Galatea Bay—The Excavation of a Beach-Stream Midden Site on Ponui Island in the Hauraki Gulf, New Zealand

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By

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Abstract

SHELL middens are common archaeological sites along the shores of New Zealand. Their occurrence suggests the importance of shore and marine resources in the daily life of the prehistoric Maori. An area excavation was conducted at Galatea Bay on Ponui Island in order to investigate the function of beach middens in Maori settlement and determine the range of evidence which has survived. In addition, an intensive laboratory study of the midden materials has made it possible to describe several techniques in midden analysis experimentally, and to interpret the non-artefactual evidence in natural and cultural terms.

INTRODUCTION

THIS report describes the excavation of a small shell midden site (N-43/33) at Galatea Bay on Ponui Island in the Hauraki Gulf, New Zealand. This work was carried out to recover information about the occupation represented by the beach midden in order to add to our knowledge of Maori settlement patterns. Before discussing the excavation and the results which have come out of it, an assumption about human behaviour upon which archaeology rests will be pointed out, and how this assumption influences archaeological research will be reviewed. These general introductory comments on archaeology, and a subsequent statement on objectives and methods are intended to emphasise the reasons why the Galatea Bay site was excavated and show how the excavation is related to current research on the prehistory of New Zealand.

THE SIGNIFICANCE OF CULTURAL PATTERNS TO ARCHAEOLOGY

In general discussions about archaeology, much emphasis is placed on the uniqueness of each archaeological site. It is claimed, quite rightly, that by digging, the archaeologist destroys the relationships which exist between the evidence he uncovers and also destroys a good part of the evidence itself. In other words, each time he excavates, he performs an experiment which can never be repeated. Thus, while like the natural scientist, the archaeologist can try to objectify his procedures and observations, unlike the natural scientist he cannot reproduce an identical set of conditions. It would appear that the results of an excavation have a uniqueness about them which cannot be verified by repetition. To stress such a point of view too strongly, however, obscures the very discovery the archaeologist wishes to make: the discovery of regularities, of patterns, in the phenomena he observes.

The archaeologist believes, as does the natural scientist, that there are statements which can be made about the evidence he uncovers which go beyond the description of specific sites and the expression of unique historical events. To arrive at such general statements, he assumes that much of human action is patterned under recurrent relationships. It is this patterning of human behaviour into regularities which the anthropologist calls "culture." For the archaeologist, recurrent associations of prehistoric evidence are the "cultures" he studies, and the relationships between the elements in such associations are seen as the result of cultural patterning in the old human behaviour he is indirectly observing.

If this assumption about cultural patterning is correct, and most prehistorians would agree that it is, then two conclusions can be made about the testing of archaeological evidence. First, we can see there must be general characteristics in each archaeological site, as well as unique ones. Second, because these general characteristics can be interpreted as the result of the repetition of behaviour at similar sites belonging to the same cultural pattern, they avoid to a great extent the difficulties inherent in the unreproducible nature of each field excavation. These two conclusions have several implications.

First of all, general statements about a prehistoric culture which are based on the results of a single excavation are only "inferred general statements". This is the case because only by repeated experimentation at other similar sites can a common pattern be fully isolated from the unique aspects of a specific site. Moreover, it follows that conclusions founded on evidence from truly unique sites are only inferred generalities, and as such give the prehistorian very little to work with in his efforts to revitalise the past.

In addition, in talking about general statements a useful point can be raised about validation in archaeology which is a corollary of the observation already made. It is important to recognise that the archaeologist ought to worry about testing his conclusions just as much as the natural scientist must, although no one would pretend that the archaeologist can ever achieve the same degree of accuracy and reliability. General statements in archaeology, therefore, should follow from the evidence at hand and should suggest real ways in which they may be verified by further analyses and excavations. If such validating limitations cannot be applied, then the archaeologist must admit he is only speculating. He is not concluding.

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Finally, if the archaeologist is to discover regularities in his data, he should look upon excavation as deliberate experimentation. It is not merely observation. The experimental method seeks to observe isolated phenomena by controlling known variables, and no single experiment ever pretends to handle all possible variations and contingencies. Thus, in archaeology research must be directed toward stated aims and be conducted in a systematic, clearly formulated manner. For example, selection of a site must take into cognisance the kinds of questions to be investigated and the actual contingencies which can be known prior to excavation.

Now it may be objected that excavation is not experimentation because the archaeologist cannot manipulate the factors involved. In as far as this objection goes, it is quite acceptable. The archaeologist does not manipulate past events. But he does manipulate the surviving traces of such events and it is here that he must exercise control over what he investigates. How a site is selected, what excavation techniques are used and how the results are analysed and interpreted: in all these aspects of research he must be objective, explicit and purposeful.

On the following pages the excavation at Galatea Bay will be described and its objectives, methods and results detailed. The overall purpose of the excavation can be briefly stated: by this initial excavation of one beach-stream midden it was planned that we could arrive at certain inferred generalities about this kind of site in New Zealand, the validity of which would rest on further testing at other similar sites. In the various sections of the paper the following subjects are discussed:

1. History of the research.
2. The location of the site and the reasons for its selection.
3. The objectives of the research and the methods used.
4. The observations made and how these were analysed.
5. The range of conclusions which can be proposed.
6. Some of the broader implications for the objectives and limitations of archaeology in New Zealand which can be raised because of the present research.

History of the Research

The Galatea Bay site was first recorded on 13 March 1965, when the author visited the locality. On 4 April arrangements were made with the owner, Mr G. Chamberlin, for an excavation there by the Department of Anthropology and the Archaeological Society at the University of Auckland. On 11 April Mr K. M. Peters of the Department of Anthropology and the author arrived at the site to set up field operations and prepare the site for excavation. In accordance with the research programme which had been formulated for Galatea Bay, they conducted a test excavation in the south half of Square D–1 which established an initial knowledge of the stratigraphy.

The full labour force of twenty-five student and amateur excavators worked from 16 to 19 April under the direction of the author and Mr W. Shawcross of the Department of Anthropology. Afterwards, a small labour force remained until 25 April to complete the recording, photographing and mapping of the excavation.

A final visit to the locality was made on 28 July when Mr Peters, Mr A. Michael of the Department of Zoology, University of Auckland, and the author returned to take samples of the living shell fish population from the shore of the bay.

Location of the Site and the Reasons for its Selection

Ponui Island is situated in the Hauraki Gulf some twenty miles directly east of Auckland (Fig. 2). Less than a mile to the north-west lies Waiheke Island. Ponui, also called "Chamberlins" after the family which has owned it since the middle of the last century, is five miles (eight kilometres) long from north to south, and 2.3 miles (3.7 kilometres) wide near the centre from east to west. The land rises over 560 feet (170 metres) above sea level toward the middle of the island. The topography is rolling but moderately steep. Even at the water's edge the land is frequently over 100–150 feet (30–45 metres) in height where it drops off abruptly in sharp cliffs of exposed rock or falls rapidly in valleys to small bays with short beach fronts. The soil, technically a yellow-brown earth which has been strongly leached (Pohlen, 1965), has developed on an old sedimentary base formed during the deposition of greywacke sands and muds in the New Zealand Geosyncline during the Permian-Jurassic geological periods (Ballance, 1965). Most of the island today is covered in grass and is used for livestock farming. In the past, however, the island was probably covered in forest. Detailed research on the pre-European vegetation has not yet been done. It is known that when the French explorer Dumont d'Urville sailed between Waiheke and Ponui on 27 February 1827, he was impressed greatly by the islands in this part of the gulf. He reported, unfortunately not by name, that some of the islands "were lofty and mountainous, covered with magnificent forests, others lower and only covered with more ordinary vegetation" (d'Urville, 1950: 163). By extrapolation, it is proposed at least two of the islands "lofty and mountainous" must have been Waiheke and Ponui.

The Galatea Bay site (N-43/33) lies beside a small, shallow bay locally known by that name on the north-west side of Ponui Island. Directly to the north is a similar embayment known as Crescent Bay, and to the south, another called Rabbit Bay. All three have sandy beaches in front of erosion valleys which are separated from each other by ridges ending in steep cliffs at the sea. The beaches at Galatea and Rabbit Bay are roughly the same in length, approximately 150–175 yards (135–160 metres) long. The beach at Crescent Bay, however, is over 400 yards (365 metres) long. Both Crescent and Rabbit Bay have an area of flat land behind each of the beaches before the land rises to the ridges over 200 feet (60 metres) high. There is very little flat land behind the beach at Galatea Bay for the steep sides of the small valley fall almost directly to the sea.

