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HORTICULTURE IN PREHISTORIC NEW ZEALAND:

An Investigation of the Function of the
Stone Walls of Palliser Bay

Helen M. Leach

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ABSTRACT

Low stone rows and alignments were reported as early as 1904 on the coastal platform of eastern Palliser Bay. In all subsequent references it was assumed that the features were horticultural and, on the grounds of their appearance, of considerable age. Methodical investigation of these claims within the context of a three year archaeological programme (1969-1972) including analysis of prehistoric settlements, economy, and physical anthropology, was regarded as a worthwhile project, since orthodox opinion at the time favoured a later introduction of Polynesian horticulture some centuries after initial settlement of New Zealand about the 9th century AD.

Extensive field surveys showed that at least 93 ha of the coastal platform between Whatarangi and Cape Palliser had been subject to stone clearance according to several simple principles, such as equal access to the best soils, maintenance of a rectilinear system, and the clear separation of individual plots with boundary markers and paths. In addition, excavations conducted within the major complexes revealed artificial deepening of the prehistoric topsoil, frequent incorporation of wood charcoal, rare addition of beach gravel, and inclusion of domestic refuse where the walls were adjacent to coastal villages. Both radio-carbon dates and artefacts found in association with the stone structures indicate early establishment of horticulture on this coast by the 12th century AD with an apparent peak of activity and complexity of garden system before the beginning of the 15th century, followed by decline and virtual abandonment.

Climatic conditions prevailing in Palliser Bay today preclude cultivation of all Polynesian cultigens except the kumara (Ipomoea batatas) and gourd (Lagenaria siceraria). It is now accepted that mean annual temperature at the time of settlement was 1° - 2°C higher. Even so, growing season length and rainfall would probably not have been adequate for crops such as taro or yam.

Within New Zealand, the kumara gardens of Palliser Bay find close parallels on both sides of Cook Strait, and on the eastern coast of the Wairarapa. Similar principles of garden layout applied in the larger Auckland wall complexes, and in 18th century gardens

north of Hawkes Bay. From a survey of tropical Polynesian garden structures it appears that an extensive repertoire of horticultural techniques was introduced by the first settlers to temperate New Zealand and despite the loss of variety in cultigens it persisted until the 18th century as a viable means of subsistence.

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CHAPTER ONE

Although William Colenso travelled the coastline of Eastern Palliser Bay twice yearly between 1845 and 1852 his voluminous journals carry no reference to the extensive dry stone walls which have subsequently attracted much interest. The first squatters and runholders took up their land in 1846 but the surviving station journals examined offer little description of the environment. The walls must have attracted their attention quite soon, but no published reference can be found before Smith's account of the movements of the East Coast tribe Ngati Kahungunu (Smith, 1904a). This tribe was said to have moved south from Poverty Bay in the early 16th century, displacing in their turn the Tini-o-Awa (regarded as the earliest residents or tangata whenua) and the Rangitane. Smith commented:

"It is probable that the numerous remains of stone walls to be found along the eastern shores of Palliser Bay, were the work of Te Tini-o-Awa. They are more extensive than anything of the kind to be found in New Zealand, and were raised apparently as the boundaries of cultivations."

(Smith, 1904a:156)

These comments pose several important questions:

Was Smith personally acquainted with these features?

What led to his conclusion that they functioned as garden boundaries?

On what evidence did he assign them to Te Tini-o-Awa, who, according to most traditions, were the earliest occupants of the East Coast area?

Smith became acquainted with various parts of New Zealand as a Surveyor's Cadet, in 1855, initially working in the New Plymouth area and extending his interests to the Wanganui region, Kaipara, the central North Island, the Chatham Islands and the Kermadecs. His appointment as Surveyor General in 1889 required a shift to Wellington where he continued to live for a few years after his retirement in 1900, before finally returning to New Plymouth. Apart from a newspaper account of his walk through the central districts of the North Island in 1858, Smith's publication record begins with his arrival in Wellington and

active involvement with the New Zealand Institute and the Polynesian Society, which he founded. His knowledge of the Palliser Bay stone walls probably dates from this period. N.M. Taylor (1959:349) noted that he "had personally triangulated large areas of the North Island", but there is no record that this activity took him to the difficult terrain of the southeastern Wairarapa. The information may derive from field surveyors' notebooks or verbal reports made to him as Surveyor General. Alternatively, fellow members of the Polynesian Society may have passed on the details.

Even if he had not seen the Palliser Bay stone walls for himself, he claimed to have observed in Taranaki as early as 1852-3, "innumerable long lines of flat boulders set up on edge close together and running back from the coast away inland" (Smith, 1921: 174; Golson, 1956:50). These were also described in 1910 when Smith published his work on Taranaki history and traditions:

"...on an excursion to Warea about 1853, I noticed a vast number of paengas [sic], or boundaries of individual lands, which crossed the native track, and ran inland from the coast. These were all marked by flat boulders set on edge, and running in straight lines. Though then quite overgrown by high flax, they denoted a former dense population."

(Smith, 1910:113)

He may have based his view of their function on Campbell's observations on Brown's Island in the 1840s:

"We were not a little surprised to discover, en route, signs that the island had once been inhabited. There were long lines of stone walls here and there, and the usual six-foot-high fern was replaced by a short dry-looking grass - a sure sign that the land had been cropped for many and many a year, so as to have completely eradicated the fern."

(Campbell, 1881:244)

Logan Campbell's assumption that cropping had taken place was undoubtedly related to his personal experience of his homeland, Scotland, which he had left in 1838, and where the tradition of dry-stone wall construction was well established (Rainsford-Hannay, 1957). In Scotland the wall served the purposes of a boundary marker, a barrier

against stock, a shelter and windbreak, and often a 'consumption dyke' where stones cleared from nearby stony ground could be piled up.

A knowledge of Marshall's observations inland from the Bay of Islands may also have influenced Smith's judgement of the function of the Palliser Bay walls. Marshall (1836:69) referred to a pathway through a maize field "bounded on both sides by a dwarf wall, made of cinders and lava, collected from a neighbouring plain". From the paucity of records it appears that very few stone walls were being built as an accompaniment to agriculture by the 19th century Maori. However, on a stretch of coast at Fitzroy Bay between Wellington and the Wairarapa, Carter noted the association of cultivated ground and a stone wall just over 1m high . (Carter, 1853:85; c.f. Bagnall and Peterson, 1948:219, 227; Adkin, 1955:453; and Palmer, 1963:131-21).

In the light of this latter evidence it is interesting to speculate why Smith attributed the adjacent Palliser Bay walls to the earliest inhabitants of the area. It is possible that his informants on traditional matters knew of the existence of the walls, and also knew that they were not the work of their own tribe Ngati Kahungunu. However, three other groups were traditionally associated with the area: Te Tini-o-Awa, Rangitane and Ngati-Ira. Smith gives no clue as to why he selected the first. It must be remembered that at this time a tribal designation could be used as a chronological marker, and so the chain of reasoning could have proceeded as follows: the walls are in a collapsed state, much broader than they are high; it is likely, therefore, that a long time has elapsed since they were last used; now the earliest occupants of Palliser Bay were Te Tini-o-Awa; therefore they were responsible for building the walls. Of course this reasoning depends on the assumption that the walls were once free-standing, in the manner of the 'dry stone dykes' of Scotland, an unwarranted assumption which reappears in later publications (e.g. Adkin, 1955; also see below p. 6).

On the whole Smith's assumptions were very much influenced by his own personal and cultural experience of European stone walls,

while his views on the origin of the Palliser Bay examples seem to emerge from a pre-existing framework of prehistory based on recorded oral traditions and his current syntheses of them (e.g. Smith, 1896, 1897, 1900, 1904b). This intellectual climate was unfortunately not favourable for the further investigation of the purpose and origin of the walls, and Smith's views became accepted as fact: the walls were garden boundaries and were built by the earliest occupants of the area. This latter belief received no further attention until G.L. Adkin examined the field features for himself, nearly fifty years after Smith's publication.

In 1925 Elsdon Best published an extensive monograph on "Maori Agriculture" in which appeared every reference to cultivation techniques and plants which was currently available, together with notes from various Maori informants. Naturally reference was made to Smith's (1904a) publication which was preceded by the following comment:

"Similar stone walls, rows, or heaps of stones cleared from former cultivation grounds are seen in other places as at Omakau, in Palliser Bay, and on the Hauraki Peninsula, notably near Port Charles.

A correspondent remarks that, on the eastern side of Palliser Bay signs of former cultivation are seen over a considerable area. Much labour has been expended by former generations in clearing the ground of stones which have been deposited in hollows, while the cultivatable ground has been divided by paths bordered with neat rows of stones"

(Best, 1925:66)

Best's mention of a specific Palliser Bay locality (the Moikau Valley, a few miles east of Lake Onoke) together with details of hollows filled with stones and stone-bordered 'pathways', suggest that the correspondent was well acquainted with the area, an impression which Smith fails to give. It is interesting to note that 'pathways' are associated with stone-filled hollows only at two coastal locations, Pararaki river mouth (south bank) and Waihero river mouth (north bank), sites approximately 14 and 20 km south of the Moikau Valley and accessible at that time only by horseback or on foot. There seems to be a good possibility that Best's correspondent was a local runholder or regular visitor to the area.

It is apparent from Best's monograph that only one instance was known to him of stone boundary lines actually associated with gardening activities (Marshall, 1836), while Nicholas's observations also in the Bay of Islands area, were cited as examples of clearing stones into heaps in the course of preparing garden plots. The numerous other references to walls, heaps, rows, and lines of stones, cited by Best are all concerned with archaeological features of which the function and age were not directly discoverable. Although in two cases stone walls were said to be associated with habitations (Best, 1925:63, 65-6), there is a strong assumption underlying the whole section that almost all these stone structures were associated with abandoned gardens. This is not surprising in view of the subject of the monograph, and the accumulating comments from other workers who were also quite content to assume an agricultural function for the walls.

Adkin's six day visit to the area in 1952 seems to have been inspired by a desire to describe the form of the stone walls of Palliser Bay and to investigate a possible ceremonial site discovered in 1936 in the Makotukutuku Valley, on a promontory 1.9 km from the coast. Between Whatarangi Stream and Black Rocks Point, Adkin found "assemblages of artificial stone walls" in nine localities (Adkin, 1955:459). All were found to be in a "ruined condition", but despite the dense mats of mingimingi (Hymenanthera crassifolium and Muehlenbeckia complexa) growing on them, and the wind-blown sand sometimes obscuring them, Adkin was able to distinguish a variety of wall types. He mentioned "occasional massive constructions of large stones carefully fitted together", long and low ridge walls made up of smaller rock fragments, and lines of spaced stones not intended to be "true walls of continuous structure". He was satisfied that all had been built from "rock fragments obtained from the ground surface adjoining them" and he added the following comment:

"The present ruined state of the walls seems to point to a long period of time having elapsed since they were built and in use, and one's impression on the spot is one of considerable antiquity for them."
(ibid.: 460)

The layout of the walls impressed him greatly, particularly the

rectangular wall junctions and the long straight lines. He found that the longest walls ran parallel to each other at right angles to the beach and were sporadically linked together by shorter transverse walls. Attempts were made to calculate the original height of the walls and two suggestions were put forward as to the range: 5 feet (if originally 2 feet wide) and 4 feet (if originally $2\frac{1}{2}$ feet wide) based on a linear foot of collapsed wall containing 10 cubic feet of stone (ibid.). No reason is given why the walls are assumed to have been constructed with vertical sides, a natural if unjustified error for a European.

A notable feature of Adkin's paper is his initial attempt to qualify his remarks concerning the association of stone walls and ancient gardens. For example, he described "an elaborate system of stone walls and heaps" found 2.3 km inland in the Makotukutuku Valley as a "presumed cultivation ground" (ibid.:471-2, Fig.6). Adkin gave two reasons for this view, good drainage and the soil "being the best obtainable within the valley" (ibid.: 471). In discussing the Pararaki walls and heaps, Adkin states that they "were thrown up merely to clear the ground for cultivation or some other purpose" (ibid.: 475). However, in the conclusions the open-minded approach is abandoned, and Adkin follows Best and Smith in the interpretation of the coastal stone walls as "boundaries and divisions of areas used for the cultivation of crops" (ibid.: 479).

A consideration of Adkin's views on the antiquity of the walls gives some measure of his ability and insight, especially if one takes into account the fact that he had less than a week in which to record them. Unlike Best and Smith, Adkin was only partly dependent on genealogical and traditional methods of establishing chronology. He claimed that Smith had not known that Te Tini-o-Awa were preceded in their occupation of the North Island by the Waitaha, equated by Adkin with the Moa-hunters. Elsewhere stone minnow lure shanks had been found in Waitaha sites, and Adkin had recovered such an artefact at the mouth of the Makotukutuku River. Admittedly this was "but one slight clue" (ibid.: 477), but it reinforced Adkin's existing conviction that the walls were contemporary with the coastal habitation

sites, and that they had been abandoned for many centuries. Such views were based on his actual field observations of the disposition of walls and midden. It is perhaps unfortunate that the term Waitaha became entangled with Adkin's later special pleading for Melanesian influences in New Zealand (Adkin, 1960), for his conclusion that the Moa-hunters of Palliser Bay were gardeners will be shown to be substantially correct. At the time this 1955 paper appeared the orthodox theory was that horticulture was not introduced into New Zealand until Moa-hunters were joined in the 14th century by new arrivals from Polynesia known as the "Fleet Maori" (Duff, 1956:17). Adkin's suggestion amounted to a clear reversal of this theory, but because it was couched in traditional language its archaeological foundation and merit went unnoticed.

