to be implicitly relied upon. All the more suitable places, such as springs and streams and canyons, were visited; but very often mounds of comparatively large size were found by chance in what appeared to be most unnatural situations.

All the foregoing circumstances clearly confirm the opinion that the original number of shell heaps on the San Francisco Bay shores may have been much larger than the figure now given, and that indeed this figure may not even include all the deposits existing at the present time. As to the latter point, however, it is fairly certain that no mounds of any considerable size or special importance are left unnumbered.

APPEARANCE, SIZE AND STATE OF PRESERVATION.

To detect the presence of a shell heap, even if inconsiderable in size, is not as a rule a very difficult task. During the dry season, and especially after the crops have been removed or the natural vegetation has died down, a slightly bluish tinge, imparted by the mussel shells, distinguishes these places often at a considerable distance. So also, immediately after the first heavy rains, the mound material being unusually rich and vegetation quick to respond, the sites lie revealed here and there before the observer as richly green spots in the generally barren, dull-colored landscape. Another fact which drew attention to the deposits was a frequently accompanying growth of buckeyes (*Aesculus californica*). Indeed, after the relation once became apparent, the discovery of a group of these trees often became an irresistible argument for making long detours into parts otherwise judged unsuitable for mound sites. As a rule trees do not grow directly on the mounds, unless there happens to be a good deal of earth mixed up with the shell and ashes; and the presence of the buckeyes immediately about the deposits is somewhat of a puzzle. It is well known that the Indians of recent times prepared the large, bitter nuts of this tree for food. They are said, moreover, to have used its soft wood for making fire and to have believed in the medicinal virtues of its bark. There can be no doubt, therefore, that at least the latest of the shellmound people also used some of the products of this tree; but it is impossible to say whether they planted the trees about their camps or whether the sites were originally chosen because of the presence of the trees. The latter alternative seems hardly tenable however; and neither may be correct, as the trees in many instances (*i.e.*, where they grow on top of the mounds), must have developed from seeds scattered perhaps accidentally at the time of the departure of the inhabitants.

Certain definite physical conditions, such as the presence of fresh water, timber, shelter from the wind, and easy access to the sea shore, appear to have controlled the location of most of the camps; and the presence of these elements, singly or in combination, in turn yields valuable guidance. Fresh water was probably one of the first essentials, and it is often to-day a matter of superstitious conviction with the old settlers that "wherever you find an Indian mound, there you'll find water—if you look long enough." Generally the connection holds, but not invariably, and this partly by reason of the geological changes which have taken place in the region since the shellmounds were begun.

The size and form of the shell heaps, while often much altered by one cause or another, are still in most cases approximately determinable. For instance, if a mound has been partly hauled away, abundance of material made economy unnecessary, and the thinner peripheral portion is usually left undisturbed. Actual dimensions vary greatly. Thus the basal diameters range from thirty to six hundred feet, and the height runs from a few inches up to nearly thirty feet. Curiously enough, the famous mound referred to the San Francisco Bay region by Southall and De Roo,⁹ and probably the same that Marquis Nadaillac¹⁰ locates at San Pablo, was not found; and in spite of the fact that it is definitely described as measuring one mile by a half-mile across and as having a height of over twenty feet, it appears never to have existed. There are, however, three mounds of more than average size in the vicinity of the old Spanish town, and the circumstance that these lie within the area of half a square mile may possibly have given rise to the error.

The typical shell heap of the San Francisco Bay region is oval or oblong in outline, with smooth slopes, steepest of course on the short transverse diameter; and the longer axis is generally parallel to the shore-line or stream to which the pile may be contiguous.

A remarkable fact about the accumulations is that while they are made up of comparatively loose material they do not appear to weather appreciably. This may be due partly to the resisting

⁹ P. de Roo, *Hist. of Am. before Columbus*, p. 54.

¹⁰ Marquis de Nadaillac, *Prehist. Am.*, p. 50.

quality of the shells and partly also to the binding power of the broken fragments which, when laid down horizontally, may in some degree resemble loess in structure, and, like loess, cave less readily than ordinary soil. To illustrate this binding power may be cited the fact that it has been found safe and practicable to sink a vertical shaft, six feet square, through twenty-five feet of the material without the provision of a curbing. In one instance such a shaft was carried about twelve feet below sea level, but even the strong head of water failed to break down the walls. At the surface, the shell disintegrates somewhat, but probably more in consequence of vegetal processes than those of weathering. It would appear therefore that under perfectly natural conditions the configuration of the mounds would have remained perhaps almost unchanged for many decades, if not for centuries; and they might in that condition have told a valuable story. As it is, on account of recent artificial disturbances, it is generally uncertain precisely in what state the mounds were left. Nevertheless, a few of the larger and better preserved examples present roughly flattened tops and in two instances these surfaces are dotted with distinct saucer-like depressions, as of house pits.

The state of preservation of the mounds, just touched upon, is a matter of some consequence. It so happens that the majority of the larger accumulations lie precisely in the places since found suitable for habitation by the modern invaders, and therefore have to give way to the requirements of civilization. Towns are growing up in the principal valleys favored by the shellmound peoples; and in the canyons, as well as on the plains, ranch houses often cluster about, and not infrequently occupy the summits of these ancient dwelling sites. The accumulated refuse has also been found useful in many ways. For example, the composition will sometimes yield splendid crops of potatoes and other vegetables; and this fact, as it has become known, has generally led to reduction and cultivation of the mounds. In addition to this source of destruction, the material is removed to serve a variety of purposes, such as ballast for roads and sidewalks, as garden fertilizer, and even as chicken feed. It is said that the mound material, mixed with rock salt, produces tennis courts that for combined firmness and elasticity are unexcelled. The result is

that while there is still ample opportunity for the investigator, not a single mound of any size is left in its absolutely pristine condition.