Galatea and Rabbit Bay each have a single valley stream. Crescent Bay has two. During April, 1965, only the streams at Crescent Bay had flowing water. The stream at Galatea Bay carried no surface water, while that at Rabbit Bay held ponds of stagnant water with only a slight flow at the beach front. It seems reasonable to assume, however, that if the island was forested in the past, water flowed in all the streams at least part of the year. In spite of aggradation of the stream bed due to erosion and the probable lowering of the water table because of deforestation, surface water was observed in the stream at Galatea Bay during the winter when the site was revisited in July, 1965.

Beside each of these three bays are extensive deposits of shell midden with cooking or *hangi* stones, ash and charcoal. These shell deposits are well known to the local inhabitants who report that skeletal remains, said to be human, were pulled from the midden at Rabbit Bay several decades ago. Because the shell middens in all three valleys are directly associated with bays where fish and shell fish could be obtained and also lie next to fresh water streams, these two important associations have been combined in calling these midden sites " beach-stream midden sites ".

At Galatea Bay, shell midden can be seen in the raised beach front on both sides of the stream (Fig. 3). Each midden grades out toward the stream bed. Thus there are two separate midden areas along the beach front because while the stream separates the two middens, it does not bisect them.

It is the midden layer to the north of the stream which is of particular interest for it is here that excavation was conducted. The deposit rests below the valley side on a sloping bench of land 10–13 feet (3–4 metres) above the high water mark and roughly 115 feet long by 33 feet wide (35 x 10 metres). The midden is well preserved. The bench face has been stabilised by grass except for a few exposed patches, and slumping has been minimal.

The midden stratum on the south side is 8 inches (20 centimetres) thick. It is buried beneath a sandy turf 7 inches (18 centimetres) in depth, and rests on a moderate slope, which may have been artificially terraced, at the foot of the valley. The natural section at the beach front is highly eroded and affected by slump action. The section shows several distinct stratigraphic zones below the midden layer, but these cannot be adequately interpreted without detailed pedological analysis. None of these lower zones appears to be cultural in origin. The lowest level visible is a well sorted sand without shell, which suggests it may be an old dune formation.

In addition to these two major midden areas, there are also several other archaeological features in the immediate vicinity. On the valley slope directly above the south midden area soil slumping has exposed a scatter of shell. On the ridge is an artificial pit. At the end of the ridge by the sea there is a small flattened area which may be the vestige of a terrace. Just inland behind the terrace are several pit-like depressions. If these are rectangular pits, little remains of them, because erosion has carried much of the cliff edge down to the waters below. The large pit and possible vestigial pits and terrace have been designated by a separate site number (N-43/34) in accordance with the practice of the New Zealand Site Recording Scheme. The relationship of the pits and terrace to the beach middens is unknown.

The last remaining feature in Galatea Bay which may have archaeological importance is the peninsula outcrop which runs out into the gulf on the south side of the bay. Today the sides are steep and very weathered, and there is little flat land along the top. K. M. Peters of the excavation staff attempted to investigate the possibility of traces of occupation there. The ascent proved to be impossible without special equipment. Mr G. Chamberlin, the owner of the land at Galatea, reports, however, that a ditch-like feature exists on the crest.

These are the features of Galatea Bay and its location. Figure 1 shows the appearance of the locality today. There are a number of reasons why the bay was selected for excavation. Here was a well-preserved midden site of small dimensions which was physiographically very well defined and delimited by the small valley itself. The middens showed a variety of shell fish, and evidence for at least one domestic activity, that of cooking, existed not only in the presence of charcoal and burned cooking stones, but also in a naturally sectioned *hangi* or cooking pit on the south side of the beach front. The bay suggested the source of the shell fish. The stream bed suggested a probable source of fresh water. With only a limited amount of time available for excavation, Galatea Bay seemed to offer an excellent place to investigate the question of the function of at least one kind of shell midden site. It is to the further examination of this question of the function of middens in Maori settlement, as well as to the specific objectives and techniques adopted at Galatea Bay, that it is now necessary to turn.

Objectives and Methods

During the development of New Zealand archaeology much attention has centred on sites belonging to the " Moa-Hunter Period " in Maori prehistory (Duff 1956: 13, 16–17), a theoretical phase also referred to by some as the "Archaic Phase of New Zealand Eastern Polynesian Culture" (Golson, 1959: 36–37). In the last six years, however, great interest has grown in the study and excavation of the Maori hill-forts, the *pa,* which are usually assigned to a later period termed the " Classic Maori " phase or culture (Golson, 1959: 47–48, 54). Major excavations at *pa* sites have been carried out. This research has uncovered sequences in terms of certain constructional features and some artefactual materials. It has only been in the last two years that attempts have been made to excavate enough area inside two *pa* to give an idea of the range and spatial distribution of archaeological elements within the fortified locations (Groube, 1965; Shawcross, 1964), although work by Smart (1962b) along the same lines had somewhat earlier indicated the advantages of wide area excavation.

Principally because of theoretical discussions by R. C. Green and W. Shawcross of Auckland University (Green and Shawcross, 1962; Green, 1963a) and ethnohistorical study by L. M. Groube of Otago University (Groube, 1964a, 1964b), the interests of *pa* site archaeology have been extended to include the more general problem of what were the prehistoric and protohistoric settlement patterns in New Zealand. For example, Groube has raised the question of the actual function of the hill-forts (Groube, 1964b: 138–140). By re-examining the earliest European accounts, he has demonstrated how imprecise are our ideas about the Maori use of *pa.* At a more general level, he has described evidence which contradicts former concepts of Maori settlement patterns.

In the older point of view variously articulated by scholars such as E. Best, P. Buck and R. Firth, the prehistoric settlement pattern in New Zealand consisted basically of two elements. The first of these was the fortified village, the *pa.* The second was the unfortified village, the *kainga.* Some scholars have held these were two contemporary kinds of settlement (Best, 1952: 254; Firth, 1959: 91–93; Golson, 1957: 71–72; Vayda, 1960: 10–11). Others have declared that with an increase in the occurrence of warfare in prehistoric New Zealand, the *kainga* gave way to the *pa* (Buck, 1962: 137–139). In addition to these two kinds of villages, Firth, for example, also notes the existence of temporary camps (1959: 93). The difficulty with this settlement pattern picture lies in the definition of " village " in each case.

According to Firth (1959: 91–94) the prehistoric Maori lived in " village communities " composed of a number of huts of various sizes and degrees of workmanship and containing also a plaza or *marae,* a large village meetinghouse or *whare runanga,* storage facilities and other defining features. An individual village consisted of a number of household groups in the form of nuclear or extended families (1959: 105, 110–111). In general, a village was inhabited by one extended kinship group or *hapu,* which may be designated loosely by the term " clan," which was made up of a number of related households, although a large village might have had several *hapu* residing together (1959: 113).

Firth has clearly explained what he considers to have been the relationship between fortified and unfortified villages (1959: 92). He states that *pa* differed from *kainga* virtually only in the presence of defences around the former: " *pa* and *kainga* exhibited the same essential features, although the fortifications of the former were of necessity so laid out as to conform to the exigencies of the site, and no consistent shape of settlement was in vogue. In regard to social life and institutions, apart from war, one may speak equally well of either ". As indicated above, this kind of interpretation is often encountered in the literature, both in archaeology and anthropology (for example, Piddington, 1963: 167–168). It is, however, not the only one.

Best, in his extensive description of Maori hill-forts (1927), presents a more complicated picture of Maori settlement than the one often encountered. While he does draw attention to the existence of " open hamlets " or unfortified villages as well as " fortified hamlets " (1927: 4), he records the Maori had names for a number of kinds of fortified sites which ranged from a term for any kind of fortified place to a term for simple retreats for non-combatants during a war, places frequently not fortified in any artificial way. Included in this wide range are the terms *pa kokori* and *pa korikori* which " were applied to any defences of an inferior nature, such as a few huts surrounded by an ordinary type of palisaded barrier. Such places were often constructed at cultivation grounds away from the fortified village, and at fishing camps on the coast " (1927: 14). Most important, however, is Best's interpretation of the function of *pa*:

> Nor must it be supposed that the Maori village community lived permanently in the fortified village. When no attacks were feared from enemies the people often lived outside the fort, and even moved away from it to live for a while on the sea coast, or in the forest, when engaged in fishing or bird taking operations, etc., or at their cultivation grounds when planting, tending, or lifting crops. In many cases the community lived in a village protected merely by a fence or stockade, but had a strongly fortified *pa* in the vicinity to retreat to when danger threatened (1927: 19).