After 1955 only occasional references were made to Adkin's work on the stone structures in Palliser Bay (e.g. Golson, 1960:400), and it appears that by the time academic archaeology began to grow in the early 1960s, Adkin's remarkable claims were forgotten or overlooked by most archaeologists. Local interest remained, however, and collectors (who included K.R.Cairns and R.G.Broughton of Masterton and Dr H.Budd of Martinborough) continued to acquire predominantly 'Moa-hunter' artefacts from Palliser Bay, often in association with eroding burials. Dr Budd believed in the great antiquity of certain stone walls in the area, on the grounds of the depth and type of overburden, and this combined with his enthusiasm for the area aroused the interest of B.F.Leach, then a resident of Martinborough. In 1969 B.F.Leach and the writer were able to initiate the first archaeological investigation of prehistoric sites in Palliser Bay, under the aegis of the Anthropology Department of the University of Otago. A three year programme was proposed to study pre-European cultural behaviour in the area from a variety of viewpoints, including subsistence activities at Black Rocks Point, settlement pattern and economy in the Makotukutuku Valley, the proto-historic period in the lower Wairarapa Valley, domestic structures in the Moikau Valley, geological sources used by prehistoric inhabitants, and the physical anthropology of the earliest residents of the Makotukutuku Valley. The possibility of early horticultural evidence, already raised by Adkin and his

predecessors, was also regarded as an important field of research.

The programme was devised as an exercise in "conjunctive archaeology" (W.Taylor, 1948) which, it was felt, was the approach most suited to the overall objective: a description of prehistoric behaviour through time in the southern Wairarapa. The polarisation of objectives which was under way in the United States in the late 1960s had resulted in a division between 'culture historians' and 'process theorists' (Flannery, 1967). Inasmuch as the complex causes and effects of human behaviour were to be studied alongside the tangible results, the Wairarapa programme was to be a blend of both approaches. The essential feature, however, was not the degree to which systems models or normative frameworks would be adhered to, but the belief that the more aspects of prehistoric culture were studied from as wide a variety of viewpoints as available, the better our understanding of ancient behaviour (a view which owes much to Taylor, 1948:93-4).

As a consequence of this approach, the study of the stone walls of Palliser Bay relies on the analysis of shell middens at Black Rocks, the distribution of pits in the Makotukutuku Valley, and the industrial debris of several habitation sites, almost as much as on the description and excavation of the walls themselves. It will be shown that many of the anomalies encountered in the course of excavations became explicable by reference to contemporary behaviour patterns reconstructed from other sites. Indeed if the stone walls had been studied as a discrete project, with all the energies of the team devoted to mapping, excavating, and analysing them, there would be little more information now about the identity of the wall-builders than was in the hands of G.L.Adkin.

The problem selected for analysis, and which is the subject of this dissertation relates to these stone walls, and can be expressed by the familiar interrogatives: when (chronology), where (distribution), how (method of construction), why (purpose), and by whom (cultural affinities). In later chapters the walls will be described in some detail, and the activities represented by the field evidence will be enumerated. A number of possible

explanations of this wall-building behaviour will be assessed, in the light of ethnographic and archaeological evidence from elsewhere in New Zealand and Polynesia. One stands out as a 'best-fit' explanation and this will be explored in depth to allow a reconstruction of the whole behaviour pattern of which wall-building was but a small part.

It has been shown that earlier investigators concluded immediately on seeing them or even learning of them by letter, that the stone walls of Palliser Bay were garden boundaries, which also served as repositories of unwanted stone and occasionally marked pathways. There is every indication that they reached this conclusion on the basis of their own experience of European responses to stony ground, which take the form of heaps, walls, and curbs. Furthermore there is no evidence that they even entertained, let alone rejected the possibility that the coastal walls marked the boundaries of residential plots, or surrounded ceremonial areas. Smith, Best, and Adkin must have been acquainted with ethnographic accounts and archaeological surveys of other parts of Polynesia where stones were used in the construction of marae, paepae, and pigpens as well as for garden and orchard enclosures. Two quotations illustrate this diversity of uses:

"The archaeological remains in Tubuai include maraes, village and home sites, burial places, either isolated or in groups, curbed wells, curbed and paved bathing places, stone walls marking land boundaries, paved roadways and stepping stones across streams and low ground."

(Aitken, 1930:118)

"Remove the maraes and there would be almost no ancient construction of stone in the Society Islands except terraces and house sites on steep or rough ground in the interior of the islands. On the flat coastal plains there would remain a few low boundary walls, an occasional enclosure, and a few house sites outlined by pavements and stones laid on edge."

(Emory, 1933:14)

It appears that these commentators on Palliser Bay gave no thought at all to such comparative material from Polynesia; if they had, the assumption of horticulture might not have been so facile.

Today, students of archaeology are taught that as in other disciplines, such conclusions must be accompanied by a logical argument constituting a proof, or at least a statement of probability, after due regard to alternative explanations. While Smith, Best and Adkin reached the same basic conclusion as will be reached in this dissertation, the blend of intuition, unstated personal experience and common sense which they employed render their findings inspired guesses. This study, therefore, will establish the purpose of the walls within a cultural framework by rigorous and explicit archaeological procedures.

CHAPTER TWO

THE FIELD EVIDENCE

Methods

One of the initial tasks of the project was to locate and describe the various groups of stone walls. The original site survey was intended to provide distributional information concerning all site types from pa to middens, stone walls, terraces and find spots, which would be relevant to all projects within the programme. The lower Wairarapa Valley from Martinborough to Lake Onoke and the tributary valleys of the Whangaehu, Tauanui and Turanganui streams, were covered by a small party using aerial photographs of the NZMS 3 series, on-foot survey, and interviews with land owners. Few signs of stone walls were found except at Kiriwai (at the southwest corner of Lake Onoke) where a few short stone walls, largely obscured by gorse, were observed running down from the foot of the coastal hills to the lake edge. The party then spent two weeks covering the east coast of Palliser Bay and associated valleys from Lake Onoke to the Cape Palliser Lighthouse. It was in this area that stone walls were most frequently observed, concentrated on the coastal strip but also found on terraces and gently sloping consolidated fans in the Moikau (Whangamoana), Makotukutuku and Kawakawa (Otakaha) valleys up to 2 - 3 km inland (see Figure 1). Field descriptions were compiled on a card index, and photographs taken, but the emphasis was on recording sufficient topographical detail to permit rapid relocation of each group of walls or isolated feature. At the end of the survey it was found that the major groups of coastal walls occupied an area in excess of 80 ha, and that they were commonly located in close proximity to habitation sites.

As part of the project, an aerial survey of the coast from Whangamoana to Cape Palliser Lighthouse and the lower reaches of the Makotukutuku, Pararaki, Kawakawa and Mangatoetoe valleys was undertaken. The camera height was 3500 feet and a set of 9 x 9 inch photographs (focal length 6 inches) were supplied suitable for stereo plotting of topographical detail. The scale was approximately 10 chains - 1 inch. It was found that because of the short grass cover and the

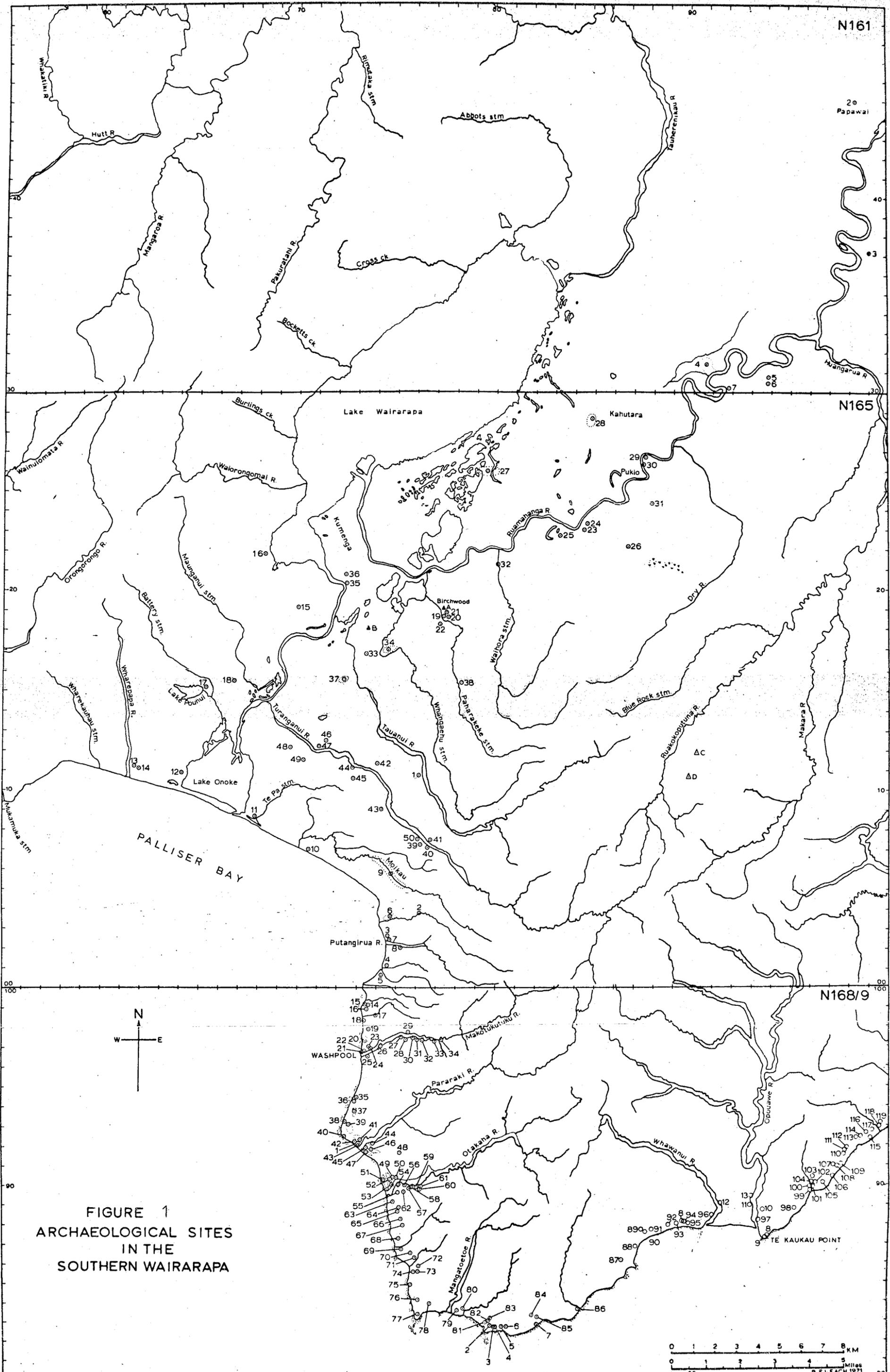


FIGURE 1
 ARCHAEOLOGICAL SITES
 IN THE
 SOUTHERN WAIRARAPA

frequent presence of compact bushes growing on the walls, almost all the larger stone constructions, walls and heaps, stood out extremely clearly. Even low rows now covered by grass were readily identifiable through differential vegetation growth. Since the aerial survey was primarily for topographical map production, long-shadow light conditions were avoided. While these conditions have revealed much additional detail in other surveys of field features, there were limitations to their use here. These were related to the orientation of the majority of Palliser Bay walls which lie between east-west and northeast-southwest. In the early morning during summer most of the walls are in the shadow of the coastal hills, while the setting sun shines parallel to the rows. In winter, areas like the mouth of the Makotukutuku may not receive any sunshine until 11.00 am, while the evening sun sets at a relatively high angle over the Rimutaka Mountains across Palliser Bay. Of the other aids to photo-interpretation, differential growth patterns were the most useful particularly as the grass dried up in December-January.

The clarity of the aerial photographs suggested the possibility of preparing maps of each group of walls from enlargements. The alternative, plane table surveying, possessed two disadvantages: it was time-consuming, and it depended on the recognition of all relevant features from ground level. In some places, as at the south bank of the Pararaki River, it proved possible to walk over a double alignment of stones on several visits before their pattern was recognized in the confusion of surface stones. Mapping directly on to transparent material fastened to the enlargement would overcome this problem to a great extent, although some accuracy would be sacrificed. To test the method 5x enlargements of particular photographs were ordered, and care was taken to choose photographs where the area to be mapped was positioned in the centre of the photograph, in order to avoid the lens distortion so noticeable around the photograph edges. Furthermore, with the exception of the consolidated fan at the northern end of the Black Rocks group of walls, height differences within the areas to be mapped were within 5 - 10 metres. Changes in altitude of the survey aircraft are seldom greater than $\pm 30m$, and so an estimate of error

for the central area of the photograph can be obtained by simple proportion. This proved to be about 3%; in a particular case where the distance between two walls might be 10 m the photo error would be ± 15 cm. This was field-checked by measuring the distance between two telephone poles (47.5 m) and comparing with the distance measured off the photograph - 47.4 m, calculated at the scale of 1" = 2 chains. The error here was far less than 3%. Since the walls themselves may spread over 2 - 3 m as a result of erosion or stock damage, it is often difficult to make an accurate measurement of the true centre of the wall from which the measurement must be taken (whether on the photograph or in the field), and so the error of measurement may be $\pm 50 - 100$ cm. Now this latter error is a problem in plane table surveying as well; so the additional photograph error is not regarded as sufficiently great to outweigh the advantages of using the enlargements.

The decision to use photographic enlargements called for a new field survey technique. The enlargement was pinned on to 15 cm thick board 1.20 m square. A sheet of Permatrace was attached to the photograph with adhesive masking tape; this material was chosen because, unlike many tracing papers, it undergoes very little expansion and consequent buckling and curling when exposed to hot sunshine. Using a compass, magnetic north was determined by sighting between two readily identifiable points on the photograph; in the Palliser Bay situation power and telephone poles are conveniently situated within all the major groups of walls and these show up clearly from their pencil-like shadow. The intersection of fence lines can also be used as reference points. It was also fortunate that high-ground vantage points lie to the east of all the coastal groups. Generally at the beginning of each day's survey the board would be carried up the hillside to a convenient ledge, whence the most prominent features on the photograph would be located and pencilled in on the tracing paper. The matching 9 inch stereo pairs would also be checked using a pocket viewer. This process of familiarization from a distance was essential, for once close ground-level plotting of detail begins, accuracy depends on correct identification of a particular bush, pile of stones, or in situ boulder. Plane tabling can be used at this stage to establish the position of

small features. It was used at the mouth of the Kawakawa River, by working with an alidade directly on to the Permatrace-covered photograph.