Many of the accumulations, as indicated on the map, have disappeared in recent years, leaving only the faint traces that lead to inquiries, and usually to only very general results. The artifacts from these obliterated deposits have as a rule been scattered broadcast among individual curio seekers; and even when found in more or less representative groups, there are no accompanying data. It is said that a good share of the archaeological material from the two large mounds formerly located in the town of San Rafael found its way to the British Museum in London; but, according to the informant who claims to have culled the deposits for the one-time English consul at San Francisco, no detailed records went with it. From only two more of the destroyed sites is any collection known to be extant. The Golden Gate Park Museum of San Francisco obtained some years ago a small but quite complete culture exhibit from mound no. 276, at one time located in the yards of the Standard Oil Company at Richmond; and only recently the city of Alameda collected a small group of implements from no. 316, a large shell heap formerly located near the intersection of High Street and Santa Clara Avenue.

Exclusive of the results obtained in the systematic work carried on during the last six years by the University of California, there are only a few minor collections from mounds still partially intact. The Stanford University Museum is in possession of several pieces from no. 356, near Mayfield; the owner of no. 3, at Sausalito, shares with the public school of that place a collection of skulls and stone implements; and from no. 199, at Lakeville, a small exhibit has found its way to the Dime Museum in Petaluma. All of these collections, while taken from scattered sites, are numerically small and probably in no case fully representative of the given culture, and cannot therefore furnish an entirely safe basis for comparison and generalization. Enough is known to warrant the statement that a general similarity in culture obtains for the entire region; but the differences, if any, remain to be brought out clearly.

SITUATION WITH RESPECT TO SHORE-LINE AND SEA-LEVEL.

The shell heaps under consideration are situated in a great variety of places; but, on the whole, the positions may be characterized as *convenient* rather than in any sense *strategic*. Many of the largest mounds are located at the head of the sheltered coves, yet not a few deposits lie in thoroughly exposed places, out on the bluffs and higher headlands. Occasionally a hillside, with or without any accommodating shelf or hollow, has been chosen, doubtless on account of some small spring issuing in the vicinity. Good illustrations are furnished by no. 65, at Corte Madera, and no. 379, near South San Francisco. From San Rafael northward nearly every ravine and every gully appears to have offered attractions. But the great majority of the mounds are situated on or near the small streams, though with considerable indifference, it seems, as to whether the surrounding country is barren plain or timbered hills. Wherever a group of separate deposits line a stream it is usual to find the largest accumulations at the lower end of the series. Lastly, some mounds are found in apparently unnatural situations, such as on the plain where no streams pass, or out in the salt-marsh where fresh water could not be had; and a few deposits are to be seen also on the small islands, both those immediately surrounded by marsh and those which are completely insulated by deep and swift currents.

Normally the shell heaps lie quite close to the open waters. The only general variation from this rule occurs on the north and northwest, where some of the deposits are situated four or five miles back from the present shore. But it seems legitimate to assume in explanation of this fact that at least the larger and older of the accumulations in this locality were begun, if not actually abandoned, prior to the building up of the now broad belt of reclaimable marsh, away from which they do not in any case extend very far. A more singular and striking exception occurs on the east, between Rodeo Creek and Carquinez Strait, where two neighboring mounds are situated comparatively far inland and at unusual elevations. Thus no. 254, directly east of the town of Rodeo, is located nearly one and one-fourth miles back from the shore, at an approximate elevation of two hundred

and twenty-five feet; and south of this mound, on Rodeo Creek, lies no. 259, which is over two miles inland and about one hundred and twenty-five feet above sea level. Both were extra large mounds and probably of relatively great age.

The unusual situation of the two deposits mentioned above, while suggestive perhaps of a local rise, may after all be perfectly normal. The barren hills close to the shore offer little attraction, while back in the canyons, where the mounds lie, the laurel and the oak find existence possible on the shaded slopes, about the springs and along the wet-weather gullies. There is also the further argument against a recent upward movement, namely, that within two or three miles on either side of the elevated deposits several shell heaps of more than average dimensions are situated at sea level, with indications of having been lowered into their present position. Among these apparently lowered deposits may be specified no. 236, at the head of Glen Cove on Carquinez Strait, and no. 262, on the San Pablo Bay shores, southwest of Pinole. But, whatever may have taken place in this particular locality, there can be no doubt about the subsidence of the bay region as a whole or concerning the fact that however ancient or slow this movement, the latter portion of it was witnessed by man.

As a natural consequence of favoring proximity to the open shore, the shell heaps tend to keep close to sea level. The fact is that nearly all the mounds lie within fifty feet of the surface of the bay waters, and this may be termed the normal zone. But exceptions occur on either side of this zone; and these, because of their numerical scarcity, are perhaps all the more significant. We have already seen that two mounds lie very far above the normal zone, and there remains only to state that at least ten of the known deposits extend below sea level. Most of these sunken accumulations, it is true, occur in the central part of the region, about Berkeley and Richmond, and also on the opposite shore, near Tiburon; but good examples are not entirely wanting at either extremity. Thus to the north one large mound lies well out in the Petaluma Creek marsh, off Lakeville; while to the south there remains at least one small shell heap, scarcely noticeable any longer, out on the reclaimed flood lands on the north bank of the

Coyote River; and there is evidence that two additional deposits once lay on the marshy shore near the south end of the Coyote Hills.¹¹ Besides these ten or twelve partially submerged accumulations, there are also the scattered deposits previously mentioned as giving indication of having been lowered to their present position, within reach of the waves.

The foundations upon which the submerged refuse heaps rest are generally of firm material, excluding the possibility of the accumulated weight of the mound having forced the mass below sea level. Several of these unique deposits lie on the alluvial slopes; but others, such as those on Brooks Island (pl. 34, fig. 2) and at Tiburon, rest on older formations, even upon solid rock. Up to the present time only three of the ten submerged deposits have been carefully tested for depth, and these show a subsidence ranging from three to eighteen feet.