The late prehistoric settlement pattern now proposed by Groube (1964b: 82–107) after an examination of the accounts of early explorers most resembles that given by Best, but differs in the definition of occupation within *pa* and undefended sites. Settlement at the time of first European contact in 1769 may have consisted basically of scattered undefended " hamlet sites " of only three or four houses associated with separate cooking sheds and a communal dump. Moreover, these hamlets may have been used only by one or two extended families and may have served only particular specialised functions such as seasonal activities (fishing or cultivation). Thus, they cannot be called *kainga* in the traditional sense because of their limited size and shifting utilisation throughout the year. Settlements with a number of huts, which might correspond with what ethnographers working with the historic Maori have termed *kainga,* seem to have been rare. In addition, *pa* may only have been fully occupied by entire communities during periods of crisis or during particular seasons. Groube suggests:

The *pa* then is not necessarily permanently occupied, but seems to be the centre of a more extensive settlement pattern of which it is the citadel. Seemingly in the majority of cases, it was occupied only during crisis with only 'a few remaining' on the *pa*. Everyday economic activity, at least during summer, was carried out in dispersed hamlets or huts (Groube, 1964b: 102).

Two important points can be drawn from this brief discussion of the various conceptions of the prehistoric settlement pattern in New Zealand. First of all, in view of these conflicting interpretations of the ethnographic data, it is apparent that there is great need for an archaeological examination of settlement evidence in the hope that by such study, patterns can be determined both for the late prehistoric Maori which may be compared with the ethnographic data, and also for earlier times in New Zealand. Second, and following from this point, to arrive at such patterns it is necessary that sites other than *pa* be excavated as well, if it is to be decided whether or not undefended *kainga* or specialised hamlets in fact once did exist.

Only a few late prehistoric sites* other than *pa* have been excavated. Most of these have been middens (for example: Dawson, 1949; Dawson and Yaldwyn, 1952; Fomison, 1963; Green and Pullar, 1960; Hunt, 1962; Nicholls, 1963 and 1964; Skinner, 1953; Spring-Rice, 1963; Trower, 1962; and unpublished excavation by the Department of Anthropology, University of Auckland, at Smuggler's Cove, Whangarei, in 1964). Other work has been done on the rectangular pit sites which are alternatively interpreted as storage areas or house sites (Batley, 1961; Green, 1963b; and Parker, 1962), on above-ground houses (Buist, 1962), and on cave sites (Batley, 1961; Hosking, 1962; and Wright and Bennett, 1964). Systematic study along these lines, however, has only begun.

As Elsdon Best long ago commented (Best, 1927: 98), beach middens are extremely common along the shores of New Zealand. He interpreted them as refuse dumps near the cooking sheds of "old time villages". Although a limited amount of excavation has been carried out on beach middens not attributed to the Archaic phase of Maori culture, no site, prior to the one under discussion, had been systematically excavated in order to demonstrate its function in Maori settlement and determine the range of archaeological evidence which such a site contained. Thus, it seemed desirable to excavate a beach midden to gain these kinds of information to complement in part that available from *pa* excavations.

Once the Galatea Bay site had been chosen for study, careful consideration was given to the selection of the most suitable archaeological methods by which the desired information might be obtained. An excavation limited to a small area of the site would give only a stratigraphic sequence. Therefore, it was imperative that a wide enough area be opened to secure evidence on the full range of activities at the site, the spatial distribution of that evidence, and, in turn, the general function of the midden. The method of excavation finally chosen was area excavation of all of the site which it was feasible to examine.

The size of the excavation grid (18m x 6m) was settled upon after field examination of the site (Fig. 3).* The southern end was limited by the presence of the root system of the large *pohutukawa* tree (*Metrosideros tomentosa*). Study of eroded areas at the bank suggested the midden probably graded out over or beneath the old slope slump to the north, a prediction which proved to be correct. The northern end was arbitrarily determined to include only part of the midden where it seemed to grade out. The western edge was set back from the raised bank to prevent erosion and allow for a causeway for spoil transport to the dump established north of the site. A similar causeway was left at the foot of the slope on the east side of the excavation. Time limited work to the midden alone.

Stratigraphy of the Test Excavation, Square D-1 (Fig. 4)

The southern half of square D-1 was excavated before the rest of the site to gain an impression of the stratigraphy of the midden which could be used to predict to some degree that in the rest of the area to be studied. Five stratigraphic zones were distinguished:

Layer A: 5–10cm thick.

A dark brown humic sandy turf. No other constituents.

Layer B: "Upper" 10–22.5cm thick.

Concentrated shell in a black sandy matrix. The shell, mostly *pipi* (*Amphidesma australe*), was largely unbroken. Other constituents were bone (mostly fish bone), small lumps of charcoal, and burned fire stones (*hangi* stones), most of which were small, well-broken and angular, except for whole stones actually in position in a *hangi* at the bottom of Upper Layer B in the south-west corner of the square. The midden contained no visible smaller subdivisions or lenses, although during excavation, small concentrations of shell with little matrix were sometimes encountered which suggested small dumps of shell within the relatively homogeneous midden deposit.

"Lower" 3–20cm thick.

Less concentrated shell in a black sandy matrix. The shell in this zone was more broken and less concentrated than the shell in Upper Layer B, although the other constituents were the same. Because of the higher proportion of charcoal black sand to shell, this layer gave the appearance of being a darker black-grey in colour than Upper Layer B.

Features:

The portion of a large *hangi* found in the south-west corner of the square consisted of a large shallow basin approximately 150cm in diameter and 20cm deep which was filled with a compact mass of large, angular cooking stones in a loose, black, sandy matrix. In square D-1 the basin had been cut through the Lower Layer B zone and slightly into the underlying Layer D. The basin with the contained cooking stones was itself filled with the debris of Upper Layer B.

The two other features in the test square which are shown in Figure 5 contained no concentrations of cooking stones. The feature in the north-west corner was a basin 12–13cm deep which was filled with a sandy dark grey matrix and appeared to have been cut from Upper Layer B. The other feature was a depression at the base of Lower Layer B which held patches of concentrated charcoal.

Layer C: 8–20cm thick.

A layer of yellow sand in the east half of the test square could be differentiated from the underlying Layer D by the presence of shell, mostly broken, small lumps of charcoal, pebbles and fragmented stones.

Features:

Removal of Layer C exposed two basin-shaped pits in the south-east and north-east corners of the test square which were 10–12cm deep. These pits lay at the base of Layer C and were filled with the materials which made up that layer. The fill of the pit in the north-east corner had a visible band of charcoal within it (Fig. 4: "ash layer"). Moreover, the surface of the underlying sand, Layer D, between the two pits was red in colour, probably because it had once been heated by a fire. For descriptive purposes, pits of this kind on the site have been called "ash pits" (Fig. 6).

Layer D:

Natural yellow beach sand with water-worn shell fragments, small rounded pebbles, and small weathered fragments of the bedrock of Ponui Island.

Interpretation of the Stratigraphy in the Test Excavation

The stratigraphy in the test square was interpreted in terms of a sequence of events which the subsequent area excavation was able to test and augment. This initial reconstruction can be briefly detailed.

It was felt that Layer C was sufficiently dissimilar to either subdivision in Layer B to suggest that it probably denoted at least a distinct phase in the utilisation of the site, if not a different period of occupation. The two pits seemed to be the most significant aspect of Layer C. While they contained some charcoal and a few fragmented cooking stones, they were quite unlike the *hangi* in Layer B. Yet the presence of charcoal and stones in the fill and a red fire zone did suggest they were small cooking pits of some kind.

Because the fill of the pits was the same as the material of Layer C, it appeared the only activity represented by the layer was that associated with the pits themselves. Certainly this would have been the case if Layer C was a natural accumulation after the use of the pits. An alternative interpretation, of course, was that the pits had been deliberately filled in.

Layer B was more complex than Layer C. Three different phases could be interpreted. First there was the deposition of Lower Layer B. Two explanations for this zone seemed possible. Either it represented the formation of a midden dump which merely contained less shell or it was composed of material raked out of cooking pits. In the latter case, an associated midden dump might be elsewhere on the site.

Second was the construction of the cooking pit in the south-west corner. It definitely appeared to post-date the formation of Lower Layer B, and date before the deposition of at least most of Upper Layer B. Third was the formation of the concentrated shell midden of Upper Layer B which filled and covered the cooking pit. Since Upper Layer B was explained best as a dump of debris created by cooking, it seemed probable cooking pits would be found in or adjacent to this level, unless these had been eroded away by the sea.