In most cases the area covered by a group of walls could be broken up into sub-areas on the basis of topographical features such as ridges or hollows, or European fence lines. In each sub-area features such as single boulder alignments not usually apparent on the photographs are plotted in along a rough traverse and checked by recrossing the area from different directions. Notes are made beside the feature of any special characteristics, while symbols are used to indicate the presence of other site types such as middens or ovens. Symbols are also used to show whether the walls are composed of roughly piled stones, of single stones placed on edge end to end or side to side in a line, or of spaced stones set up on end in a discontinuous line. Ridges and hollows are marked in by reference to the stereo pairs, as are springs, ponds, dunes, alluvial fans, stony patches, and areas where loose sands and gravels indicate disturbance by erosion, or where silt suggests possible burial of walls.

Decisions on what to record were made in the context of the particular Palliser Bay archaeological evidence and landscape; elsewhere symbols may be needed for walls showing carefully laid courses of stones for example, or for areas where soil types change between volcanic ash and sticky weathered clay. Nevertheless such maps should bear information relevant to the following questions:

- (1) What is the extent of the area on which walls occur? Indicate any features which may have led to the burial or destruction of walls, such as alluvial fans, dunes, or European sheepyards.
- (2) What is the nature of each wall? Record under a few easily recognizable categories.
- (3) What is the appearance of the ground near the walls? Record stony ground, damp areas, springs, hollows, ridges, rock outcrops and steep slopes.
- (4) What other signs of prehistoric cultural activity are visible? Record presence of oven stones, midden, artefact find spots, charcoal-enriched soils, terraces etc.

In his 1970 handbook for site recording, Daniels recommended that for both stone walls (which "have more or less perpendicular parallel sides") and stone rows (which he describes as "elongated heaps

of stones") (Daniels, 1970:26-7) the following details should be given*:

height, width, type of construction, alignment, arrangement, area covered, associated stone features, nature of the ground, and possible source of stones.

It can be seen that the same basic checklist was devised for recording the Wairarapa walls, except that after the first period of survey it was decided that no attempt would be made to measure height or width. No perpendicular-sided stone walls were encountered anywhere in eastern Palliser Bay, and unless a staff and level are used it is impossible to measure the height of a low mound of stones with a 2-3 m wide spread. In such cases, too, the measurement of width is most imprecise, especially if the surrounding ground is stony; subsequent excavations showed that the original width may be $\frac{3}{4}$ of the present width or as little as $\frac{1}{4}$.

The Geological Setting of Eastern Palliser Bay

The Wairarapa province lies in a tectonically active zone marked by numerous faults running northnortheast; the most active of these is the Wairarapa fault which runs along the eastern edge of the Rimutaka Range and was involved in two major earthquakes in the 19th century (Ongley, 1943; Vella, 1963). As well as fault movement, rapid anticlinal uplift is taking place on the eastern and western margins of the area. In the Aorangi Mountains which lie behind the eastern shores of Palliser Bay frequent uplift and tilting have been responsible for characteristic steep-sided valleys with little development of the valley floor. The mountains are chiefly composed of Upper Jurassic argillites and sandstones, massive greywacke sandstones and conglomerates, and these have provided, under conditions of erosion, ample material for fan and terrace development in the lower reaches of the valleys and on the coast. Cook Strait currents have also played their part in piling erosion products along the beaches for waves to sculpt into banks of shingle such as the bar which often closes the mouth of Lake Onoke.

Recent studies of coastal features at Cape Turakirae (Wellman, 1969; Stevens, 1969, 1974), White Rock (Wellman, 1971a), Glenburn (Wellman, 1971b) and Oterei (Singh, 1971) indicate that both

*Footnote:

In this dissertation 'stone wall' will be used as a general term covering both 'stone row' used in Daniels' sense, single boulder alignments, and combinations of these two.

the Aorangi Mountains and the Rimutaka Range are still very active. Pleistocene activity is evident in the flight of marine terraces in eastern Palliser Bay. North of the Makotukutuku Valley these are cut in Miocene siltstones and sandstones, while to the south, in the harder Jurassic rocks. Well-weathered Pleistocene gravels cover them in most places (King, 1930). Between Lake Onoke and Te Kopi these terraces terminate in unstable cliffs constantly eroded by the sea, while from Whatarangi a virtually continuous shingle-covered platform runs between the foot of the terrace and the beach. It is widest at Te Humenga Point - about 400 m.

More recent activity is represented by a series of beach ridges found on this coastal plain. In general, four are visible, but seven are clearly marked in certain East Coast locations, e.g. Oterei (Singh, 1971). These ridges can be traced in many areas in eastern Palliser Bay, especially at the mouth of the Pararaki River, on the coast just north of Waiwhero Stream, at Black Rocks Point, and at an area just south of the mouth of the Mangatoetoe River - interestingly enough all areas where stone walls abound. Over large areas alluvial fan and river terrace formation has buried or removed all traces of the beach ridges. Wellman (1971a) has concluded that the ridges at White Rock were formed between uplifts over the last 6,250 years, and his thesis has been largely supported by work at Oterei, Glenburn and Cape Turakirae.

It is almost certain that a similar situation applies in the case of the eastern Palliser Bay ridges: the rate of uplift is about 2m per 1000 years. Although the ridges at Cape Turakirae have been dated (Wellman, 1969) it would be risky to correlate them with those in eastern Palliser Bay, since the two areas lie on different sides of the Wairarapa fault. Nevertheless it is possible that the present seaward beach ridge corresponds to Wellman's ridge B which was uplifted in the 1855 earthquake. At Black Rocks Point Anderson found that this ridge had no soil developed over it and no prehistoric occupation evidence extending on to it, in contrast to the ridges further inland (Anderson, 1973). However he also pointed out that the comparable ridge at Black Rocks to Wellman's ridge C (estimated age 600 years BP) had occupation debris on it dated by C-14 analysis up to 900 years BP (ibid.)

A situation of overall uplift and growth of the coastal plain does not rule out the possibility of local coastal erosion, and the eastern shores of Palliser Bay have a complex history in this respect. In the northeast corner of the bay, cliffs have been retreating rapidly in the last 200 years (for example at Te Kopi, see Mair, 1972: 252-4; King, 1930:506), while artefacts are occasionally washed out of the bank by wave action at the extreme northern end of the Whatarangi coastal flat. Further south, prehistoric sites are now situated well back from the beach, but where they occur close to the mouths of streams and rivers there is much evidence of erosion caused by flooding. The worst instance of this was the removal of several acres of occupation debris (ovens, middens, and burials) on the north bank of the Pararaki River at its mouth in April, 1968 when a severe cyclone of tropical origin passed through Cook Straits. Both scouring floodwaters and high seas seem to have been responsible. A less spectacular form of erosion caused by channel course changes affects riverbank sites only intermittently but nevertheless quite seriously. This process is typical of the wide shingle-choked river beds of Palliser Bay and was aggravated by uncontrolled burn-offs, overstocking, and population build-up of deer, pigs, rabbits; and opossums between the 1880s and 1950.

The recent geological history of the area is relevant to this study in two ways: it enables us to assess the significance of the locations of the walls, and indicates the possible source of the building materials. The majority of stone walls in eastern Palliser Bay are situated on the coastal plain and are most commonly found where the beach ridges are still intact, usually close to a stream or river mouth. Many groups of walls have their apparent boundaries at the foot of alluvial fans and it is tempting to suggest that large areas of walls have been over-run by the products of erosion. In a few cases such burial can be substantiated, but only restricted areas seem to have been involved, and the processes concerned are still active today. In fact there are more examples where walls have been built on consolidated fans. At Black Rocks Point walls occur over an area of 16 ha and are distributed on 4 separate consolidated fans and a much smaller area of coastal plain. On the north bank of the Pararaki River, on the other hand, of the total 9 ha of walls, only about 0.2 ha is occupied by two walls and

two terraces on the edge of a large fan. In this case there is no question of walls running under the fan. Groups of walls in the lower reaches of the river valleys are usually situated on consolidated fans or small terraces, while the customary pattern on the coast appears to reflect a 'preference' for wall building on or between beach ridges.

It is to be expected that the building materials derive ultimately from the Aorangi Mountains, and constitute the harder members of the suite of rocks. However the processes of erosion affect the surface appearance of the stones in different ways. Rocks incorporated in beach ridges were heavily rolled and sorted by wave action before uplift took place, and the shingle matrix in which they occur is also well-sorted and rounded. On the other hand alluvial fans are composed of sediments of various sizes from silt to boulders, with the finer materials concentrated at the toe of the fan. Walls built from fan debris often consist of more angular stones with the corners smoothed off by abrasion. This is particularly true for the Black Rocks fan walls. Further north, however, fans may carry heavily waterworn boulders and gravels deposited on the upper terraces during the Pleistocene; there is also a more angular component produced during the transport of these boulders and its presence may permit differentiation of walls built from beach ridge or alluvial fan products.

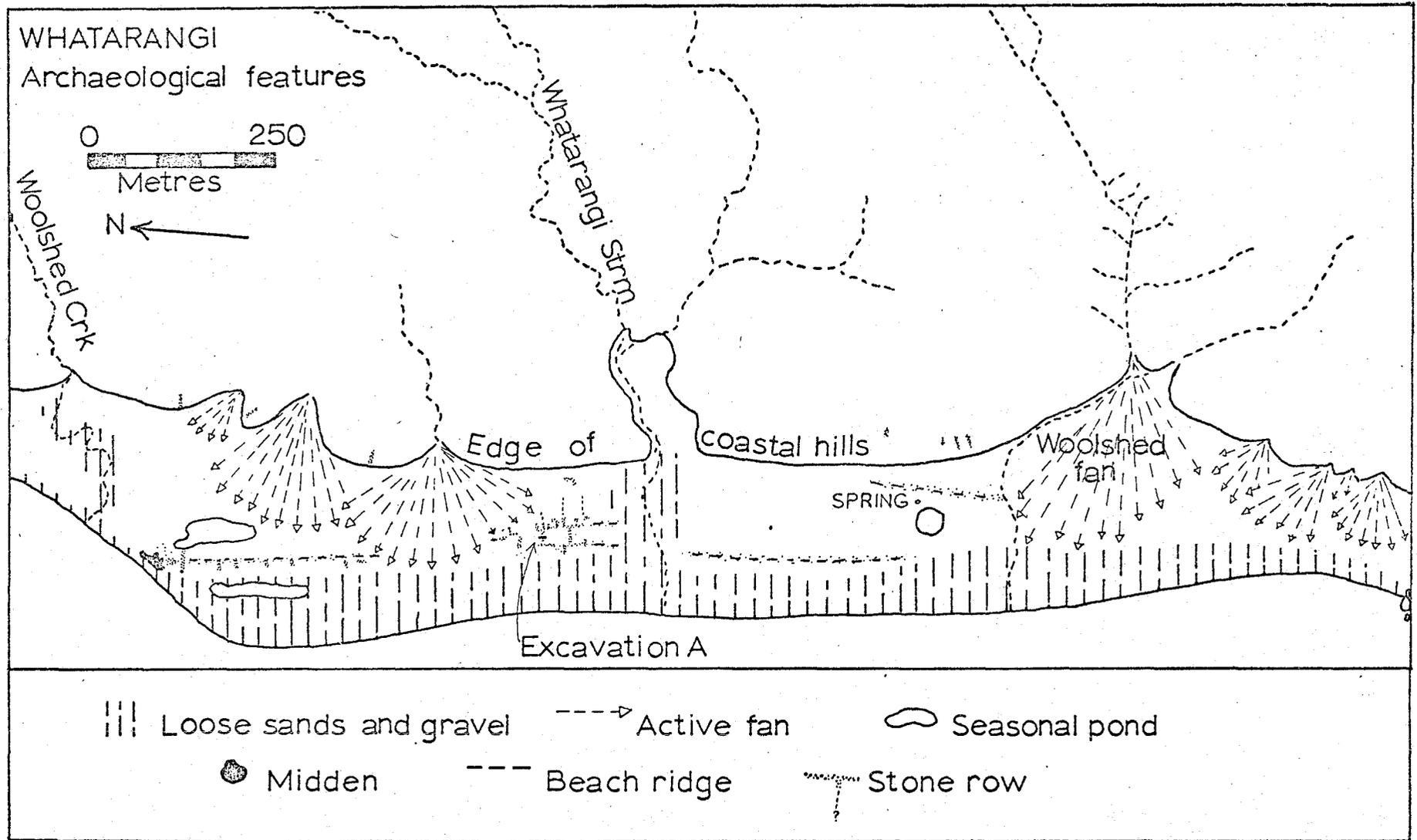
Description of the Walls

Each group of walls on the coastal plain between Whatarangi and Cape Palliser Lighthouse will be described in turn from north to south. The accompanying maps prepared from the field originals are at a scale of 2 chains = 1 inch for the major groups of walls, and 10 chains = 1 inch for the less extensive groups (these scales have been converted to their metric equivalents which appear on the maps). The groups of walls will be discussed under 13 sections. New Zealand Archaeological Association Site Recording Scheme numbers appear in Appendix 1.

1. WHATARANGI (Figure 2)

The "Great Wall of Whatarangi", as it is locally known, lies between the mouth of Woolshed Creek and Whatarangi Stream. Adkin (1955:460) described it as "unusually massive...built of large stones and apparently

FIGURE 2



a solitary structure...trending parallel to the shore". He does not indicate its length, but it was first pointed out to the writer as running for some 600 m beside the coastal road, with its middle section buried under alluvial debris from a recent fan. In fact aerial photographs taken on August 25, 1944 and September 27, 1944 show that the two larger fans were being actively enlarged at that time. Adkin was certainly correct in his term "unusual", for nowhere else in Palliser Bay are there such massive and long walls running parallel to the coast.