GEOGRAPHICAL DISTRIBUTION AND ITS CONTROL.

A glance at the map will show the relative frequency of the shell heaps along the bay shore to vary somewhat locally. It is uncertain, of course, what the original geographical distribution may have been, on account of the disturbing factors, more or less active, all around the bay. At the same time, it is hardly to be doubted that economy was in some sense a primitive trait, or that these rude savages had intelligence enough to take advantage of a combination of favorable circumstances. At any rate, judging from present conditions, the general scarcity of mounds at the extremities of the region under consideration does not seem inexplicable. The southern arm of San Francisco Bay can not now be regarded as entirely suitable, even if molluscs were abundant; and there is no indication of any very recent change from a better to a worse condition. To be near the main source of animal food would often mean to be several miles distant from the foothills which yielded wood, acorns, berries, etc. And granted even that the alluvial slope was covered with live-oak, which is not at all probable, the water supply close to the shore-line, would still be

¹¹ Since formulating the above statement the writer visited Halfmoon Bay to locate the mounds thought to exist in that region and thus to complete the survey of the coast line included in the accompanying map. Several mounds were found here and the largest of these, situated just inside Pillar Point, lies well out in the marsh and certainly goes below sea level.

a very uncertain quantity during the dry season. Finally, to judge from the nature of the shell heaps now remaining about the southern end of the bay, molluscs then as now, were not plentiful or were not easily obtained. Central on the bay, however, and especially on the west side from San Mateo to Petaluma, the more or less wooded hills, charged with springs and streams, come in many places directly to the open water and here, consequently, as might be expected, the mounds are relatively numerous. On the east side, from Alameda to Carquinez Strait, the deposits are also at intervals quite well represented both as to number and size; and this fact can hardly escape relation to another fact, namely, the comparative narrowness or entire absence of the alluvial plain, which brings the small wooded canyons within easy reach of the shore. There is one exception to this generalization in the case of the mounds located on or near the Potrero Hills in the vicinity of Richmond; for here, at the present time at least, both water and wood are practically absent. It may be assumed, however, that recent changes have removed these necessities or else that an extraordinary abundance of shell fish was the compensating element.

Reasonable proof of the suggestion that the presence of shell fish was the first essential to a camp is furnished by the ocean shore. Conditions have been closely studied here for about two hundred miles adjacent to San Francisco Bay, *i.e.*, from Halfmoon Bay to the mouth of the Russian River; and the results are not without interest. Water and shelter are easily obtained and timber also is fairly abundant north of the Golden Gate; but the nature of the beach is either unfavorable for a molluscan fauna or is too steep and difficult of approach. Consequently, within the mapped limits, mounds are scarce except at the head of Halfmoon Bay, where shelter is good though timber is lacking. The few deposits indicated along the coast northward are often not even near any of the predisposing elements, but lie exposed on high barren rocks and sand dunes. But along the coast immediately to the north of the map, shell heaps, though usually small, are very numerous, particularly on Tomales and Bodega bays where all the favorable conditions obtain.

NATURE OF THE SHELLMOUNDS.

GENERAL STATUS OF SHELLMOUND INVESTIGATION.

Since the first recognition of their place in culture history, artificial heaps of shell have been observed in many parts of the accessible world. They occur not only on various of the islands and along the continental shores, but have been traced inland along the rivers and their lacustrine ramifications, being here often partially or wholly replaced by accumulations of earth. Even the more isolated lakes of the far interior, whenever capable of supporting molluscan forms of life, appear to have attracted more or less permanent settlement of primitive peoples. In brief, it seems to be true that, given the proper environment, these accumulations have been found wherever due search has been made.

Actual study of the contents of these shell heaps has not yet proceeded very far on a world scale. Aside from the initial work in Denmark,¹² begun in 1851, systematic investigation seems to have been carried on most extensively in the United States, specifically in Florida¹³ and the adjacent Atlantic and Gulf states, on the Aleutian Islands,¹⁴ and in the Puget Sound country.¹⁵ Some minor studies have also been made in scattered places on the Pacific Coast from the Columbia River to Southern California, as well as on the Atlantic shores from Virginia to Labrador. There are besides, for the world at large, some more or less complete records of investigations in such widely separated localities as the West Indies,¹⁶ Brazil,¹⁷ Chili,¹⁸ Peru,¹⁹ Japan,²⁰ Australia,²¹ Italy,

¹² Smith, Rep., 1860; also *Affaldsdynger fra Steenaldere* in Danmark by Sophus Muller, K. J. V. Steenstrup and others, Kjöbenhavn, 1900.

¹³ Moore, Clarence B., *Certain Shellheaps on the St. John's River*, *Amer. Naturalist*, 1904. Also this author's publications by the Academy of Natural Science of Philadelphia.

¹⁴ Dall, W. H., *Tribes of Extreme Northwest*, *Contrib. N. Amer. Ethnol.*, Vol. I.

¹⁵ Smith, H. I., *Mem. Am. Mus. Nat. Hist.*, Vol. I, part 6; Vol. II, parts 4 and 6, of the publications of the Jesup Expedition.

¹⁶ Fewkes, J. W., *The Aborigines of Puerto Rico*, *Ann. Rep. Bur. Amer. Ethn.*, 25, p. 275.

¹⁷ Reclus, J. J. E., *The Earth and Its Inhabitants*, Vol. II, p. 88.

¹⁸ Evans, O. H., *Notes on Stone Age in Chili*; *Man*, London, 1906.

¹⁹ Uhle, Max., *Los Kjoekkenmoddings del Peru*; *Rev. Hist.*, Lima, 1906.