General Stratigraphy of the Area Excavation (Fig. 7)

The prediction of the general stratigraphy made on the basis of the evidence from the test excavation was so successful that it is unnecessary to alter the details of each layer already given. The only difficulty in excavation arose during the tracing of Layer C: construction of the cooking pits of Layer B seems to have destroyed much of the underlying layer and it is likely it may not have been originally a continuous deposit.

Layer B: "Upper"

The concentrated shell midden of Upper Layer B extended over the entire area excavated. The thickness was not uniform: ranging from between 10–25cm in squares B-2 to E-2; 15–22.5cm along the east wall of squares B-1 to E-1; 10–15cm along the west wall of squares B-1 to E-1; and grading out at the north end of the site to 8–12.5cm and at the south end to 5–10cm. While the amount of shell in the midden varied with each square, it was markedly lower at the northern limit of the excavation (Fig. 10: midden sample 2). The concentration of charcoal in the matrix decreased toward both ends of the site. Only five cooking pits were found within the layer (Fig. 9a). No significant midden sub-divisions were discriminated, although a possible level within Upper Layer B, denoted by a scatter of ash, fragmented shell and cooking stones, was found around the large *hangi* in square E-1 at a depth of approximately 10cm below the surface of the layer (Fig. 5).

" Lower "

Lower Layer B was less homogeneous than the upper division. It varied between the black-grey matrix described in the test excavation to a grey sandy matrix. The distribution of the layer shows that it did not extend into squares A-1 and A-2, and that at the other end of the site, the layer was a thin greyish zone 8–12cm thick on the south side of square F-1 which graded out entirely in the eastern half of square F-2. No concentrated shell midden was uncovered in association with this layer.

Examination of the stratigraphy supports the interpretation of the deposit as one formed *during* the utilisation of the cooking pits. Figure 8 well illustrates this explanation. There the deposit is linked directly to a *hangi*. Conceivably the dark grey sandy material was formed during the raking out of ash and charcoal after the stones were heated. Such a practice is recorded for the historic Maori (Best, 1924: 417). When the pit was abandoned, shell was dumped back into the cooking pit with the stones still in place. Subsequently, the area was covered with the shell midden of Upper Layer B. The *hangi* shown in the west square on the North 625cm section (Fig. 7) also had a similar spread of black-grey sand to one side of the pit. This characteristic was clearly observed for the *hangi* on the North 1525cm section of square F-2 and the South 575cm section of square B-1.

Layer C:

Layer C proved to consist of two distinct but contiguous deposits. In square E-1, E-2, D-2 and C-2 the layer was the same as in the test excavation, in square D-1. Six " ash pits " were found at the bottom of the layer in square C-2. An additional pit was uncovered in square D-2, but it could not be stratigraphically linked directly to the other pit features. The small " fire basin " in square E-1 also belonged to this level. This feature was a shallow (5cm) basin containing white ash. The sand at the bottom was red.

The contiguous layer was a deposit of charcoal and ash 2.5–8cm thick in the northern half of square C-1, 2.5–5cm thick along the northern wall of square C-2 and the southern quarter of square B-2; and 2.5cm thick in the test area of square B-1 (Fig. 6). Removal of the baulk and midden block between squares C-2 and B-2 showed that this zone was directly connected to the Layer C deposit in square C-2 (Fig. 7). Moreover, in squares B-1, B-2, C-1 and C-2 the charcoal zone was covered by a layer of yellow sand 2.5–15cm thick (Fig. 7) which lensed out toward the middle of squares C-1 and C-2. Thus, in these squares Layer C was stratigraphically separated from Layer B by a layer of sand.

Lying within the charcoal zone were two concentrations of cooking stones which were not in cooking pits (Fig. 6 and 7). In square B-2 where the zone was less extensive, a circular patch of charcoal was found at the same level. The surface of the sand below was red. This latter characteristic was seen clearly also at the bottom of the charcoal zone in square C-1.

Layer D:

Beach sand lay at the base of the excavation over the entire area excavated. A small excavation made in the north-east corner of square A-2 to a depth of 90cm below the surface revealed no lower cultural horizons below the midden area excavated.

Features:

Layer B: Twenty-two *hangi* pits containing cooking stones in varying concentrations were uncovered in the excavation. All but three were well defined basins roughly 15–25cm deep. In the remaining three, the basins were more difficult to distinguish from the surrounding matrix. On the composite plan of the features in Layer B (Fig. 5), concentrations of cooking stones found in the midden have also been indicated. These concentrations were not associated with cooking pits, and seem to have been merely dumps of stone in the midden layer. Most of the stones used were angular lumps of the local greywacke and could have been obtained easily from the nearby outcrops. In addition, there were rounded beach pebbles of a coarser-grained sedimentary rock which may also be of local origin, although they could also be pebbles of sandstone from the Waitemata Group in the Hauraki Gulf. The conclusion important to archaeology is that none of the *hangi* stones was imported to Ponui Island. Today, even the pebbles can be picked up from the beach in limited numbers.

Stratigraphic analysis of the *hangi* pits (Fig. 9) indicates that all but five lay *under* the midden deposit of Upper Layer B. This stratigraphic distribution supports the inference that Lower Layer B was created by the activity of cooking itself and suggests that at any one time the cooking area was distinct from the dumping area. Most of the *hangi* were found directly beneath the midden (Fig. 9b), but a few seem to date somewhat earlier than the rest because they were found either in or below the accumulated debris of Lower Layer B (Fig. 9c). From this evidence it can be concluded that at the beginning of the Layer B occupation, at least most of the area excavated was used as a cooking site. Any midden build-up must have been elsewhere, perhaps to the front of the cooking pits where the site is now eroded. Subsequently, the cooking area must have shifted, and the old *hangi* were covered with midden debris.

GALATEA BAY N-43/33
Layer B

STRATIGRAPHIC POSITION OF FEATURES

Features within layer B (upper)

Features directly below layer B (upper)

Features in or at bottom of layer B (lower)

Layer C: Nine " ash pits " and one " fire basin " were found at the bottom of Layer C. The ash pits were approximately 10–15cm deep and 50–65cm in diameter. Interpretation of their function is uncertain. Because they were associated with a contiguous charcoal area with two distinct concentrations of cooking stones, it is likely the pits may have been a form of *hangi* which Best (1924: 419) has said the historic Maori were known to have sometimes favoured. In this variety of *hangi*, called *umu konao*, the stones were heated in a separate fire, and then placed in a cold pit. The rest of the cooking process was identical with that for the more traditional form. If this interpretation is correct, it would be the first known time this cooking technique has been identified in an archaeological excavation. This interpretation does not explain the red sand zone between the two ash pits in square D-1. Since this red zone was on the surface and not actually in the pits, it may very well have been formed before the construction of the pits and be unrelated to them.

Post holes: 88 post holes were found in the excavation. They were 3–15cm in diameter, with an average of roughly 7cm. The holes seem to have been made by small stakes driven a short way into the sand. It was impossible to trace them in the midden layers. The only time they were distinct was when they appeared in the underlying sand. Examination of the eight post holes which were found on the sections in squares E-1 and E-2 (Fig. 6) shows that four appeared to be cut from Lower Layer B and the other four from the bottom of Upper Layer B. They form no recognisable pattern. The most likely interpretation is that they represent former cooking sheds made of light poles, such as those described by ethnographers (Best, 1924: 419, 1952: 254; Buck, 1962: 120; and Firth, 1959: 93).

Composition of the Midden

A small block was left unexcavated in the north-west corner of each square to facilitate the taking of samples of the shell midden for analysis of the composition. Roughly the upper 10cm of the midden in each block was later removed for study. No sample was taken from the block in square A-1 because of the low concentration of the midden there. Instead, a sample was removed from the baulk between squares A-1 and A-2 (Fig. 5). In addition, two samples were taken from Layer C (Fig. 6).

Analysis of the midden was conducted for a number of reasons:

1. To determine the composition of each layer, the range of variation between the samples, and the difference between the two layers;
2. To interpret the findings in natural and cultural terms;
3. To examine and objectify the analytical methods used; and
4. To evaluate some of the uses of quantitative midden analysis in New Zealand.