Aerial photographs suggest an alternative explanation of this great length, for the feature appears to continue on the southern side of Whatarangi Stream. Here it forms an even broader ridge with fewer stones and some irregular hollows - in fact it is a typical raised beach ridge. The "Great Wall" has been cut in several places by drains and the appearance of the sections supports this diagnosis. The 'natural' matrix (sorted gravel and sand containing waterworn beach boulders) rises about two metres quite steeply on the seaward side and drops more gradually on the other side, forming a broad ridge 3-4 m wide. There is no trace of burning, either in the form of charcoal or cracked boulders (common components of man-made stone walls throughout Palliser Bay), at any depth in the profile.

It is probable that the ridge was mistaken for a wall because it has been the site of prehistoric activity at a number of points, in particular at the northern end. Here, artefacts such as a small polished untanged rectangular-sectioned adze, a one-piece fishhook tab of moa bone, and obsidian and chert flakes, are frequently recovered. The eroding sea-section contains burnt stone, and a pile of stones sectioned along the inner edge of the road contains artefacts and Haliotis, Lunella, and Melagraphia spp. shells and opercula. x

More significant to this study are the short lengths of stone row which run east-west a few metres out from the seaward side of the ridge to be sectioned by the road. These display an entirely different profile where 'natural' is a yellow-brown, sandy gravel on which a darker more sandy A horizon has formed. This horizon has been modified by the incorporation of finely divided charcoal, and where the wall occurs, contains abundant stones and charcoal pieces. Proceeding along the road section towards the recently active fan one encounters a number of x

thickening layers of silt, gritty sand and angular gravel stratified over the beach sand; it is likely that these layers have buried any east-west walls built out from the middle section of the beach ridge.

The southern section of the "Great Wall" is somewhat more complicated: there appear to be two beach ridges present with a hollow between them, which has been partially filled in by silty outwash from the fan. This hollow is traversed by two well-built walls, while the upper ridge has some short lengths of wall running inland from the edge. A corner outlined by stones set on edge is also visible at the northern end of this ridge where it becomes buried by the fan.

The practice of building walls joining at right angles on to raised beach ridges is common at Waiwhero and North Pararaki (see below), but there such walls are considerably longer. At the northern end of the "Great Wall" the presence of boggy land and a seasonal pond on the inland side of the ridge may have deterred wall building altogether, while on the seaward side only a narrow strip of land (now occupied by the road) was available between the ridge and a damp hollow in the dunes. This explanation does not hold for the southern section where the shortness of the walls on the inland side of the ridge does not seem to be related to natural barriers to construction. Again the 1944 photographs throw some light on the matter: they show traces of what may have been two walls running east of the ridge for a distance of 30-40 m. They also reveal that the stream forming the fan had flowed down the southern flank of the fan, cut a shallow channel in the inland ridge and formed ponds in the wall-enclosed portions of the hollow.

There is only a little evidence that walls may have been built on the southern side of Whatarangi Stream, an area which has been modified by flooding, the construction of floodbanks, haysheds, houses, fences and pipelines. The site of the Whatarangi shepherds' quarters (now destroyed by fire) is slightly elevated and may occupy the position of the inner beach ridge. Rubbish pit digging in the vicinity showed a typical beach sand-gravel matrix with dark, charcoal-stained horizons from a few centimetres below the present 'A' horizon to a depth of 1 metre. No European debris occurred at this depth; so it may indicate prehistoric activity on this side of the stream. The outer

beach ridge continues along beside the road for another 300 m but provides no unequivocal evidence of wall building.

Adkin recorded "walls and piled heaps of stones" just north of the Whatarangi woolshed, and commented that the walls ran at right angles to the beach (Adkin, 1955:460). Since the woolshed is built on a relatively active fan and much new material has been brought down by floods just prior to 1944, he must have been referring to the remains of an old beach ridge about 300 m north of the woolshed. On the ridge itself stones are abundant and in places there are low mounds of stone. On a sloping terrace at the foot of the coastal hills a few metres above this beach ridge are three possible stone rows oriented east-west and presumably equivalent to Adkin's "walls". They show up more clearly in the 1944 photographs, but today are partly obscured by gorse and taluvial debris. Excavation would be needed to determine their status.

From an archaeological point of view the Whatarangi coastal strip is disappointing. There are clear signs of occupation and wall building at the northern end, but insufficient area remains of the midden site and adjacent walls to make excavation worth while. On the north bank of Whatarangi Stream, walls are more extensive but large areas are covered in thick layers of compacted silt. Around the farm buildings European activities have destroyed any signs of walls, while stock movement and active fan formation near the southern end of the strip have made the task of distinguishing between natural and cultural stone agglomerations virtually impossible. The eroded edges of a dry stream bed which follows the northern margin of the woolshed fan suggest the extent of former prehistoric evidence in the area (see p.70 and Figure 21). Charcoal-stained friable sandy loam soils occur under as much as 90 cm of fan alluvium for a distance of 160 m between the edge of the hills and the coastal road. The lateral extent of these modified soils cannot be easily assessed but several acres may have been involved, as well as stone walls. One of the attractions of this area may have been a perennial spring flowing out from the base of the beach ridge just north of this stream bed. The only artefact recovered from this southern section was a large, water-rolled, tanged quadrangular-sectioned adze of argillite found on the beach just south of the stream outlet.

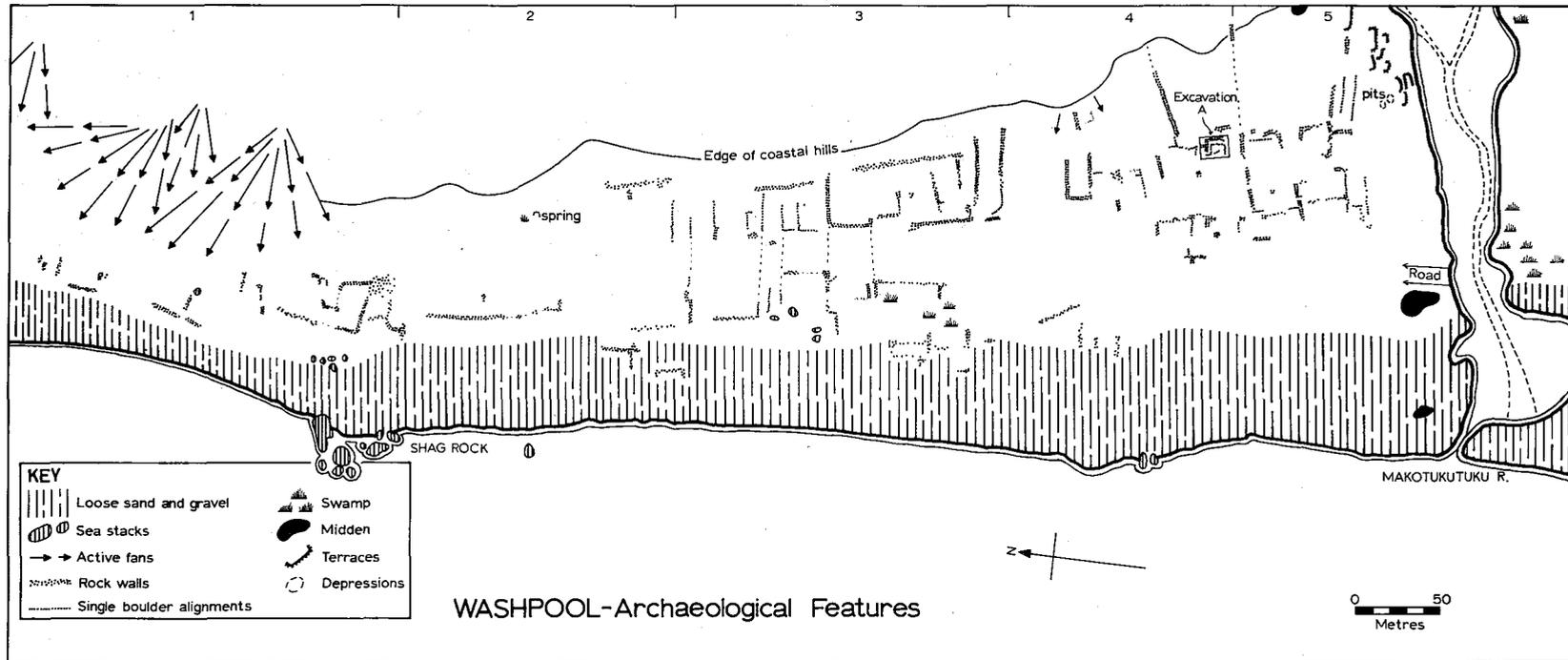
2. WASHPOOL (Figure 3)

The Washpool walls and the adjacent habitation sites, pits and terraces occupy an area of roughly 9.7 ha of the coastal plain from the bank of the Makotukutuku River north to Shag Rock. The name Washpool is locally used for the river mouth area and the farm property of which the holding paddocks, implement shed and house are to be found among the walls close to the river.

Although farming activity has resulted in the destruction of some stone features by bulldozing and the dispersal of stones through stock mustering, the majority of rows and alignments are visible on the ground surface and are in good condition. In recent years grass management has been good and any tendency to deflation which has occurred elsewhere on the coast has been checked, except just behind the fore-dunes. Short lengths of beach ridge stand out at the northern end of the strip but they are difficult to relate to each other; at the southern end they have been totally obscured by dune movements and blowouts. Nevertheless the beach ridges were clearly the source of the heavily rolled stone material in the majority of walls. Fortunately the slope behind the coastal plain is relatively stable and there has never been any major alluvial fan formation to bury features or discourage wall building. A certain amount of taluvial debris has accumulated at the foot of the slope but this has affected only the hillside ends of a few large stone rows. In general, therefore, the area covered by the walls, their state of preservation and visibility, and the proximity of other site types make the Washpool walls a worthwhile field of study.

Proceeding from the northern end, the coastal strip is so narrow at Shag Rock that between the recently active fans and the exposed, rocky beach, only 40 m of consolidated raised beach occurs, and part of this is taken up by the modern road. As a result the stone rows which run at right angles to the beach are short, and some have obviously been further truncated by the road. Two, possibly three beach ridges are identifiable here and in three places have had stone rows built along them, meeting the short walls at right angles. One feature deserves special mention: at the extreme northern end, a low stone row has a carefully laid base-line of boulders some of which have been set

FIGURE 3



WASHPOOL-Archaeological Features

upright. The placing of uprights is particularly rare in Palliser Bay (see descriptions of North Pararaki and Waiwhero).

At Shag Rock itself and for 170 m south the ground is extremely stony and the location is buffeted by both northwest and southerly winds. Apart from one transverse row which runs a few metres back from the edge of a beach ridge and may have joined up with two semi-scattered arrangements of stone in a hollow, there are few signs of wall-building. It is worth recording, however, that just beside a perennial spring which flows out at the base of the hill there is a semi-circular arrangement of beach boulders placed end to end around a damp hollow, believed to have been a former exit of the spring. This may constitute a rare feature in New Zealand but would not be considered unusual in the Marquesas (Bellwood, 1972:38) or Hawaii (Hommon, 1972:55). Such an arrangement is very practical since it prevents erosion of the pool's edges with consequent muddying or blocking of the water supply.

The next section of the Washpool walls runs south from the southern edge of an old consolidated fan for a distance of 200 m. It is divided by a rather substantial stone row into two roughly equal parts, of which the northern is remarkable for the number of stone alignments. In all, there are eleven sections of curbstones running at right angles to the beach, and these may join up across the road to represent eight separate alignments. Some turn corners and run on for a short distance, but the two main transverse walls are not alignments but rows. In two cases here alignments turn into rows; so there can be little doubt of the contemporaneity of the two types of feature. Although this northern area is now bisected by the road, it is clear that it forms some sort of discrete unit 95 m wide with internal divisions into at least seven east-west strips, 76 m long and from 20m wide. The eastern boundary is marked by piles of taluvium which have been heaped up along part of its length to form a high stone row. The western boundary runs along the edge of a steep-fronted beach ridge.

South of the large central wall which appeared to be at least 110 m long in 1944, the other half of the section reverts to the more usual stone rows with only three pieces of curbing, one turning into a row, and a second consisting of a 4 m line lying off the central

row at a 70° angle. At the southern end of the section a row terminates in a line of curbstones which curve round to meet the main transverse wall. Seaward of this wall only a few short lengths of wall can be plotted today. The 1944 aerial photographs suggest that three walls continued across the road, and two of these joined up with the south-east corners of two rectangular features situated in the dunes. Unfortunately these have been damaged by deflation but sufficient stones remain to show that they formed enclosures. Judging from the more intact eastern portion, this section was 105 m wide and divided into 5 or 6 strips. There is some evidence from the 1944 photographs that an additional transverse wall occurred about 18 m seaward of the main wall, but if this was so it has now been totally obliterated by roadside grading.

The next section to the south contains an assortment of stone rows and alignments separated from the river edge group by a long (116 m) partly destroyed wall. On the hillside overlooking this section a spring has caused some slumping and it is possible that some of the lower features such as curbstones may have been covered by a silty outwash. This area does not demonstrate the geometric precision of the sections to the north and it is much harder to join up the lengths of wall separated by a recent farm track. Of particular interest here were some alignments which seem to meander beside portions of stone rows, turn corners and merge with other rows. It was decided, therefore, to excavate within this section to clarify the relationship of rows and curbs (see Chapter 3).

The southernmost section is also the site of three middens, two beside the river near the mouth, the third at the foot of the coastal hills. In addition at least two raised rim circular pits and at least nine terraces occupy sloping ground above the river bank. The walls do not continue on to this terraced ground, possibly because it is far less stony. Single boulder alignments are common in this section and occupy similar positions beside rows as in the adjoining sections, as well as forming long lines at right angles to the beach as in the third section.