²⁰ Morse, E. S., *Shellmounds of Omori*, *Univ. of Tokio Pub.*, 1879.

²¹ Both, W. E., *North Queensland Ethnog. Bull.*, No. 3, 1901, p. 7.

Spain,²² France, and the British Isles. In many cases, however, the work seems to have been inadequate for rigid analysis; and the present study, which is scarcely more than superficial, must therefore be limited to comparisons along only the broadest lines.

RELATION OF SHELLMOUNDS TO OTHER PRIMITIVE STRUCTURES.

The abundance and world-wide distribution of shellmounds may, it seems, be considered as tending to indicate the wide distribution of the human race by the time it had begun effectively and consistently to devise improvements on nature. The shell heaps are themselves a species of invention; and as such they are particularly interesting from a psycho-historical point of view, in that it appears as if they might have resulted from an accident by which, possibly, they became the models for the earthworks so exceedingly numerous in the interiors of Europe and North America. It would be going too far perhaps to assert, without qualification, that all the shell heaps antedate all the earth mounds, either temporally or culturally. At the same time, it would seem in accord with reason, and certainly not contrary to the accounts of early explorers, that, exclusive of limited groupings in the caves and natural recesses of the interior, the most primitive form of voluntary community life began, and was for a long time confined, largely to the shore margins of the continents. Here only could animal food be obtained in any quantity and literally bare-handed. The enforced community life may also be supposed to have furthered the division of labor necessary to the perfection of implements and weapons with which to conquer the interior. At any rate, permanent settlement or continued maintenance of life in the interior required, besides considerable knowledge respecting the utilization of vegetable products, a certain skill in the production and use of weapons such as only a long period of time and experience could supply.

It is possible that what the observed geographical distribution suggests may be disproved by a thorough examination of cultural

²² Ranke, J., *Der Mensch* II, p. 553.

For a fuller bibliography of the Pacific Coast shellmounds see Vol. 7, No. 1, p. 6, of the present series.

and palaeontological remains. It is probable, moreover, that the designer of modern palaces may disdain tracing the origin of his art to any thing so lowly as even the most elaborate executions done in earth; although, for our purposes, it is essential to acknowledge every perceptible or possible step in both art and science. And, if in looking for the beginnings of architecture, we are permitted to pass beyond the rough masonry of the cliff-dwellers and the rude, often earth-covered, burial chambers of Megalithic times, to the earth mounds themselves, then perhaps we may proceed even so far as the shell heaps; for these accumulations appear in reality to represent the transition from what began as a mere accident and often ended in a structure with more or less definitely recognized purposes.

Turning to the shell heaps in the San Francisco Bay region, it is only by a wide stretch of the imagination that they can be considered "structures" in an architectural sense. They are thus at once to be distinguished from the pretentious earthworks of the Ohio Valley. Beyond the fact that the shell heaps under consideration were used for burial and domiciliary purposes, and were sometimes raised into more or less conical mounds, they show no evidence of consciously constructive design. There are no effigy mounds among them, as in Brazil;²³ nor are there any strong suggestions of defensive or ceremonial purposes about them, as in Australia.²⁴ At the same time these accumulations are not quite in the same class with the enormous shell heaps which, whether entirely artificial or not, are found in several places on the Atlantic shores of both North²⁵ and South America. where they often cover many acres to a depth of as much as twenty feet. From previous description it will be recognized that the San Francisco Bay shell heaps are comparatively small

²³ See Reclus, *The Earth and the Inhabitants*, p. 108.

²⁴ Roth points out that the large and remarkably steep-sided shell heaps at the junction of the Hey and Embley rivers in Australia could readily be defended against attacking enemies and suggests further that the shell-and-ash composition probably afforded protection against fleas and other insects. *North Queensland Ethnography Bull.*, 3, p. 7.

Mound no. 256, east of Rodeo, is situated on a hillside directly above the entrance to a cave. This cavern, said to be forty feet long and of more than man's height, may well have served for protection against enemies but its chief importance was probably as a source of water supply.

²⁵ e.g., Holmes, W. H., *Am. Anthropologist*, n. s., Vol. IX, p. 113.

in volume; but, judging from the nature of their composition and the probable slow rate of their accumulation, they may reasonably be considered fully as ancient as any known deposits elsewhere in America. They are kitchen middens, of the type found in Denmark, and have their counterpart in certain shell heaps in the Gulf and Atlantic Coast states, and in their general nature quite agree with the refuse heaps in the vicinity of Puget Sound on the northwest coast. From a strictly cultural standpoint the group may in a way be said to show wide affiliations along certain broad lines, but to be otherwise quite isolated.

COMPOSITION AND INTERNAL STRUCTURE.

The San Francisco Bay shell heaps contain, besides molluscan remains, a large percentage of ashes and charcoal, together with varying quantities of broken rock and waterworn pebbles. Occasionally there seems also to have been added more or less of ordinary earth or dirt, until in some of the mounds—and usually those farthest from the shore—the shells become an almost negligible element. The presence of the pebbles in some of the deposits is difficult to explain, unless they were brought with the earth; and this seems not always to have been the case because the pebbles are often most abundant in the accumulations containing little but shell and ashes. Furthermore, it is to be observed that some of the mounds containing the pebbles are situated on the marsh and in other places near which pebbles are not now to be obtained.

The cracked and broken rocks, which were supposedly brought together chiefly for hearth and cooking stones, vary in kind locally, but foreign specimens are everywhere present and some of these must have been brought long distances.