A.—Initial Study

Research began with an analysis of the composition and variation of the midden. The methods used were those described by New Zealand authors (Ambrose, 1963; Davidson, 1964a, 1964b, 1964c; and Smart, 1962a). Difficulty was encountered in ascertaining the size of the sample necessary for study. No empirical test was known by which a minimum sample could be determined. Arbitrarily, a sample of 1000gm was taken from eleven of the field samples under controlled conditions to ensure that each was representative of the total sample from which it came. Because of the presence of large stones in sample 9, which Davidson proposed might affect the success of analysis (1964b: 148), 1500gm were removed from that field sample. Further, because of the lower concentration of the samples from Layer C, 2000gm were extracted from each field sample from that layer.

Following in part the procedures already outlined by Davidson (1964b: 148–161), each sample was dried, sifted through ½in, ¼in, ⅛in and $\frac{1}{16}$in sieves, and the resultant fractions isolated separately. Then the composition of the ½in and ¼in fractions was analysed and weighed. No attempt was made to analyse the shell constituents by the number of each species present. The graph of the composition shows that each sample varied in terms of the amount of each constituent present (Fig. 10). The most abundant single constituent was *pipi* shell fish (*Amphidesma australe*) which had an average weight of 32% of the total composition weight. Cockle shell fish (*Chione stutchburyi*) averaged only 4%, while the remaining species of shell fish combined averaged 5%. Stone, bone and charcoal combined amounted to an average of 6%. The remaining weight was taken up by the ⅛in, $\frac{1}{16}$in and less than $\frac{1}{16}$in fractions, with the latter having an average of 31.5%. The data are presented in a table at the end of the paper (Appendix).

During this initial study it was observed that while the midden samples did lose weight upon dehydration, as one would naturally expect, the loss had a mean of only 4% (Fig. 11). Although Davidson (1964b: 147) considered such weight loss to be of significant analytical importance, it had not been demonstrated by empirical study that this loss varied differentially from constituent to constituent. In other words, it would only affect the relative weight of each midden constituent if certain constituents were relatively heavier than others because of their contained moisture. Moreover, it had not been made clear that dehydration was not a steady-state. If drying was a useful procedure, then the samples would have to be maintained at the same degree of dehydration throughout the period of analysis. Otherwise, they would naturally absorb moisture from the air once drying was halted. For example, it was noted that control samples during the drying process gained 5gm during the night when the heating element in the drying rack was turned off. Because of these observations, subsequent research was designed to examine and objectify techniques in midden analysis and began with a study of dehydration.

B.—An Experimental Approach to the Quantitative Analysis of Shell Middens

1. *The Importance of Dehydration*

Four test samples, two from square B-2 (sample 4) of 1000gm and 2000gm and two from square E-2 (sample 10), also of 1000gm and 2000gm, were used to study the effect of dehydration. These samples were sifted and analysed before drying. It was noted that in the process of sifting as much as 1.6% of the total weight was lost. In other words, an error of as much as 1.6% was introduced into the analysis by sifting alone.

The analysed portions of each sample were then dehydrated until they showed no further weight loss, and the total loss in each case was computed. Next, the individual loss of each constituent was calculated as a percentage of the total loss. The results of these four tests were consistent (Fig. 12). Half the weight lost was given up by the less-than $\frac{1}{16}$in fraction. The rest was more or less evenly divided between the other constituents. Therefore, the only significant differential weight due to contained moisture occurred in the less-than $\frac{1}{16}$in fraction. Analysis by fractional combustion of a sample of this fraction from square E-1 (sample 9) showed it was composed of:

Charcoal	7.8%
Organic matter	9.4%
Sand and silt	82.8%
	100.0%

Thus, as one would expect, the greatest amount of moisture was held by the fraction composed of small particles.

To test further the possibility that different kinds of shell fish might hold significantly varying amounts of moisture, two test samples were collected of the most common shell fish in the midden, *pipi* and cockles. Because of the low concentration of cockles, the samples were of limited size; 80gm of each species were taken from a ½in fraction of field sample 13, and 50gm from the ¼in fraction of the same sample. The *pipi* shells lost 0.8% of their weight in drying and the cockle shells lost 1.5%, a difference of only 0.7%.

Conclusion: On the basis of these results, for at least most purposes it is not necessary to dehydrate midden samples before they are analysed to determine their composition.

2. *The Size of the Sample*

To determine the effect sample size has on the results of quantitative midden analysis, eleven test samples were analysed and the results compared (Fig. 13).* The size range of the samples was 500–2000gm. Three of them were ones previously analysed in the initial composition study. Three came from square A-2 where the initial composition analysis showed an unusually low shell concentration.

Comparison of the results shows a relatively high degree of consistency between the results, regardless of the sample size. While she did not detail her evidence, Davidson arrived at a similar conclusion (1964b: 149). Although the number of test samples in the present study was not large, several important points may be drawn:

(a) In analysing a portion of a larger field sample, one is, in effect, "sampling a sample". Thus disagreement between analyses of the same field sample must be expected, and is not, therefore, only a function of the size of the sample. Sampling error must be taken into account. This error can be observed by comparing the results of the two 1000gm samples from square B-2, and also the two from square E-2. Moreover, sampling error seems to be the most logical way of explaining the total disagreement of all four of the less-than $\frac{1}{16}$in sample fractions from square E-2.

(b) While not truly conclusive, the results suggest that 500gm test samples are too small to obtain a reliable estimate of all of the constituents in a midden. On two occasions, constituents were totally absent from these samples which were identified in larger ones (Fig. 13). On the other hand, even the 500gm samples gave a generally consistent estimate of the constituents present in them. Therefore, for many purposes a 500gm sample may, nevertheless, be adequate for ascertaining midden composition.

(c) Comparison of the 1000gm samples in square B-2 and E-2 shows that the overall error due to sampling is less than 2%. In Figure 13 sample disagreement of more than 2% has been identified. Even here no clear picture relative to sample size emerges.

Conclusion: Sampling error and not sample size accounts for most of the discrepancies found in a comparative study of eleven test samples.

3. *The Effect of Sifting*

The use of sieves in midden analysis simplifies research by sorting the constituents in terms of size. It is a convenient procedure. It must be asked, however, what effect this arbitrary sorting has on the results of analysis. Because sifting divides the midden into fractions, then theoretically the mathematics of fractions must be taken into account. That is, if the largest fraction is the one left in the $\frac{1}{2}$in sieve, then analysis of the smaller $\frac{1}{4}$in and $\frac{1}{8}$in fractions should not alter greatly the picture of the composition obtained from the $\frac{1}{2}$in fraction alone.

Study of the midden composition table in the appendix shows that for the midden at Galatea Bay, the largest fraction was that left in the $\frac{1}{2}$in sieve. Comparison of the results for shell fish in the midden obtained from the $\frac{1}{2}$in fraction with the combined results of both the $\frac{1}{2}$in and $\frac{1}{4}$in fractions supports the theoretical prediction made above in terms of the mathematics of fractions (Fig. 14). It can be seen that in both graphs, the general pattern of variation remains more or less the same. The range of variation from sample to sample is only moderately affected. Moreover, the mean percentages also change only slightly with the addition of the $\frac{1}{4}$in fraction. Even for the largest single shell constituent, *pipi* shell fish, this change is only 4%.

Conclusion: Within the range of accuracy indicated, at least when it is the major fraction present in the midden, analysis of only the $\frac{1}{2}$in fraction gives a reasonable estimate of the relative proportions of the constituents which it contains.

* By "late prehistoric sites" all that is implied, as a matter of convenience, are sites not clearly associated with *moa* remains or "Archaic" types of artefacts.

* In designating the squares, the north-west corner of the grid was selected as the datum reference point (DRP on Fig. 3). On all the plans of the excavation, this point has been placed in the upper right-hand corner. On the site map (Fig. 3), however, this point is in the lower left-hand corner. Each section was recorded as located along a line east or south of the datum reference point at a distance measured in centimetres from that point, and at a measured height above an imaginary plane optically projected from the datum zero point (DZP on Fig. 3) located to the south of the site (Fig. 7).

* Note: For convenience, the percentages in Figure 13 were calculated on the basis of the original test sample weight, but the samples were dehydrated to bring them into agreement with the three original 1000gm analyses. Therefore, failure to reach 100% can be explained by weighing error and loss due to sifting and to drying.