Generally speaking, the Washpool walls are well laid out with parallelism maintained within each section or sub-section. They

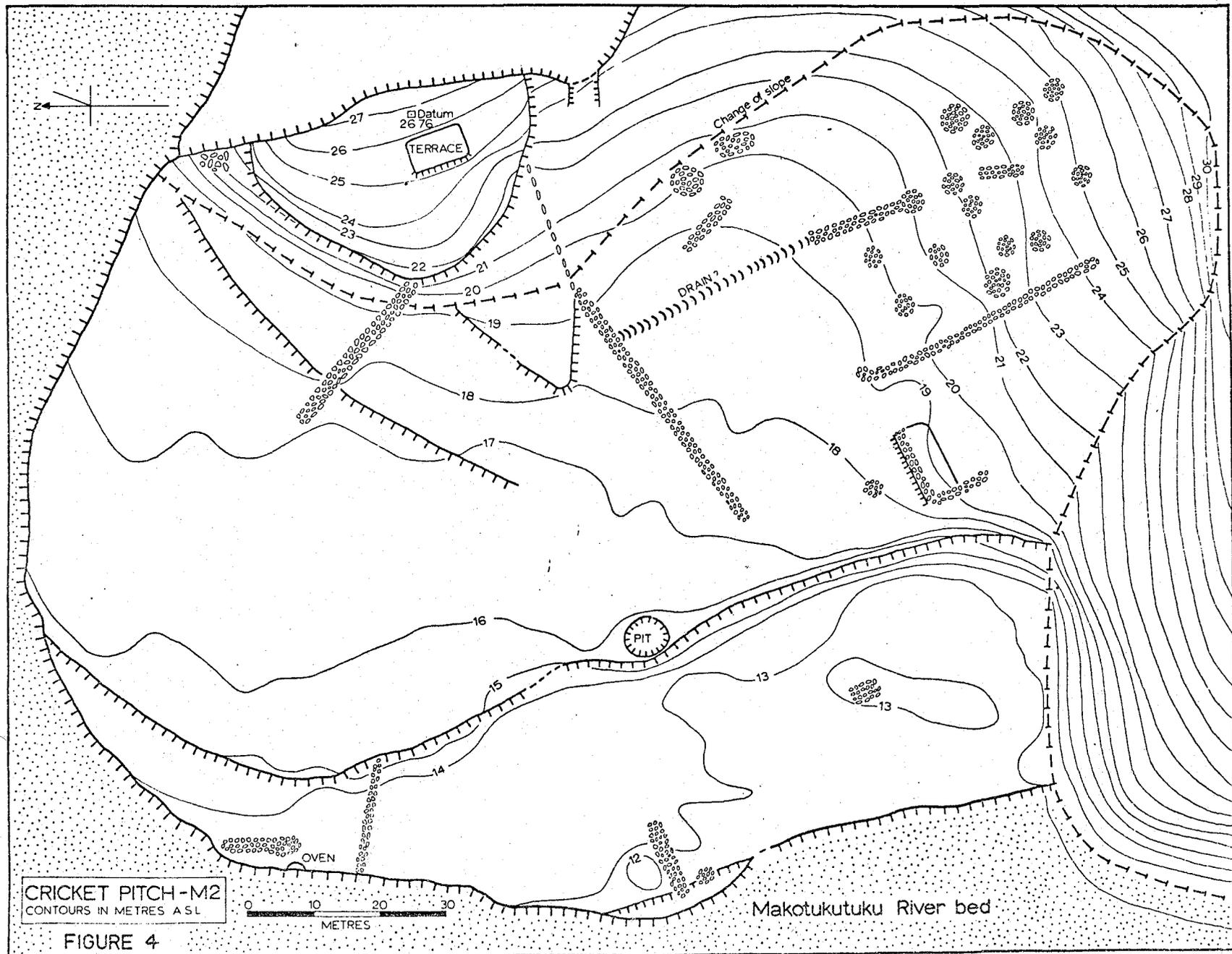
are also noteworthy for the high number of stone alignments, usually consisting of curbstones placed on their sides, in comparison with rows. Of course it should be borne in mind that the Washpool coastal plain is not as stony as the mouth of the Pararaki River, for example, where rows predominate. Nevertheless the construction of curbing to run 1-2 m out from stone rows and parallel to them suggests some additional prehistoric interest in stone alignments at the Washpool not evident elsewhere.

Stone rows occur at two locations within the Makotukutuku Valley, 0.8 km and 2.3 km inland (B.F. Leach, 1976:232, 243-4). The first (M2 - Figure 4) is sited on three river terraces and the walls and mounds cover an area of 1.76 ha. Four rows run down the slopes on the eastern side of the flat river terraces while one long transverse row with a possible single boulder alignment at one end lies at the foot of the slope. Some small sections of wall occur on the lowest river terrace, two of which are close to an oven eroding out of the river bank. Eighteen circular mounds were recorded, and fourteen of these are clustered together on the slope at the southeastern edge of the complex. One of the long walls terminates over 30 m from the transverse wall but appears to be joined to it by a straight ditch-like depression. A small terrace beside the mounds has a low row running along one side and across the front edge. A second terrace overlooking the river flats near the highest point of the area is of similar dimensions and has a depression at the foot of the back scarp, but no associated stone walls.

Further upstream (at M4 - Figure 5) an area of walls, terraces, and circular mounds was first described by Adkin (1955). One long and massive stone wall bisects a consolidated fan surface delimited by a narrow spur to the east and an active fan to the west. The slope is broken by two transverse terraces. Another 5 shorter walls were recorded, parallel to the central wall; the total area of the complex is 0.87 ha.

3. HAMENGA (Figure 6)

Between the Makotukutuku River and Te Humenga Point the raised beaches are buried beneath a series of recently active alluvial fans which



CRICKET PITCH-M2
CONTOURS IN METRES ASL

FIGURE 4

0 10 20 30
METRES

Makotukutuku River bed

FIGURE 5

CROSS SITE-M4
CONTOURS IN METRES A.S.L.

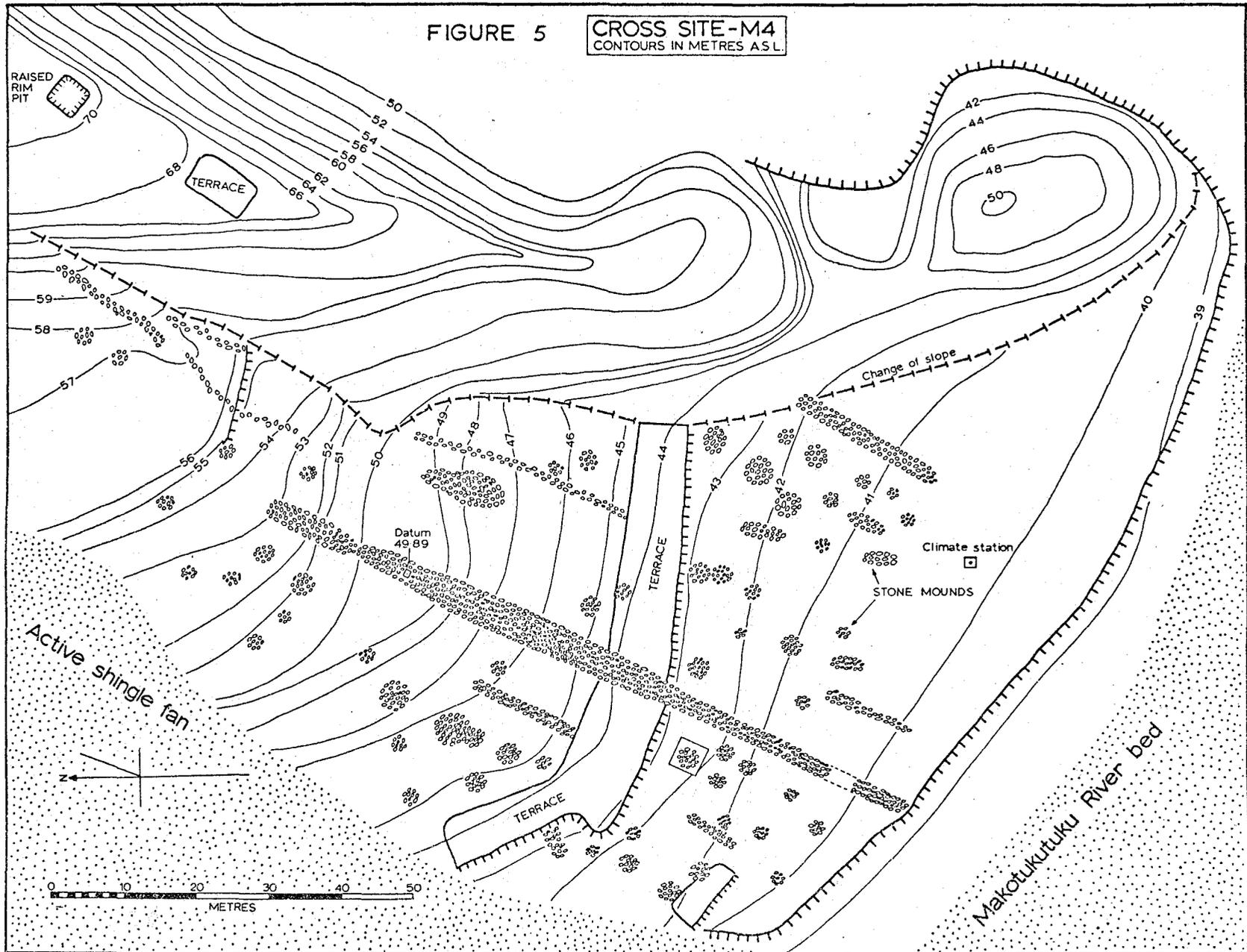
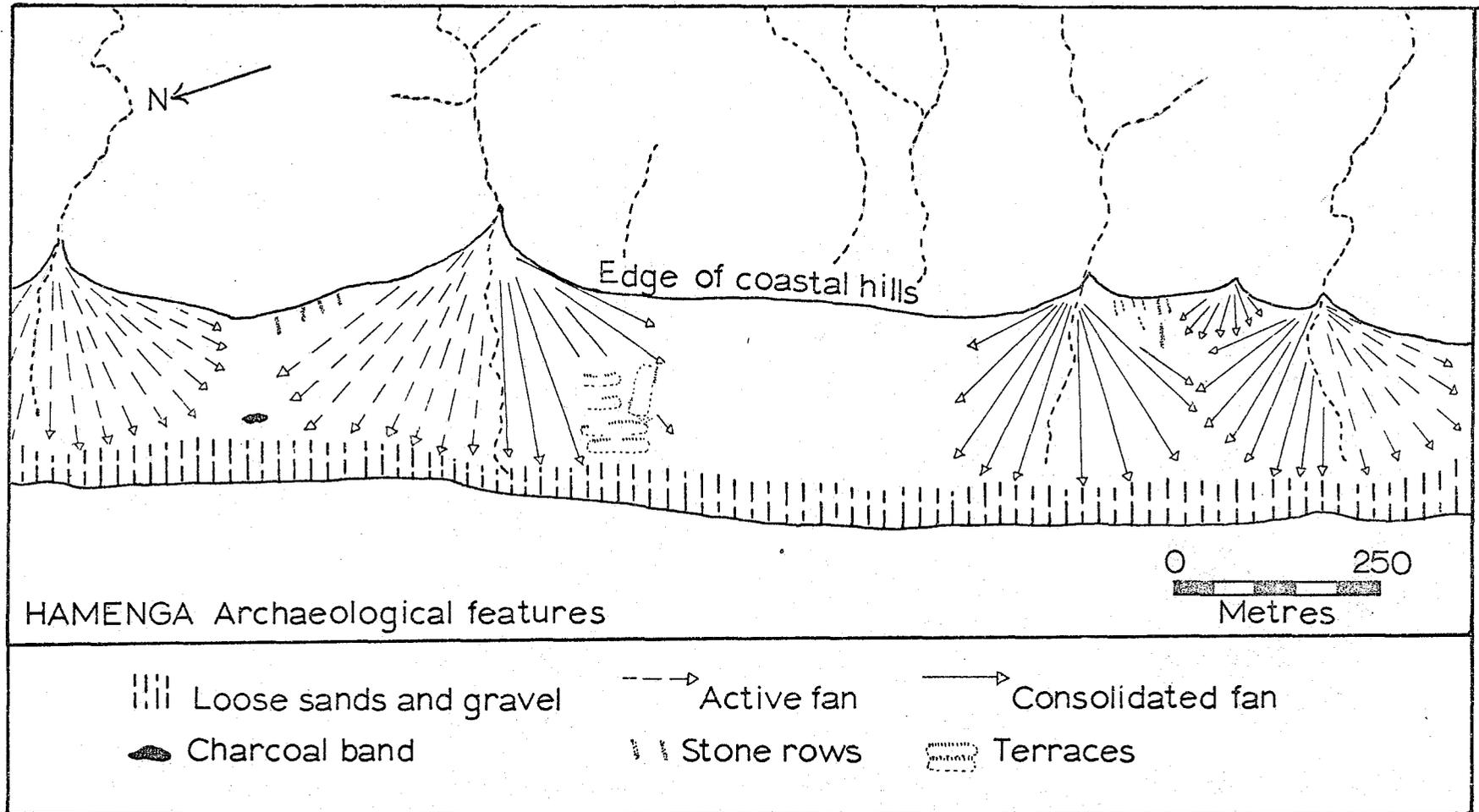


FIGURE 6



have deposited vast quantities of shingle, stones and large boulders. Testpits showed that the northernmost fan emerging from Regan's Gully has buried an extensive layer of charcoal-stained soil on the south bank of the Makotukutuku; it is possible that wall building once took place there also. However this horizon was clearly formed on a consolidated section of the Regan's Gully fan and not on an original beach ridge. Although the other fans are not as massive as this, it seems likely that they too began to form well before man's arrival on this coast.