The internal structure of the mounds has been studied with some minuteness in three places, and has besides been observed in several other widely separated localities where either natural or artificial agencies have exposed the interior to view. To speak of definite structure in a promiscuous mixture of more or less broken shell and other matter may be unwarrantable; nevertheless, bedding planes or lines of deposition are often made visible by sudden changes in the shell species or may be inferred

from streaks of ashes running through the mass. In the Emeryville mound distinct strata are in fact produced by alternating depositions of raw and calcined shells. But this is an exceptional occurrence. The burnt shells and ashes, always most apparent in the upper levels of the deposits, occur usually in streaks and sometimes in large pockets, mixed with rock, as if marking individual fireplaces. It is a noteworthy fact, however, that, unlike the shell heaps in the Aleutian Islands, these show unmistakable evidences of the use of fire from the very beginning. Thus, while actual fireplaces are not readily detectable in the lower levels, charcoal is abundant at the bottoms of two thirty-foot mounds and has been brought up repeatedly from points twelve to eighteen feet below high tide level. In one of the mounds, however, a shade of doubt is cast on this point owing to the fact that the material at the bottom seems to have been disturbed or at any rate does not truly represent the center, *i.e.*, the oldest part of the accumulation.

In general, the vertical section of a mound begins at the top with a foot or two of somewhat finely disintegrated material; grows loose, coarse and distinct in structure for some distance; and, finally, the lower end of the column becomes a compact and practically homogeneous mass in which nearly all the shells are crushed. At first, such a condition seems perfectly natural. But the rule does not hold in all cases. That the disintegration at the surface is the normal result of weathering and vegetal processes need not be doubted; but the finely broken shells of the lower half or two-thirds of the pile do not represent a clear case of disintegration. It is true that the lower levels of the mounds in question are made up largely of mussel shells, the bits of which are somewhat softened and fragile, though they still retain their lustre; and it might be argued that the mere weight had crushed the mass and reduced it to its present consistency. However, there is a small admixture of clam and oyster shells, nearly always crushed to the same fineness as the mussels, but sometimes scattered about entirely unbroken. The clam and oyster fragments are still quite as firm as the shells of the present day; and if weight or disintegrating processes reduced some, why not all? Again, if the weight could crush the mussel shells in some of the

mounds, why not in the rest? It would seem that the lower, compact portions of some of the mounds were laid down under different conditions from those on the top. In two mounds the line dividing the finer and the coarser depositions is very sharp and distinct, but whether it represents a long interval of time or corresponds to a change of inhabitants is made clear neither by the remains of the higher animals nor by the cultural evidences.

MOLLUSCAN REMAINS.

Of the molluscan remains the "soft-shelled" clam, *Macoma nasuta*, and the "soft-shelled" mussel, *Mytilus edulis*, are common to all the mounds, and usually make up the bulk of the material. The only marked exception to this rule occurs in the mounds at Point Isabel, West Berkeley, Alameda, and San Mateo, where the oyster, *Ostrea lurida*,—practically absent in the sites bordering the extremities of the bay—is found in great quantities. Other species such as the large "hard-shelled" clam, *Tapes staminea*; the long "hard-shelled" mussel, *Mytilus californianus*; the cockle, *Cardium corbis*; the abalone, *Haliotis rufescens*, and three small univalves, *Purpura crispata*, *Cerithidea californica*, and *Acmaea patina* are only sparsely represented. Of these, the two first named univalves and the mussel may have had restricted habitats in the bay; while the clam, the cockle and the abalone were probably brought from the ocean shore.

Some changes appear to have affected the species and their habitats in the bay since the shellmound people arrived. The native oyster, for example, no longer breeds in the bay, except possibly off San Mateo; the "hard-shelled" mussel has been observed only on the ocean shore where the rough surf plays; and none of the univalves mentioned above have been noticed anywhere about the bay. A particular species of clam, *Mya arenaria* Linn., observed only in one mound, central in the region, seems now to thrive wonderfully in most parts of the bay. A new mussel, *Modiola* sp., is said to have been imported from the Atlantic Coast within historic times and samples of its shell have been found on the surface of one or two of the mounds. Oysters from the Atlantic Coast have been planted in the bay in recent times and these appear to thrive fully as well as any of the native

molluscs, though at the present time all of them are threatened by crude petroleum which escapes in the form of waste from the various oil-works located on the bay shore.

Of all the molluscs represented in the shellmounds only the common clam and mussel seem to have persisted since the middens began to accumulate; and these are still found in sufficient quantities in the bay to supply the markets of all the bordering cities. Certain mounds do nevertheless furnish indication of probable local changes in the preponderating species; and wherever these changes are marked, it is the mussel which is most abundant in the lower strata while the clam becomes suddenly quite excessive in the upper horizons. It is impossible to say whether these changes are due to biological or geological causes. Probably the rate of sedimentation has been a vital factor; in any case, the sinking of the region and the disappearance of rock-bound shores would have seriously affected the life of the mussel. It is interesting also in this connection to learn from the fishermen that the last twenty years have witnessed some very marked fluctuations both in the quantity and the habitat of the shellfish.

Following is a list of molluscs known to occur in the shellmounds:

- Oyster, *Ostrea lurida*.
- Mussels, *Mytilus edulis* and *M. californianus*.
- Modiola*, sp.
- Soft-shelled clams, *Macoma nasuta* (and *M. edulis?*).
- Myra arenaria*.
- Hard-shelled clams, *Tapes staminea* and *T. tenerrima*.
- Cockle, *Cardium corbis*.
- Abalone, *Haliotis rufescens*.
- Purpura crispata* and *P. caniculata*.
- Cerithidea californica*.
- Olivella biplicata*.
- Acmea patina*.
- Standella*, sp.
- Land snails, *Helix*, two species.

VERTEBRATE FAUNA.