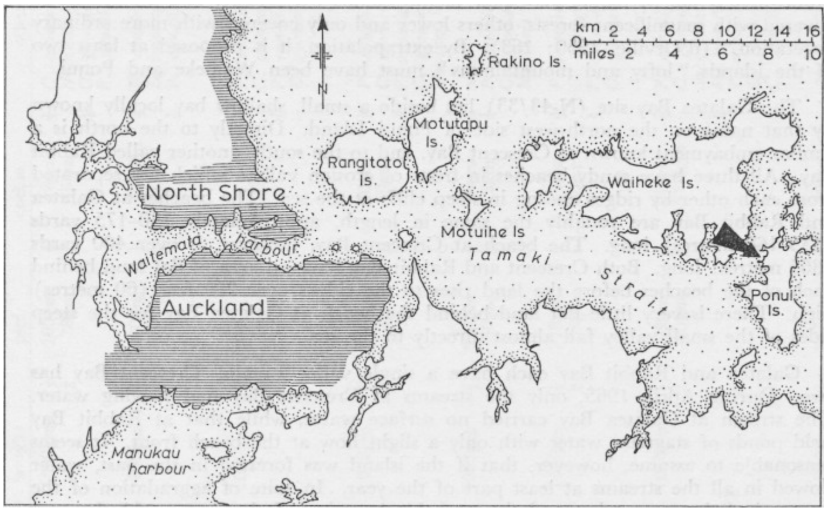


FIG. 2.—The location of Ponui Island in the Hauraki Gulf. Arrow indicates the location of the Galatea Bay site.

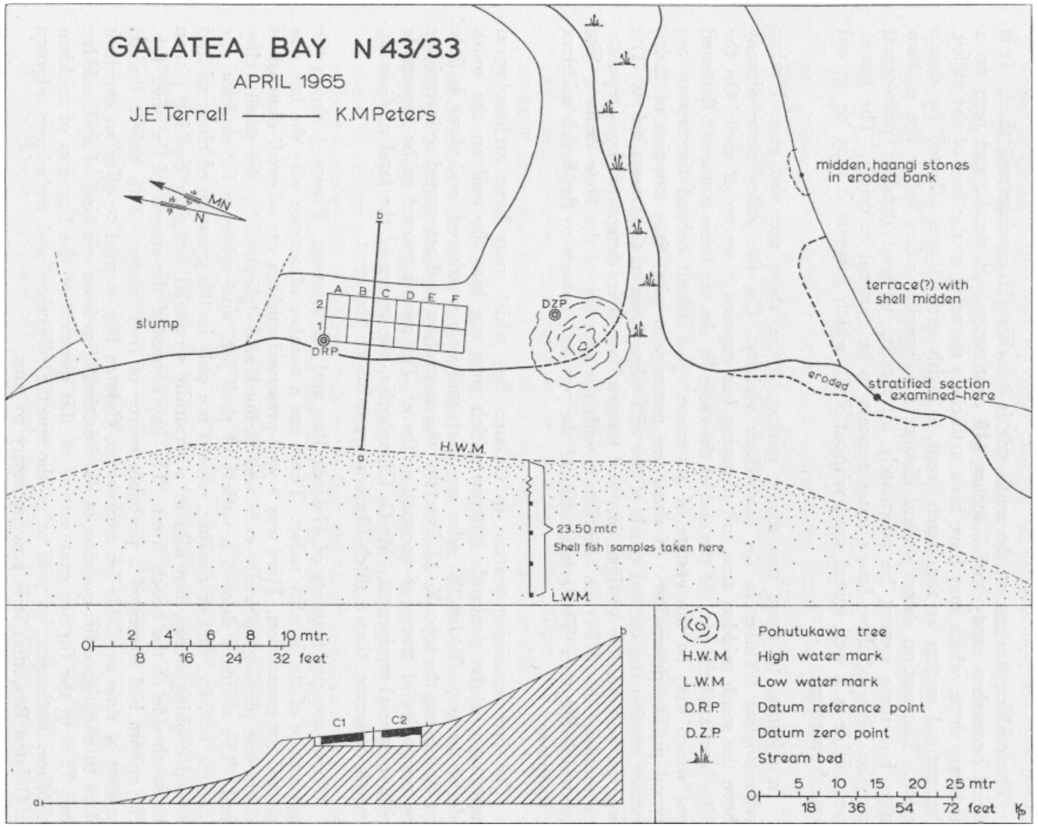

GALATEA BAY N 43/33
APRIL 1965
J.E Terrell —— K.M Peters
MN
N
slump
A B C D E F
2
1
DRP
DZP
midden, haangi stones in eroded bank
terrace(?) with shell midden
eroded
stratified section examined here
H.W.M.
23.50 mtr
Shell fish samples taken here
L.W.M.
0 2 4 6 8 10 mtr.
8 16 24 32 feet
C1
C2
a
b
Pohutukawa tree
H.W.M. High water mark
L.W.M. Low water mark
D.R.P. Datum reference point
D.Z.P. Datum zero point
Stream bed
0 5 10 15 20 25 mtr
18 36 54 72 feet

FIG. 3.—Site plan of the excavation at Galatea Bay

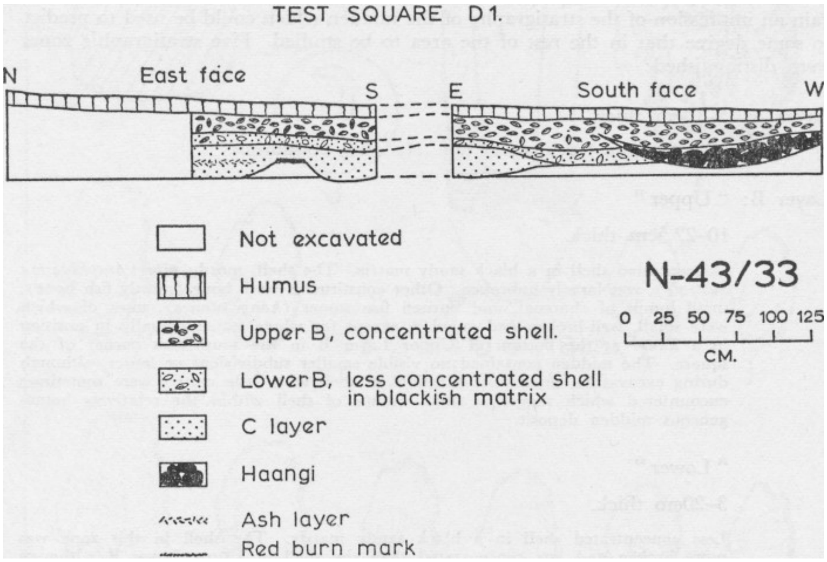


FIG. 4.—Stratigraphy of the test excavation in Square D-1.

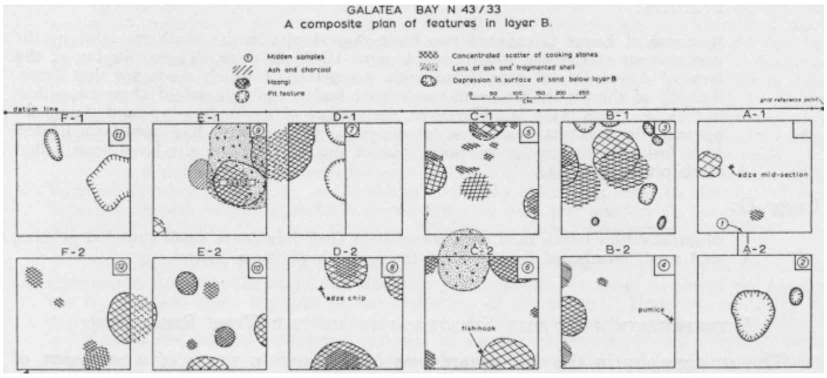


Fig. 5 —A composite plan of features in Layer B

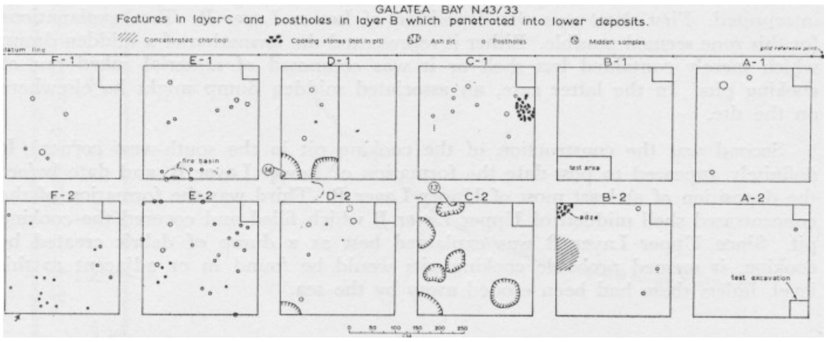


Fig. 6.—Features in Layer C and post-holes in Layer B which penetrated into lower deposits.