About 1.5 km south of the Makotukutuku River, fan formation has been less vigorous, and at the site of the Pararaki Trust homestead a triangle of land (about .3 ha) has been left untouched at the base of the hills southeast of the house. On this land aerial photographs show four stone rows running out from the foot of the slope for distances between 20 and 35 m. Each row terminates where consolidated fan debris begins, and they are spaced 25-30m apart. Directly in front of the homestead a roadside section reveals a charcoal-rich layer buried under at least 30 cm of silt and alluvial gravels and containing heat-fractured stones. This may constitute the remains of a small habitation site associated with the walls.

Another fan intervenes between these walls and the next group of possible prehistoric features 300 m further south. The southern half of this fan is relatively stable and well-grassed and towards the base of it are found four tiers of long, low terraces, covering an area about 90 x 70 m with another terrace offset. This terrace is separated from the lowest terrace of the tier by what appears to be a wall made of fan rubble, now used as the base of a track. The five terraces have the following dimensions: 80x15, 50x15, 35x10, 40x18 and 65x22 m, all measurements which put them well beyond the range of known house terraces (B.F. Leach, 1976:228, Appendix 38).

Beach ridges now much modified by stock movement re-occur for a 350 m strip west and southwest of the Hamenga homestead, followed by two semi-active fans. Between these two fans, in the same position against the foot of the hill as the four walls discussed above, a stone row stands out prominently. It is 60 m long and running

parallel to it are traces of 4 - 6 other less massive and shorter rows. The area involved is about 1.5 ha and the group is only 300 m north of the nearest wall in the important Te Humenga complex.

4. TE HUMENGA (Figure 7)

Adkin made the following comments about this complex:

"One of the largest areas occupied by stone walls on a grand scale, an area of at least 12 acres [4.8 ha], is at Te Humenga and surrounding the prominent inland sea-stack rock there.....The main walls trend at right angles to the coast and are usually about 2 chains apart; occasional transverse walls are discernable here and there. The system extends from the foot of the inland cliffs across the coastal road to a line seaward of it, a distance of about 12 chains; in a NW.-SE. direction the walls extend for at least 10 chains."

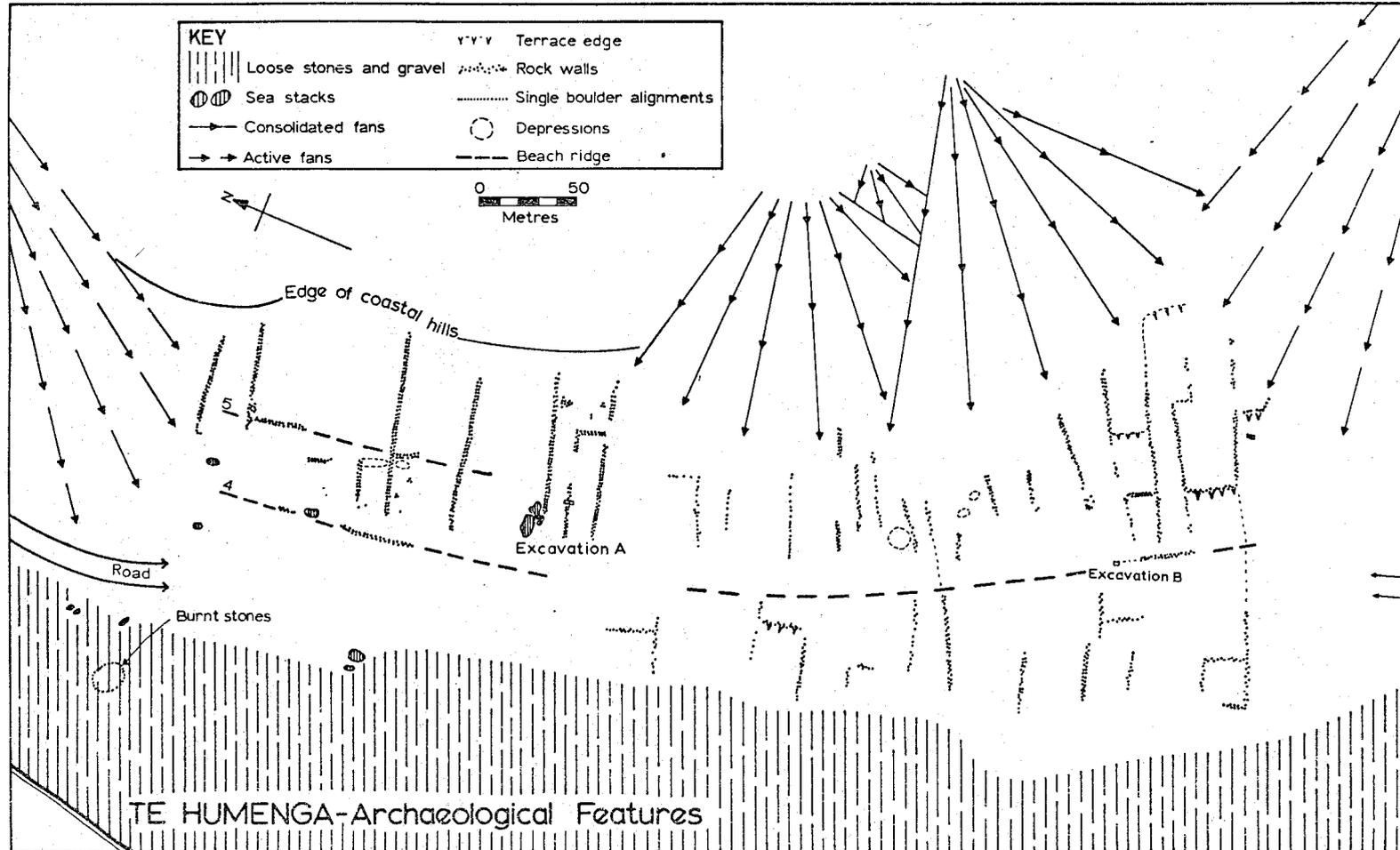
(Adkin, 1955:461, see also his Plate 1, Fig.1)

Actually the Te Humenga walls cover an area of 9.3 ha. Adkin was nearly correct in his estimation of the east-west extent of the walls which is a maximum of 10 chains (200 m), but it is clear that he did not see much of the southern portion of the complex for the total length comes to 27 chains (540 m).

The Te Humenga walls are built on the raised beach platform and at one point, just north of the large sea stack five ridges can be identified. Just inland of the third ridge the walls appear for the first time and, as at other beach ridge areas, the two main lengths of transverse wall north of the stack seem to run along the top of the fourth and fifth ridges. The fourth ridge runs parallel to the foot of the hill and thus curves across the coastal road south of the sea stack. It becomes harder to follow here but it may coincide with a few lengths of transverse wall, eventually recrossing the road and disappearing under the toe of a recently active fan. The fifth ridge can only be followed north of the sea stack, for the silty outwash of two consolidated fans has built up over the southern section, and the walls here are constructed on a compact, silty sand with fewer stones.

The geomorphological differences between the stony beach ridges and the silty, sandy, fan outwash areas allow a convenient division of the Te Humenga walls into two groups, north and south of

FIGURE 7



the sea stack, or more precisely the line is drawn along a large stone row 25 m south of the stack. The northern section covers an area 205 x 110 m and is bounded on the north by a recently active fan, and on the east by extremely stony ground at the foot of the hills. The western edge is less precisely determined, for modern roads, tracks, some loss of vegetation, and buffeting winds have all contributed to disturbance of the ground west of the coastal road. The 1944 aerial photographs do not throw any light on the problem and the present road sections are not deeply cut nor do they possess vertical faces in which to detect buried walls. In fact deflation, not burial, is the process operating here at present, and in the case of a wall this usually results in a suggestive scattering of stones (as at the Washpool). No such signs are visible at Te Humenga. Only a small patch of cracked and burnt stones is to be found in this wasteland, some 125 m due west of the northernmost stone row, and this may represent a former habitation site.

There are seven large stone rows in this northern section and five much shorter lengths of transverse row, only one of which joins up two long rows. Parallelism is maintained overall except for a length of wall 28 m north of the sea stack, which veers off course by some 3 m. All the rows are made from heavily rolled beach ridge boulders obviously taken from the adjacent ground which is clear by comparison with the area to the northeast and northwest.

The area of walls south of the sea stack is bisected by the coastal road and it has proved very difficult to join up lengths of wall across the road while at the same time preserving the parallelism evident elsewhere in Palliser Bay. Now the longest transverse wall which can be plotted runs south-north along the line of the fourth beach ridge until it meets the road, and it may possibly have extended for many metres along the line of the road. In fact, this wall, or the ridge itself may have divided the southern section into two distinct groups - eastern and western. In support of this view one can point to the substantial difference in orientation between the two portions: the eastern walls make an angle of 60 - 63° with the north-south axis, while all but one of the western walls make an angle of 75 - 78°. In contrast the long walls north of the sea stack vary only between 73 and 76°. Two walls may have crossed this boundary, one at the extreme southern edge and another 156 m north of it which stands out as being the only

western wall with a 60° orientation.

Many of the walls of the southern sections utilize fewer stones than the normal row, and some, especially toward the middle of the complex, are single boulder alignments. These are not as carefully constructed as those at the Washpool and some have extra stones offset. However, two (94 m and 128 m south of the sea stack) are definitely spaced alignments, in which the stones are set on edge, or less commonly on end.

Another feature encountered at Te Humenga is the low terrace, which usually marks a change of height in an east-west direction. Commonly a stone row or alignment is placed on top of the terrace edge. At Te Humenga the areas enclosed by the southern walls are higher than the adjoining ground which has been scoured by a watercourse associated with a massive fan. In this case several walls have been built on low terrace edges, marking a north-south change in height. An embankment on the extreme eastern end appears to mark the edge of the levelled area.

The Te Humenga walls are among the best preserved in Palliser Bay and clearly reflect the influence of surface stone distribution on wall building. The usual range of features is represented, including alignments, parallel rows, transverse walls, and low terraces. On the other hand, evidence of cooking, tool manufacture and use, and marine food consumption, which has been found adjacent to every other major group of walls is almost entirely lacking. A small patch of fire-cracked stone northwest of the walls, together with a scatter of midden just above present high-water mark on the point itself, are hardly acceptable indications of a major occupation site. Furthermore if our understanding of beach ridge formation is correct, the midden at the point cannot be more than a century old. The nearest major habitation area is on the north bank of the Pararaki River, also associated with stone walls, and separated from Te Humenga only by a large alluvial fan. In fact the distance apart is only about 400 m. This raises the possibility that the Te Humenga and north Pararaki walls are contemporary features associated with the same habitation sites.

5. NORTH PARARAKI (Figure 8)

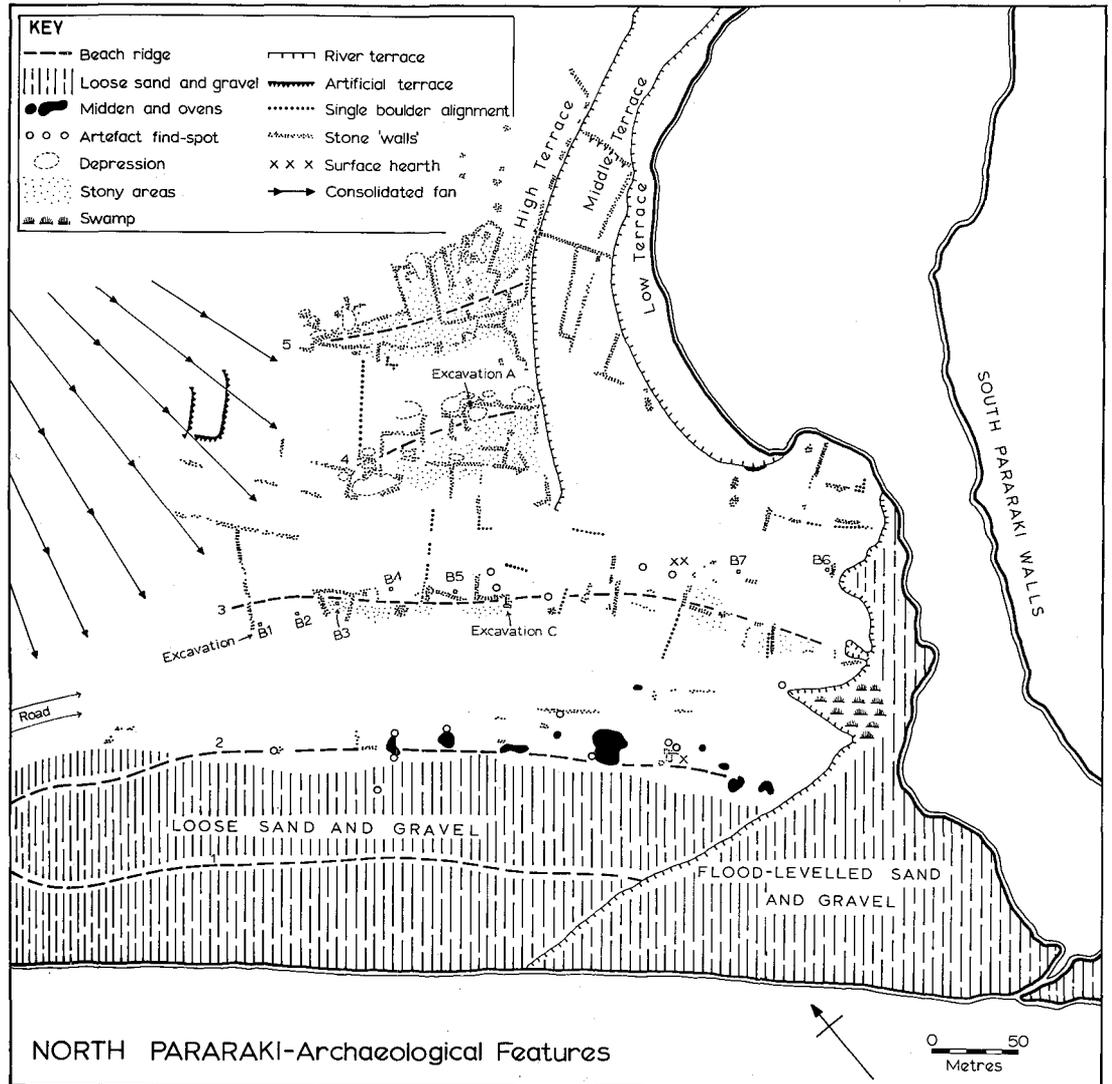
Like the Te Humenga walls, stone constructions on the north bank of the Pararaki River cover an area of about 9.3 ha., and are built largely on raised beach ridges and less commonly in the hollows between them. Five ridges are apparent, and the walls begin between the second and third ridges, on the seaward side of the old coastal road leading to the ford*. Evidence of other activities typical of early prehistoric beach front habitation covers the second ridge and overlaps with stone rows and alignments on the third ridge as well. Many artefacts have been picked up in the vicinity of these two ridges, patches of midden survive where mounds of stone have protected them from wind and sand erosion, and burials were once common in an area where the second ridge met the river bank.