While the indicated change in the preponderating shell species is of no particular cultural significance, it is otherwise with the remains of the vertebrates represented. There are no sharp changes from invertebrates to vertebrates and from fishes to

mammals, such as Dall appeared to find in the Aleutian Island shell heaps. But progress is here. Mammalian bones seem to occur at all levels in some of the largest mounds; yet it is safe to say that more than ninety-five per cent., quantitatively measured, are confined to the upper six or eight feet. The doubt implied is again due to the uncertainty as to whether or not the excavations reached the oldest part of the mounds. But in any case, the occasional surprise or accidental capture in earliest times of big game, marine or terrestrial, counts little against the successful slaughter of a great variety of animals in later days.

Fishing may or may not have been an important industry. There happen to be very few fish bones in the mound material, although the grooved stones, usually held to have been net-sinkers, occur at all levels in some of the deposits. It is of course possible that fish may have been cured for consumption elsewhere.

Bird bones, apparently of ducks and waders, are rather numerous, especially in the upper strata. Their presence suggests two things: first, that at least the latest mound people lived on the bay shore during the winter time, when ducks were present; and, second, that these peoples possessed no domestic dog. The latter inference is based simply on the fact that no half savage, hungry dog would have left the bird bones in the condition in which they are often found.

The identified animal bones include the following species:

Deer, <i>Cervus</i> , sp.	Dog, <i>Canis familiaris</i> . ²⁷ (?)
Elk, <i>Cervus canadensis</i> .	Seal, <i>Phoca</i> , sp.
Sea-otter, <i>Enhydra lutris</i> . ²⁶	Sea-lion, <i>Zalophus californianus</i> .(?)
Beaver, <i>Castor canadensis</i> .	Porpoise, <i>Phocaena communis</i> .
Squirrel, <i>Spermophilus</i> , sp.	Whale.
Rabbit, <i>Lepus</i> , sp.	Canvasback Duck, <i>Aythya vallisneria</i> .
Gopher, <i>Thomomys talpoides</i> .	Goose.(?)
Raccoon, <i>Procyon lotor</i> .	Cormorant, <i>Phalacrocorax</i> , sp.
Badger, <i>Taxidea</i> , sp.	Waders, or some large birds.
Skunk, <i>Memphitis occidentalis</i> .	Turtle.
Wild cat, <i>Lynx</i> , sp.	Skates, Thornbacks, and other fish.
Bear, <i>Ursus</i> , sp.	Wolf, <i>Canis</i> , sp.

²⁶ Otter must once have been plentiful in the region because, according to Spanish history, the skin was an object of trade for an indefinite period from the time of occupancy in 1769.

²⁷ The remains found, in one case at least, were doubtless those of a recent animal accidentally left on the mound.

CULTURE AND HISTORY OF THE SHELLMOUND PEOPLE.

MATERIAL CULTURE.

The augmenting capacity of the shellmound people, implied in a measure by their more and more successful hunting, is made sufficiently evident by a study of the artifacts. As with the animal bones, while some of the preserved suggestions of industrial life occur from the bottom of the accumulations to the top, they are after all relatively abundant only in the upper levels. But this fact would of itself prove little did not the implements of later times also show much greater variety and specialization as well as perfected workmanship. Viewing the culture as presented in its entirety however, the change or progress is not perhaps so clear and marked as might have been expected. These people, rude as they may have been, from the start employed fire; used prepared vegetable foods; satisfied their hunting instinct; and fished, supposedly with seine—if they ever fished at all. They also used body-paint and they buried their dead. In other words, they were from the beginning quite above the stage in which savage man may be supposed to have struggled for his mere existence alone. The later mound occupants may have brought, or, if they were direct descendants of the first inhabitants, may have originated activities along other fundamental lines; though the clear proof of such seems wanting. For instance, it is tolerably certain that skin-dressing and basketry were practiced in late times, but with our present knowledge it would be unsafe to say when these arts began or even that they did not arrive with the first appearance of the mound people. More evident seems the relatively recent development of certain luxurious habits and tastes such as are implied by the presence of pipes, musical devices and decorative objects. Finally, it may be well to add that there appears to be no form of artifact found at the bottom of the accumulations that does not also occur near the top.

The culture as observed, were one to describe it in terms of the present system of archaeological classification, is neolithic. Some roughly chipped flint and chert flakes were indeed found in the lower horizons of one of the shell heaps, but these pieces may

hardly be considered palaeolithic in the true sense. As would be expected, only such effects as are made of bone and stone and shell have resisted disintegration, and these remnants include weapons, household utensils, working tools, ornaments and possibly ceremonial objects. Such fundamental things as spear and arrow points, mortars and pestles, hammer stones and roughly grooved sinkers occur at all levels in many of the deposits; but the shapely and sometimes highly polished bone awls, the graceful "charm stones," the delicately worked stone pipes, the bone whistles, the stone labrets and certain shell beads and pendants, all appear to be confined to the upper horizons in at least some of the very largest mounds. The record, apparently so clear and simple, is nevertheless difficult to interpret with certainty, and even if it be accepted at face value, there still remains a legitimate doubt as to whether the cumulative nature of the culture is due to the natural development of a fixed population or is the result of substitution by conquest or migration.

Mention may be made of certain minor local variations in the culture of the mound group. Some of these changes may possibly correspond to the recently determined geographical limits of native linguistic stocks, but there are others of which this cannot be true. For example, the grooved sinker occurs in great abundance in some deposits; while in others, closely adjacent, it appears to be entirely absent. There has been found also in the northeastern part of the region a particular form of mortar—a large, roughly rectangular slab with a small bowl on the smoothed side—which has not been observed anywhere else, the usual mortar being either globose or bucket-shaped. Other differences are apparent, but they must await further investigation.

While, as previously observed, the study of shell heaps here and elsewhere does not yet warrant detailed culture comparisons on a world scale, some features at least seem to stand out pretty clearly. In the first place, this type of culture represents almost everywhere a relatively low stage and for that reason—the primitive needs being identical—shows several broad similarities, particularly in the nature of the pointed and sharp-edged types of implements. Thus the bone awl, the wedge, the flint flake, and even spear and arrow points differ comparatively little for the

entire world. All this seems natural enough because the piercing point and the cutting edge really embody fundamental requisites, such as are furnished by nature to many of man's competitors in the animal world.