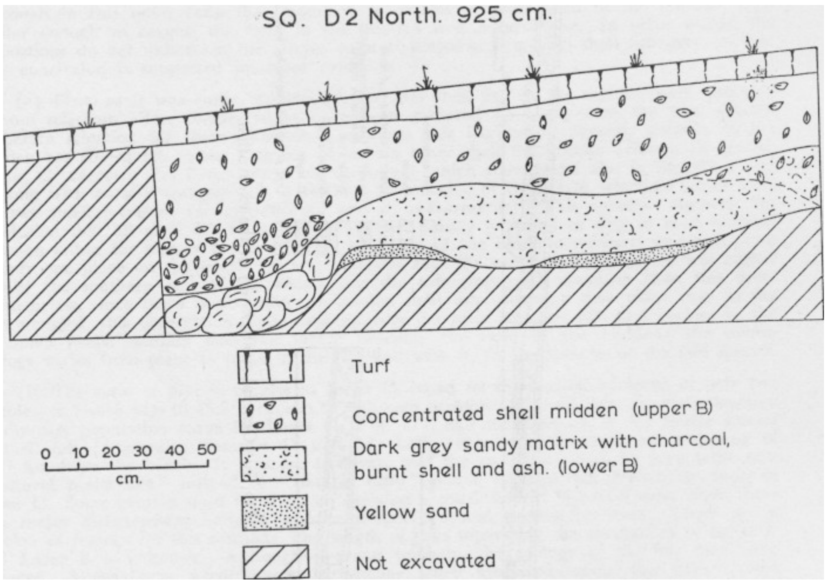
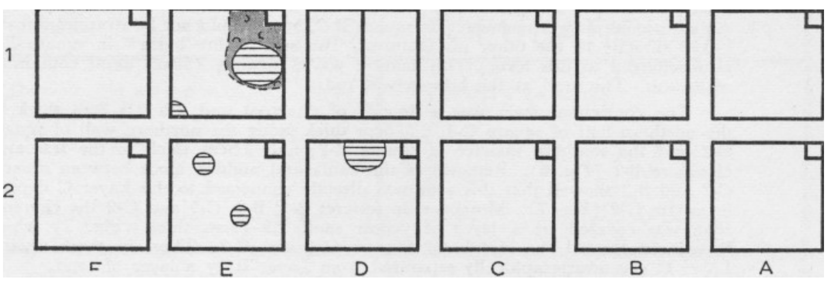
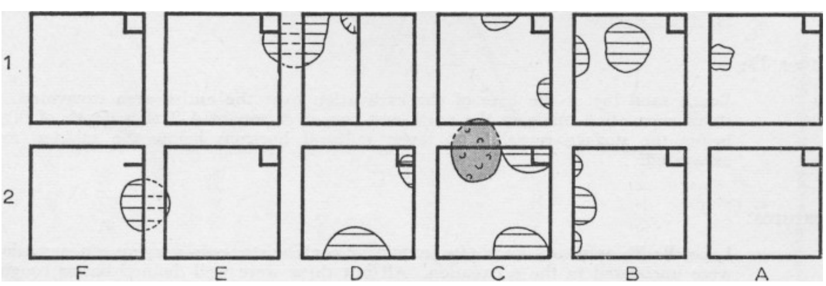


Fig. 8.—Stratigraphic section of the North Wall (925cm) in Square D-2.





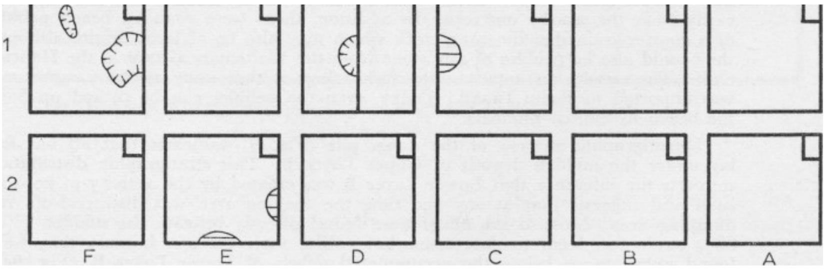


FIG. 9.—Stratigraphic position of features in Layer B. Fig. 9a (*top*): Features within Layer B (Upper). Fig 9b (*middle*): Features directly below Layer B (Upper). Fig. 9c (*bottom*): Features in or at the bottom of Layer B (Lower).

LOSS IN WEIGHT AS A RESULT OF DEHYDRATION OF MIDDEN SAMPLES

NO.	WET	DRY	%
1	1000 g.	945 g.	5.5
2	1000 g.	975 g.	2.5
3	1000 g.	980 g.	2.0
4	1000 g.	935 g.	6.5
5	1000 g.	945 g.	5.5
6	1000 g.	955 g.	4.5
7	1000 g.	960 g.	4.0
8	1000 g.	990 g.	1.0
9	1500 g.	1430 g.	4.7
10	1000 g.	970 g.	3.0
11	1000 g.	955 g.	4.5
12	1000 g.	960 g.	4.0
13	2000 g.	1875 g.	6.3
14	2000 g.	1935 g.	3.3

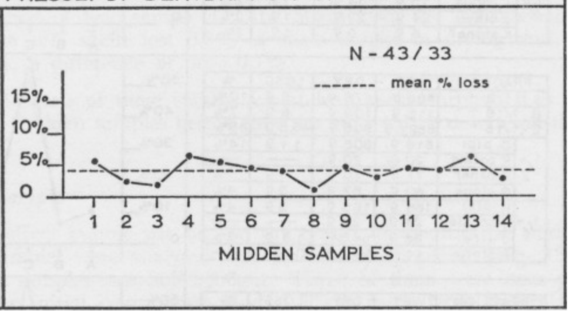
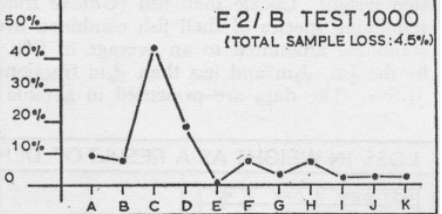


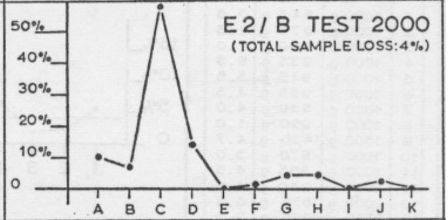
FIG. 11.—Graph of the loss in weight of the fourteen samples analysed in Figure 10 after dehydration in a drying oven.

N-43/33 : % WEIGHT LOSS in drying

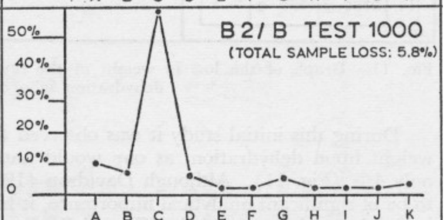
FRACTION		WET	DRY	LOSS	%
A. 1/8"		85 g.	81 g.	4 g.	9%
B. 1/16"		48 g.	45 g.	3 g.	7%
C. <1/16"		245 g.	226 g.	19 g.	43%
1/2"	D. pipi	368 g.	360 g.	8 g	18%
	E. cockle	14 g.	14 g.	—	—
	F. other	73 g.	70 g.	3 g.	7%
	G. stone	27.5 g.	26 g.	1.5 g.	3%
1/4"	H. pipi	74 g.	71 g.	3 g.	7%
	I. cockle	15 g.	14 g.	1 g.	2%
	J. other	24 g.	23 g.	1 g.	2%
	K. stone	6 g.	5 g.	1 g.	2%



FRACTION		WET	DRY	LOSS	%
A. 1/8"		186 g.	178 g.	8 g	10%
B. 1/16"		115 g.	109 g.	6 g	7%
C. <1/16"		652.5 g.	606 g.	46.5 g	58%
1/2"	D. pipi	616 g.	605 g.	11 g	14%
	E. cockle	20 g.	20 g.	—	—
	F. other	71 g.	70 g.	1 g	1%
	G. stone	60 g.	57 g.	3 g	4%
1/4"	H. pipi	168 g.	165 g.	3 g	4%
	I. cockle	23 g.	23 g.	—	—
	J. other	56 g.	54.5 g.	1.5 g	2%
	K. stone	11 g.	10.5 g.	0.5 g	—