In the last few decades Pararaki evidence has suffered increasing destruction: the wind has undermined stone features, river flooding has buried low-lying features under silt and fine shingle, heavy seas have caused erosion at the river mouth, and recently man has cut away or buried a number of walls in the course of constructing new sections of road on both banks. The most destructive force, however, has been the wind which has deflated the sites of the second ridge to the point where the original sand matrix with the charcoal and midden components has disappeared completely and only oven stones, a few flakes and broken adzes, and weathered fragments of bone remain. By the time the Palliser Bay programme began, the burials had been washed away by the storms of 1968 and such structures as the "L-shaped House" had become simply an arrangement of curbstones embedded in soft, turned-over gravel. Only a photograph of a brief and unreported excavation conducted at this site in 1958 shows the stone-edged hearth in the centre of the enclosure, a partial confirmation that it was a house (qv. Cairns, 1971). No information is available concerning a circular stone structure 2 m west of the 'house'. The hollow between the second and third ridges has been disturbed by wind and the construction of the old road, but there are traces of six walls, five running parallel to the ridge and one at right angles. Only two of the lengths appear to be portions of the same wall. All are scattered rows, and the longest shows possible

*Footnote:

With the construction of a bridge a new section of road was made which crosses the third ridge at an angle and runs behind it towards the river.

FIGURE 8



NORTH PARARAKI-Archaeological Features

signs of burning with reddened and cracked stones.

Walls on the third ridge were both more numerous and better preserved. There are eight short stone rows which run roughly at right angles to the ridge, but do not maintain overall parallelism, and a further five rows which follow the crest of the ridge. The ridge is cut by four stone alignments, with carefully laid beach boulders set on edge: one line runs northeast from a stone pile, a second runs southwest out of a stone row, while the other two alignments run parallel to stone rows, 1 - 2 metres from them. Together they reinforce the association of row and alignment in the Palliser Bay pattern of wall building. In addition to the recognizable walls this ridge contains at least two stone piles and some concentrations of stones which may be scattered rows, alignments or natural formations. Of course there is no reason why some walls are not unfinished examples; bearing this in mind, it is understandable why the boundary between natural and cultural features cannot be precisely drawn.

Although the walls which cut this ridge are not parallel overall, this cannot be attributed to careless layout - in fact they adhere to one of three orientations: $22-30^{\circ}\text{E}$, $43-50^{\circ}\text{E}$, and $55-59^{\circ}\text{E}$. Proceeding from the northeast end of this ridge, the first two walls are nearly parallel and lie at an angle of $22-30^{\circ}\text{E}$. Aerial photographs suggest that another two walls, running up on to the southwest corner of the fan, may have shared this orientation. Unfortunately no definite trace of these walls was apparent when field checking was carried out, and as fans are notorious for the formation of natural 'walls', they were not marked in. The next group of four rows is oriented about 46°E and may join up across the next hollow with the walls of the fourth ridge. South of this are three walls oriented $55-59^{\circ}\text{E}$ which may have joined up with the rows at the back of the second ridge. Finally, one row and two alignments close to the river edge follow a 43°E orientation and may be related to other river bank walls a little inland. This same orientation applies in the case of a stone row lying within the adjacent $55-59^{\circ}\text{E}$ group, thereby raising the possibility of two overlapping and hence chronologically distinct groups. Whatever the case may be, the evidence on the third ridge points to three or four different attempts at wall building: one of uncertain extent at the northern end, one joining the third and fourth ridges, another

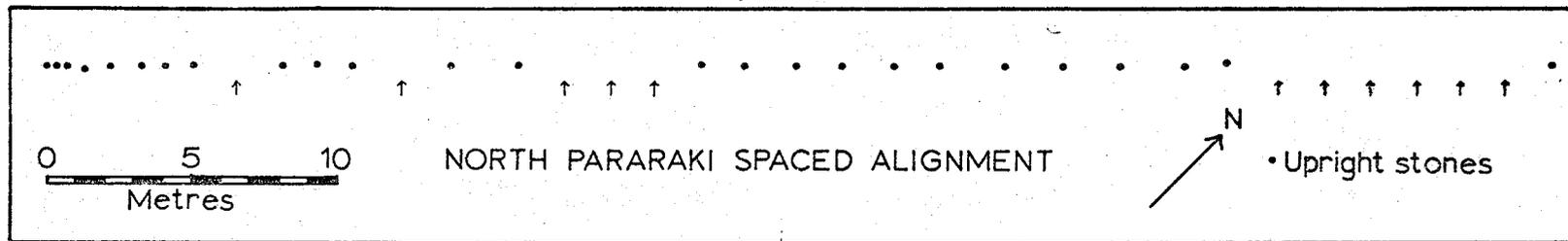
running across the ridge between the adjacent hollows, and the fourth possibly making up part of a river bank complex.

The fourth beach ridge is very much shorter than the seaward ridges, for at its eastern end the river has cut two broad flat terraces, of which the upper has numerous archaeological features partly buried under thin silt layers. The fourth ridge overlooks this terrace and in contrast is exceedingly stony and pockmarked by deep dry stony hollows of natural origin (see p.48). The walls on this ridge contain abundant stone and are oriented approximately $43-48^{\circ}\text{E}$, except for an L-shaped row at the southwest corner which is aligned to the edge of the river terrace scarp (12°E). At the western end of this ridge beach boulders become less common and the ridge merges with the silty outwash area at the foot of the large semi-consolidated fan. Three walls run up on to the fan, oriented at a somewhat different angle (144°E) from the walls on the ridge itself ($131-133^{\circ}\text{E}$). The longest wall on the fan runs for some 84 m. About 18 m northeast of its upper end is a terrace about 18 m wide and nearly 40 m long, cut into the lower slopes of the fan.

Just as the walls on the third ridge were joined to the fourth ridge by a single boulder alignment (partly spaced), the fourth and fifth ridges are linked by a line of stones crossing the flat, relatively stone-free ground between them. This feature is a very fine example of a spaced alignment utilising upright stones (Figure 9). At the southwest end are a group of 5 stones placed close together with one offset, followed by three stones about 1 m apart. From there for a distance of 50 m, the stones are positioned about 1.58 m apart, projecting 15-20 cm above the present ground level. There are three gaps in the line, and it may be argued that these were once occupied since the distances in question are approximately multiples of the average distance between the boulders.

Like the fourth ridge, the fifth, and innermost beach ridge is extremely stony, pitted (especially toward the inland edge) and cut by the river. The walls on it are aligned in three ways: on the seaward edge are some short sections of stone row oriented the same way as the inner walls of the fourth ridge (44°E) - this suggests that the two lines of walls mark the northeastern and southwestern edge of a number

FIGURE 9



of enclosures centred on the intervening flat ground. The second group of walls lie at an angle of 22-30° and seems to be oriented toward the edge of the foothills. The intervening ground surface has been partly cleared of stones and six stone piles may relate to this activity. Perennial springs flow out in two places on the slope above. The third group of walls lies along the eastern edge of the ridge and is oriented at 59°E, parallel with the river terrace edge.

It is difficult to assess how much evidence has been buried by silt, and how much lost by bank erosion on the river terrace east of the beach ridges. Two groups of walls are visible today separated by a flat area 100 x 40 m on which no trace of prehistoric activity can be found. In view of the density of evidence it is tempting to suggest that it was once divided up with low walls, possibly alignments, now buried by heavier deposition of silt than is found at either end of the river curve. Certainly there is a change of height along the terrace in an east-west direction, for the most easterly stone row actually marks the edge of a low scarp. The adjacent walls were the only ones at the Pararaki Mouth which Adkin had time to map (Adkin, 1955:461 & Fig. 9) and of the eight stone rows visible in 1971, he plotted six. The overall arrangement of walls in this figure is recognizable but the measurements given are inaccurate. Inspection of the 1944 aerial photographs suggests that an area of walls greater than that marked by Adkin's dotted lines has been lost by river bank erosion - about 1380 m² as opposed to the 300 m². Clearly some of this was lost after 1944. Although Adkin believed that "...a few more heavy floods... will obliterate all trace of this interesting site of former occupation" (ibid.:475), the river has in fact swung away from this area since he made this comment.

A few metres south of this group of walls Adkin plotted a "heap, 10 yd in length, of broken oven stones with lenses of shells of marine molluscs", some "heaps of stones covering up discarded midden refuse", and further around the curve of the river bank a "large lens of discarded charcoal from [an] old cooking site" (ibid.:Fig. 9). The large heap is in fact about 10 m long, but it is questionable whether it is composed of "discarded fire-shattered oven stones" (ibid.:475). The stones are rather more angular than in the walls or the beach ridges,

and some may have been cracked by heat, but this is hardly sufficient for them to deserve the title "oven stones". It is likely that the heap was built of river-deposited stones, consistent with the riverine origin of the surrounding sediments. Although no lenses of shell were seen in this heap during the 1971 survey, there can be little doubt that they were observed by Adkin. The recent surface survey, excavation, and road construction have revealed the presence of shell midden amongst stones in three stone rows on the third beach ridge; so the association is not a rare phenomenon. There, as in the lenses reported by Adkin, Melagraphia sp. and Haliotis sp. shells were common. Although the smaller heaps covering midden could not be relocated, the charcoal lens was still apparent in the river bank section. It is not accompanied by fire-cracked stones, and so again its origin in "cooking fires" (ibid.) cannot be assumed.

More stone heaps occur at the southern end of the river terrace and they are associated with six short lengths of stone row, and five alignments (stones placed on edge, end to end). In two cases the alignments run parallel to the rows at a distance of 1 - 2 m, and three of the lines are contiguous with rows. The same practices have already been pointed out for the southern walls of the third ridge and it seems highly likely that at some stage the two groups were joined.

The North Pararaki evidence consisting of various types of walls, of cooking debris, houses (three stone-edged hearths known), burials and artefacts, suggests considerable human interest in the area in the prehistoric period. In comparison with the other areas, only the Washpool and the Kawakawa Mouth complexes come close to matching the range of activities, while falling behind in the extent. The difference in scale is even more apparent if the Te Humenga and South Pararaki evidence is added, for in wall acreage alone the three groups total 30.3 ha as opposed to the 9.7 ha at the Washpool and 8.9 ha at North Kawakawa. To the archaeologist, however, the state of the evidence at North Pararaki is a tragedy and one has the impression today that if the survey had taken place only 50 years ago the true nature of enigmatic sections of wall, and of the relationship between various site types would have been apparent.

Even though erosion has affected the intelligibility of the evidence and apparently removed any hope of an intact and undisturbed habitation site, certain conclusions can still be drawn in relation to the walls. Firstly, they follow very diverse orientations unlike the simple hill-to-beach long wall systems so common elsewhere. Secondly, there is a higher incidence of enclosures at North Pararaki, possibly a result of the complexity of orientation. The simple system, on the other hand, often utilises natural features like ridges or hill edges to close off the narrow strips, and thus enclosures in the strict sense are not formed. Thirdly the pattern of orientation of the walls and enclosures demonstrates that the focus of the activity, that is to say the area enclosed, was far more often the hollows between the ridges than the ridges themselves. Lastly the variety of orientations together with the various discrete clusters of occupation debris may indicate a chronologically complex history of occupation and wall building.