Specialization is probably a question both of time and of ingenuity. For a long period it was doubtless held in check partly by the manner of occupation a given environment compelled and partly also by the nature of the raw material furnished by any particular geographical area. Consequently it may be assumed that real differentiation did not appear, on many lines, until individual imagination and taste were ripe enough for expression. But even the artistic instinct has asserted itself similarly over vast geographical areas, though doubtless many products apparently under this category may be the result either of trade or migration. As examples may be mentioned the "charm stones" and certain shell ornaments that are found on the Atlantic as well as on the Pacific shores of North America. In the second place, if we except Europe or those parts of the world thoroughly changed by Aryan or other acculturation, it may be stated with some degree of confidence that cultures of the various shellmound groups, in so far as they differ among themselves, usually agree with or shade into the civilization attained by the natives perhaps still occupying the respective regions.

Referring to the positive side, the culture of the San Francisco Bay shell heaps conforms, at least in its broader features, to that of the late Indians of the surrounding territory roughly designated as Middle California, somewhat as the attainments of the shellmound peoples on the Atlantic shores appear to have shaded into the civilization of the there native Red Man of historic times. Again, negatively considered, while pottery or evidence of work in clay is common to every one of the known shellmound groups in all the rest of the world, it is absent from the San Francisco Bay deposits precisely as it is in Central California ethnology. In conformity also to the same rule, no native-worked metals have been found here although such occur in many shell heaps, even in those so near as Puget Sound, where are also found certain entirely unique rock sculptures. It would appear, therefore, that so far as may be judged from the cultural evi-

dences above, no very definite conclusions can ever be reached regarding the origin of the shellmound peoples and their possible migrations. There remains, however, another means of determination, which may prove more fruitful, namely an examination of the skeletal material.

HUMAN REMAINS.

Fortunately the shellmound peoples everywhere it seems, except in Denmark, have interred their dead in the accumulated refuse on which they lived. It is certain at least that all the mounds of any size in the San Francisco Bay region contain numerous burials and the remains, even those beneath the sea-level, are often remarkably well preserved.

At the outset one is disposed to wonder at such a world-wide practice that really appears to have no precise explanation. The religious motive is sometimes assigned, and while there is no good ground for disputing such a view, especially as nearly all human actions appear to have had some religious significance at one time or another; still a thoroughly practical reason may not be entirely wanting. The shell deposits, it will be recognized, are made up usually of loose, porous material very easily dug into with a stick or a shell or even with the bare fingers; on the other hand, to make a hole large enough to accommodate a human body in ordinary California soil is a hard task at some seasons of the year, even with modern tools. However, this is merely suggestive, and primitive man may have had other reasons for burial of his dead in the mounds.

The mortuary customs cannot here be considered in full detail. It will be enough to state that the common practice from the start seems to have been interment rather than cremation, though occasional evidence of the latter has been observed. The particular disposition of the remains varies decidedly, sometimes even in the same mound. Occasionally the body has been laid out at full length with the face either up or down. At other times the arms and legs have been folded tightly against the trunk and the body laid face down. But as a rule the remains lie on the side with the limbs more or less flexed. Group burials of two or more are also not uncommon, the remains lying usually very

snugly, spoon fashion. No attention seems to have been paid to cardinal directions, as is popularly supposed; nor do there appear to be any interments in a sitting posture. The great majority of the remains are not accompanied by artifacts of any kind. Occasionally a male is fitted out with pipes and weapons, while a few females may be supplied with mortar and pestle and sometimes several awls. Children have invariably been accompanied by beads and trinkets made of sea shell. There is also reason for believing that food was placed with the body, pockets of unopened bivalves having on several occasions been found close to the remains.

No careful study has been made of the osteological remains as yet because it is hoped that additional material may be secured from at least a few more mounds. But to all appearances the shellmound peoples were of average build, with some amount of variation in skull form, but with no striking peculiarities.

ORIGIN OF THE PEOPLE.

The first questions naturally asked in connection with the study of these shell heaps concern either the age they represent or the people who made them. Were they the progenitors of the Indian or were they different? Enough has already been stated to make it clear that there is thus far no definite reply to either query. Speculation on such themes, perhaps indirectly fruitful, has long been fascinating pastime; but for even a tentative answer we must await a more thorough investigation of the facts relating not only to these shellmound people but to the pre-historic Americans as a whole.

So far as concerns the San Francisco Bay people, we have seen that there is no great gap either in the evolution of the culture as traced from the bottom of the accumulations to the top, or between the attainments of the last occupants and the culture of the Indian who inhabited Middle California less than a century ago. Moreover, as it is even certain that late Indians lived on some of the sites until a few decades ago, it becomes difficult to reject the opinion that the original migrants who began the refuse accumulations were of his own race, if not his direct ancestors. But it may be well to bear in mind that a

judgment based upon a culture so largely utilitarian is of doubtful value, and possibly a careful study of the skeletal material may lead to a different view.

AGE OF SETTLEMENTS.

A somewhat more definite statement may be ventured regarding the second question, namely as to the time elapsed since the shell heaps were begun. It is of course impossible to fix the absolute age of any of these repositories, but there are a number of things that indicate their relative antiquity. Such facts are for example the general absence of evidence suggesting European contact; the amount of wash or drift that has covered up some of the deposits; the fairly old trees that grow on the tops of two or three of the mounds (pl. 32, fig. 1); the amount of subsidence of the bay region which some of the deposits record, and the enormous volume of sediment which has been deposited in various regions of the bay, in part at least subsequent to the time when some of the largest refuse heaps were abandoned. Add to these the suggestion of the enormous volume of some of the deposits, and their great age, humanly speaking, must be apparent.