FRACTION		WET	DRY	LOSS	%
A. 1/8"		116 g.	110 g.	6 g.	10%
B. 1/16"		68 g.	64 g.	4 g.	7%
C. <1/16"		350 g.	316 g.	34 g.	59%
1/2"	D. pipi	147.5 g.	144 g.	3.5 g.	6%
	E. cockle	20 g.	19 g.	1 g.	2%
	F. other	11 g.	10 g.	1 g.	2%
	G. stone	119 g.	116 g.	3 g.	5%
1/4"	H. pipi	92 g.	91 g.	1 g.	2%
	I. cockle	28 g.	27 g.	1 g.	2%
	J. other	20 g.	19 g.	1 g.	2%
	K. stone	17 g.	15 g.	2 g.	3%



FRACTION		WET	DRY	LOSS	%
A. 1/8"		230 g.	218 g.	12 g.	11%
B. 1/16"		124 g.	114 g.	10 g.	9%
C. <1/16"		601 g.	542 g.	59 g.	53%
1/2"	D. pipi	406 g.	395 g.	11 g.	10%
	E. cockle	32 g.	31 g.	1 g.	1%
	F. other	52 g.	51 g.	1 g.	1%
	G. stone	237 g.	226.5 g.	10.5 g.	9%
1/4"	H. pipi	176 g.	173 g.	3 g.	3%
	I. cockle	55.5 g.	54 g.	1.5 g.	1%
	J. other	38 g.	38 g.	—	—
	K. stone	23 g.	20 g.	3 g.	3%

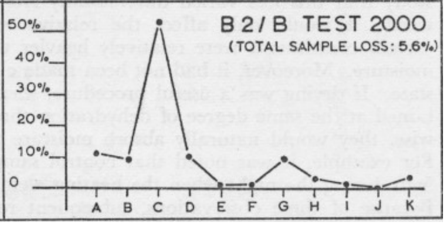
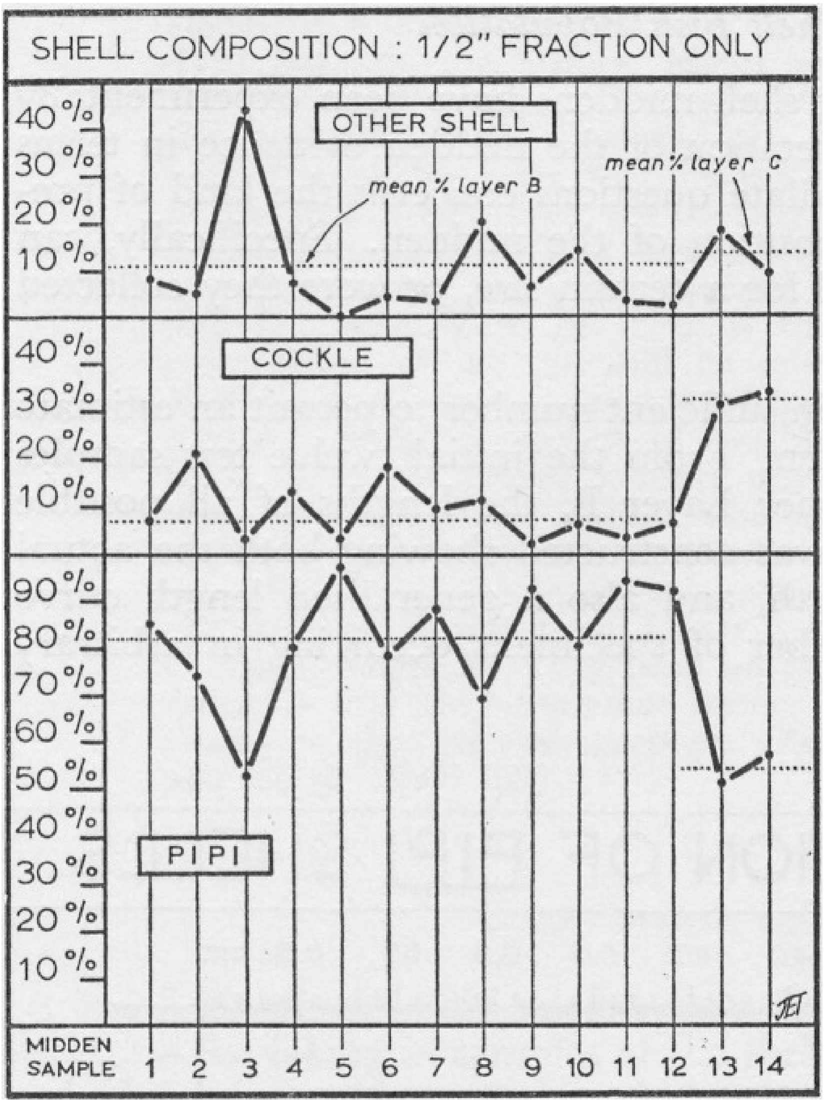


FIG. 12.—Experimental analysis of dehydration.


SHELL COMPOSITION : 1/2" FRACTION ONLY
OTHER SHELL
mean % layer B
mean % layer C
COCKLE
PIPI
40 %
30 %
20 %
10 %
90 %
80 %
70 %
60 %
50 %
MIDDEN SAMPLE
1 2 3 4 5 6 7 8 9 10 11 12 13 14
JET

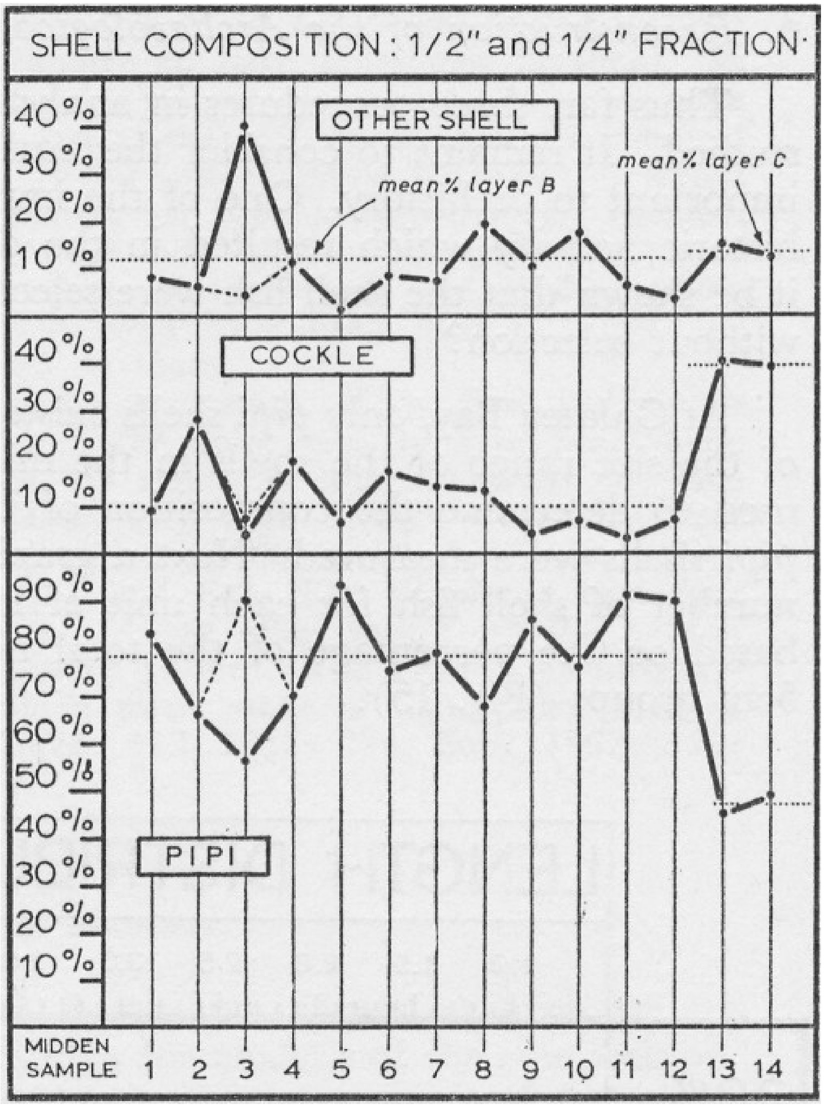


FIG. 14.—Comparative graphs of shell fish proportions based on the analysis of only the ½in fraction (left) and the analysis of both the ½in and ¼in fractions (right). The dashed lines for sample 3 (right) are a possible correction for the atypical abundance of other shell fish in that sample.