If one tries to estimate the duration in terms of years, a difficulty presents itself at once in that it is impossible to know whether the mound people shifted from one site to another, as Darwin observed in Patagonia, or whether they even lived on the bay shore at all seasons of the year. It has been suggested in connection with the presence of bird bones in the deposits that the occupants lived by the water during the winter, but there is no proof that they followed the recent custom of retiring to the hills during the summer. If territorial boundaries were respected in those days as in later times, then, in view of the fact that the immediately surrounding hills are not altogether favorable as summer retreats, it may be assumed, for our purposes, that the mound people remained practically stationary and drew a varying quantity of molluscs from the bay the year round.

For something more satisfactory than a guess let us estimate the age of one of these accumulations on the basis of the probable daily amount of deposition. Mound no. 295, at Ellis Landing, near Richmond (pl. 33, fig. 2), which has a volume approximating

1,260,000 cubic feet, may be used for this purpose. There were on the top of this pile about fifteen house pits, and if we allow an average of six persons to the family or house we may assume a community of ninety or one hundred individuals of mixed age. It has already been pointed out that these people hunted the higher animals and utilized vegetable products, so that they were never entirely dependent on the molluscs. Suppose, however, that in the earliest times, when only the mussel was abundant, they gathered a daily average of fifty shell fish per person, which would of course leave considerably more than fifty for each mature individual and an amount that, supplemented as it was by other things, would probably be sufficient. Actual trial shows that the volume yielded by the total 5,000 shells, crushed down to their present consistency, would be about 1,200 cubic inches. To this amount should be added a quantity of ashes, broken rock and such extra debris as may collect about a camp—possibly sufficient to make up one cubic foot for the daily average. Calculated on this basis it would apparently have required about 3,500 years to accumulate the pile. Even though one may refuse to take these figures at anything like face value, if we consider that the site was possibly not occupied for several centuries, and that it may never have served as permanent residence, it becomes reasonable still to believe that the mound is anywhere from three to four thousand years old.²⁸

THE IMPLIED POPULATION.

In view of the astonishment commonly expressed with reference to the great number of shell heaps in the San Francisco Bay group, it may not be out of place in closing to remark briefly on the probable aboriginal population. There are insuperable difficulties in the way of arriving at even an approximately satisfactory answer to the question, and this would still be the case were the original number of mounds present. In the first place, it may safely be assumed that the shell heaps were not all begun at the same time; and, in the second place, it is practically certain

²⁸ Dall estimates 3,000 years as necessary for the accumulation of some of the Aleutian Island mounds, and the age of some of the kitchen middens in Denmark has been placed at 3,500 years.

that some of the very largest mounds were abandoned long before others. The Spaniards explored the bay region quite thoroughly in the year 1775, and they appear not to have observed Indians living on the larger shellmounds near the shore unless possibly on mound no. 3, at Sausalito, and at Crockett, on the south side of Carquinez Strait;²⁹ but many informants have pointed out both some of the smaller sites between San Rafael and Petaluma and also some of the larger ones south of San Mateo as having been occupied by the Indians as late as 1870. Precisely how far the buried culture may substantiate these statements remains to be proved. On the one hand, no sign of European influence has so far been encountered in the three large mounds systematically investigated; but, on the other hand, reports are current, mostly referring to long past discoveries, in several of the mounds, that would suggest at least indirect contact with higher civilization. These reported finds include such things as "brick, of Spanish make," from mound no. 3 at Sausalito; "red silk," supposedly from one of the San Pablo mounds³⁰; and from no. 232, on Mare Island, even a stone slab, said to have been inscribed with "Egyptian hieroglyphics"; but the only recent and seemingly well authenticated find, coming from near the surface of no. 316, the large Alameda mound previously mentioned, is a small brass medal bearing the date of 1768.³¹

It appears therefore quite impossible to say how many of the middens were occupied at any one time. Nevertheless, if we allow that some of the older mounds have been submerged or obliterated

²⁹ The report of Portolá's first overland expedition from San Diego to San Francisco Bay, in 1769, says that they judged from the numerous columns of smoke observed that the country about the south end of the bay was well stocked with Indian villages. The party saw and had dealings with the Indians while encamped on San Francisquito Creek. Later, in 1775, Commander Ayala of the *San Carlos*, met or saw natives at two points on the present site of San Francisco and also in the vicinity of Sausalito, where, according to recent hearsay evidence, a populous Indian village existed subsequent to 1838. Cañizares expressly states in his reconnaissance report that he made four visits to an Indian rancheria on the south bank of Carquinez Strait, near the west end, and that he counted there about 400 souls. See *The March of Portolá*, pp. 39-68.

³¹ A fragment of a rectangular, three-legged metate like those common to Middle America was also found in or upon one of the mounds at West Berkeley.

³⁰ Southall, J. C., *Recent Origin of Man*, p. 550.

and that others have been started in later times to take their places, it is probable that the present number, about four hundred, is not so very far out of the way. If we may then judge at all from the number of house pits found on some of the mounds, the group as a whole may easily average, say five houses to the mound; and estimating six individuals to each house or family we get a population of twelve thousand. Such a figure may seem a little startling at first, because every observer will recognize that the territory in question could not support such a population at the present time. Still there seems to be no inherent reason why under former natural conditions a perfect utilization of all the resources should not have maintained from ten to twenty thousand individuals of mixed age. The figure at all events is not so extraordinary in view of the fact that the estimated total of the aboriginal population for the entire state of California has recently been set by Dr. C. H. Merriam at about two hundred and sixty thousand.³²

³² *Amer. Anthropologist* (n. s.), Vol. VII, No. 4, p. 594.