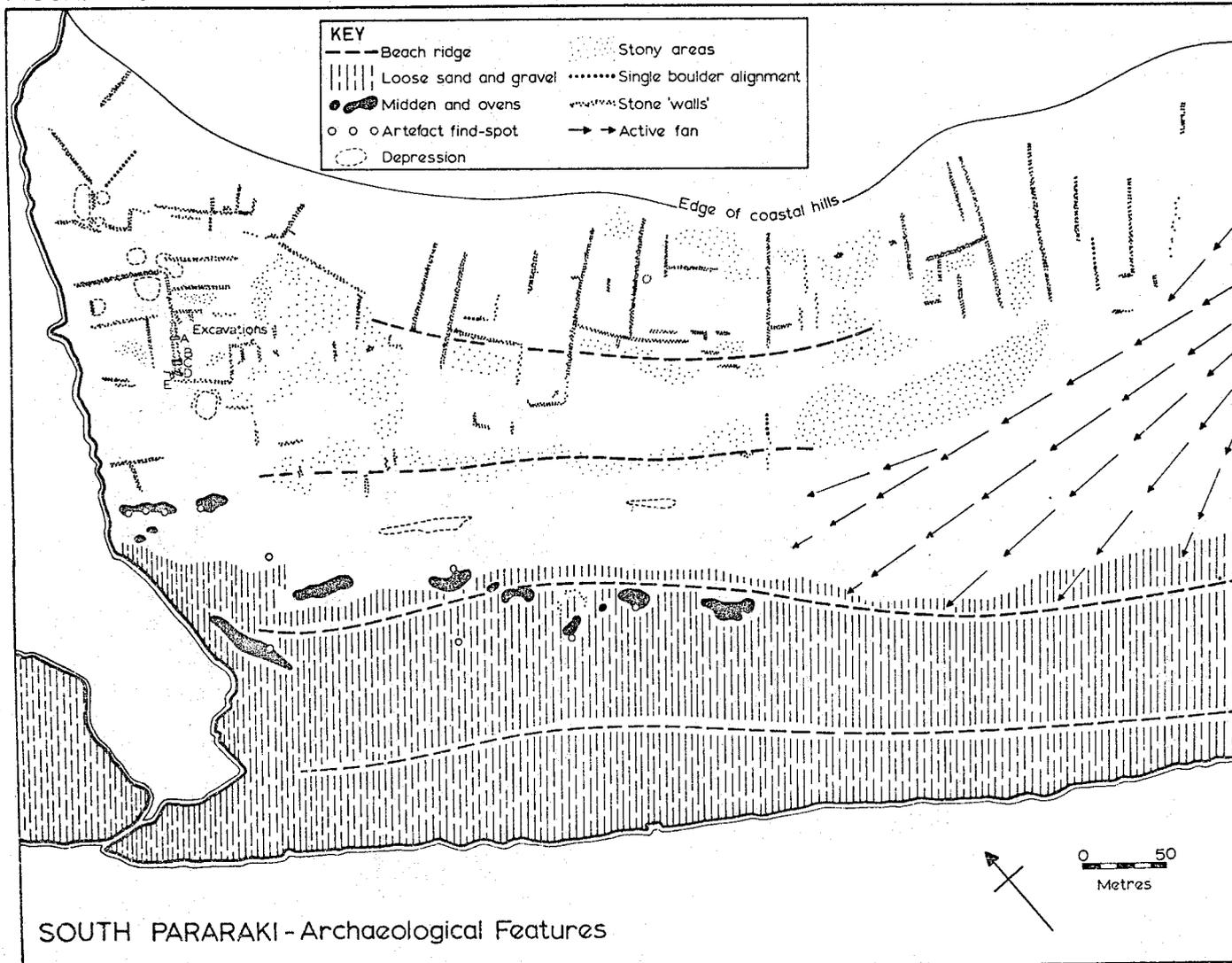
6. SOUTH PARARAKI (Figure 10)

Although Adkin referred to a group of walls "about a quarter of a mile south of the Pararaki" (Adkin, 1955:461), there are indications in his report that he did not personally visit any of the walls south of this river. He gives no sketch maps of the areas and his comments are extremely brief. Indeed to sum up the South Pararaki walls by simply referring to a locality some distance from the river is virtual proof that his survey stopped at the north bank. These walls are as impressive as those at the North Pararaki, covering 11.7 ha, and are associated with obvious cooking and habitation sites along the river bank and on the second beach ridge.

As at North Pararaki, the walls on the south bank are built on and between raised beach ridges which are progressively more stabilized by vegetation as one travels away from the shore. The ridges match those of the north bank but can be followed very much further along the coastal plain before they disappear beneath an alluvial fan. However only four ridges are clearly defined, while the fifth, if it is recognizable at all, is confined to the extreme northern corner of the coastal plain beside the river.

Prehistoric evidence first appears on the second beach ridge and takes the form of scattered heaps of fire-cracked and reddened

FIGURE 10



stones, charcoal-stained sands and gravels, artefacts, but rarely midden. Like the second ridge at North Pararaki, this raised beach ridge has suffered quite major deflation and it is likely that any shell midden deposits once present have disintegrated.

The third ridge which is only lightly grassed has very few walls on it compared with the third ridge on the north bank; two short lengths of row occur 100 and 150 m south of the river, and close by are two alignments 5 m apart and composed of loosely spaced stones. The ridge continues, stony and apparently unmodified, for another 200 m to where a short transverse row occurs close to a single boulder alignment. This is an interesting feature which appears to join up across the hollow with a stone row in the fourth ridge; on the third ridge it takes the form of large boulders roughly spaced in a line, while in the hollow it is made up of carefully fitted stones touching each other end to end. This might be an indication of the relative importance of ridge and hollow to the wall builders. At the northern end of the ridge beside the river, the old road cutting and a bulldozer ramp have exposed sections displaying midden and occasionally artefacts, in a thick, charcoal-enriched layer very similar in appearance and position to the main midden site at the Washpool. Two stone rows are situated beside it, one parallel with the river bank, the other parallel to the shore, meeting each other at an angle of 80° . The latter row joined up (according to the 1944 aerial photographs) with a length of row between the ridges some 70 m to the south; this wall seems to have marked the western edge of a group of walls which are obviously oriented to the river bank rather than to the beach.

As far as can be established from a study of orientations there are three main groups of walls at South Pararaki and three minor groups. Of the major groups one is aligned to the river bank and occupies an area of approximately 160 x 150 m, another is based on the gently sloping land behind the fourth ridge (with extensions seaward of the ridge) and covers an area of 270 x 140 m, while the third (170 x 110 m) occupies the southeast corner of the raised beach area and is sandwiched between the coastal hills and the foot of a large fan.

Although the southern group of walls is 480 m from the river,

water is available on the seaward edge of the walls, welling out along the edge of the fan. This group follows a simple pattern with 11 stone rows running at right angles to the foot of the slope, and three shorter transverse rows. Two of the long rows change their character midway: one becomes a carefully fitted single boulder alignment, while the most southern wall turns into a untidy row of spaced boulders. The appearance of the ground adjacent to the walls is most informative at the South Pararaki, for stones were common enough for wall building to be practicable but not so abundant that one cannot now distinguish between cleared or virgin ground. As a result it is apparent from groups such as this that while the majority of rows were built with stones from the ground on both sides, quite a few were constructed with stones from one side only.

The largest group of walls occupies a central position on this stretch of coastal plain and has eight stone rows running out from the base of the hills and at least ten short sections of transverse stone row, usually closing off the patches of clear ground at the seaward side. In the group there are five lengths of roughly spaced alignment and only two short sections of fitted alignment. It is difficult to determine how much of the hollow between the third and fourth ridges was included within this arrangement of walls, for there is good evidence that silt-laden water originating from the fan has formed ponds for some distance along the hollow. In recent years a drain has been cut under the old road to release this water. At least five long walls run down towards the hollow and peter out, and only three of these can be traced on the other side of the low-lying ground. Whether or not the area was prone to flooding in prehistoric times can no longer be determined since it is now under the new bridge approach. This group is notable for its geometrical precision, in particular the subtle modification of the rectangular system so that the transverse walls can follow the natural curvature of the fourth beach ridge, while the long walls, intersecting them at right angles, slowly shift in orientation from 41° to 53° E. The long rows are extremely straight and are composed of water-worn boulders from the raised beaches. One exception, a transverse row 30 m out from the base of the hills is made from rough fragments of the kind that continually pile up at the foot of the slope, and the clear ground between this wall and the

hillside indicates the precise source of the stones.

Following around the edge of the coastal hills between this group of walls and the river are the three minor groups. They are of similar area (60 x 30 m, 68 x 28 m, 56 x 56 m) but very different orientation (76°E , 45°E , 84°E). They are each composed of 2 - 4 stone rows, of which the longest are the transverse rows, and each group has a section of carefully fitted single boulder alignment incorporated in it.

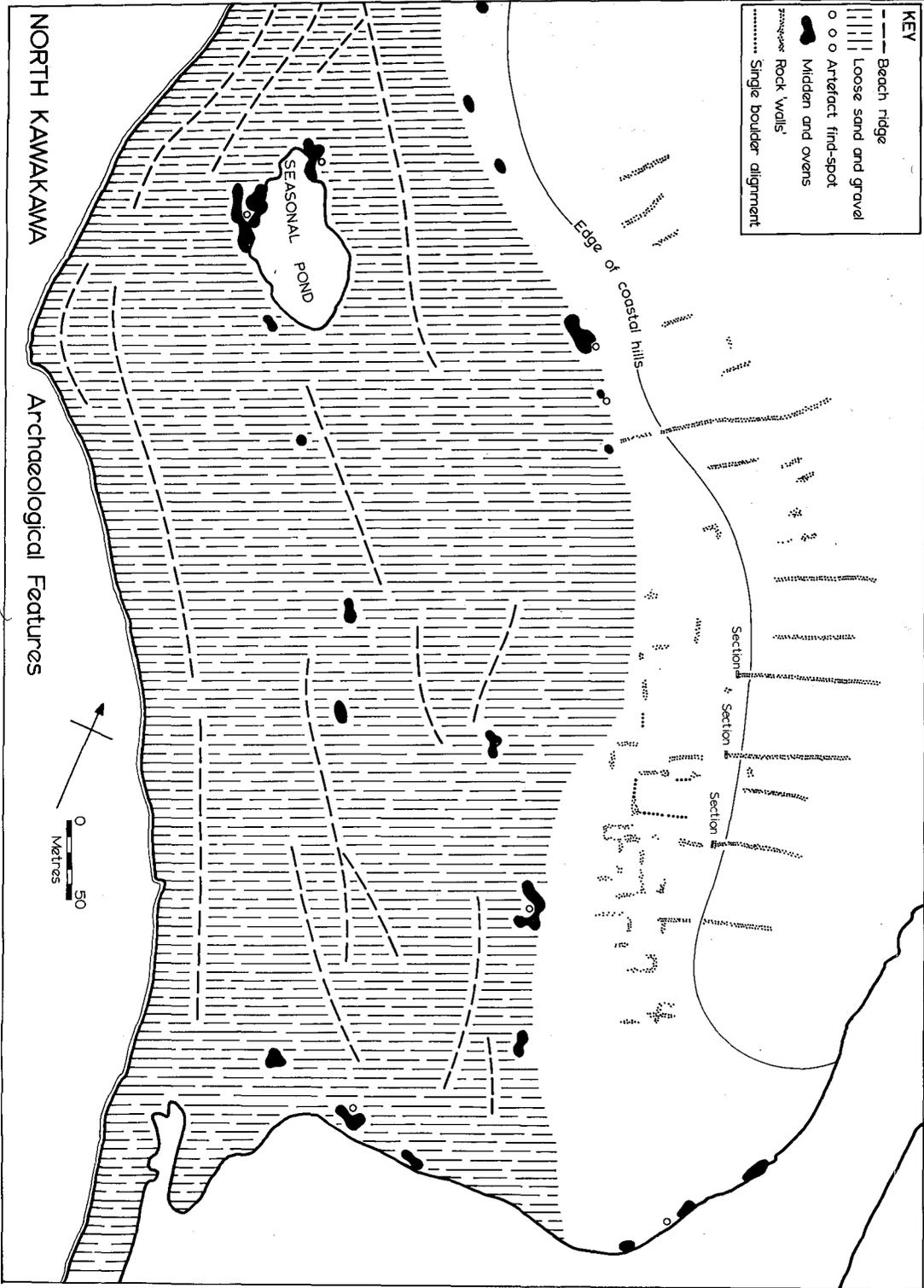
The river-oriented group is made up of ten stone rows running up the northwest facing slope at right angles to the river bank. In addition there is one transverse row 60 m long and at least 13 much shorter transverse rows. A number of these occur in a very stony 'no man's land' which begins 100 m south of the river and extends another 100 m south over the third and fourth ridges. In the vicinity of these short walls there are certainly fewer stones, but the general impression is gained that the wall builders had only a perfunctory interest in the area. Again, this is an indication that the ground between the walls meant something more to them than a handy source of building material - otherwise one might expect that the stoniest patch would be the site of the biggest walls. The riverside walls are most notable for the two sets of double row/alignments which can be found there. One set runs up from the bank for a short distance and is spaced about 3 m apart, while the longer set is parallel to the river bank and spaced roughly 0.6 m apart. This double row was later to be excavated to clarify the relationship of the two sides (pp.93-5). Unfortunately a vehicle track has disturbed the ground between the two sets.

Generally speaking, the archaeological evidence on both sides of the Pararaki River is similar, but whereas the north bank shows how wall building operated under complex topographical conditions of intersecting beach ridges, terraces and fans, the south bank evidence shows a much more straightforward pattern. Together they constitute the largest and most complex area of walls in Palliser Bay.

7. NORTH KAWAKAWA (Figure 11)

Between South Pararaki and the next group of walls, the coastal platform is covered by two semi-active fans and then disappears altogether at the foot of a spur. It reappears shortly as a dune covered area bounded on

FIGURE 11



the northwest by the sea, on the south by the Kawakawa River (more strictly called the Otakaha River) and on the east by steep slopes rising to a narrow ridge. At the southern edge of this ridge, high above the river, some terraces and pits have been cut, but there are no signs of a ditch and bank feature cutting off the ridge. On the coastal platform below and on the lower slopes of this 'pa', 8.9 ha of walls can be plotted, together with deflated ovens among the dunes, and what may have been a habitation area along the river bank. Human remains and artefacts wash out of the river section occasionally and there are also lenses of Haliotis shells exposed in a thick, charcoal-stained layer similar to the main Washpool habitation site. Some beach ridges can be identified here, particularly at the northern edge, but dune formation and the shifting pattern of sand and vegetation zones rule out any attempt at numbering them. For some reason (presumably related to topography, prevailing winds, and marine sediment transportation) the North Kawakawa area has a far greater proportion of unstable sands and gravels than any of the other river mouth areas, and the question arises as to whether the area of walls observable today may be only a small portion of what was originally involved. There are two features that suggest that little wall evidence has been destroyed: firstly only a few of the walls run as far as the edge of the sand dunes and blowouts; secondly areas of stabilized sands between the walls and the river appear never to have had walls built on them at all.

The walls vary in composition according to their position relative to the hillside. The northern walls, comprising nine stone rows, are built on consolidated fans from predominantly alluvial debris. The long stone rows which occupy the hill slope to the south of these change from taluvial fragments to water-worn beach boulders as they run down on to the flat coastal plain. The shorter walls which form enclosures between the hillside and the dunes are made entirely of beach boulders.

The Kawakawa walls are well known locally for the steep gradient they exhibit. Adkin referred to them as follows:

"The Otakaha group of walls is sited at the foot of the inland cliffs on rather steeper slopes than at other places."

(Adkin, 1955:461)

A survey made of these walls using an alidade and staff showed that the walls describe part of a parabolic curve and their upper sections have a gradient of about 1 in 2.5 (an angle of 21.5°). The steepest walls are among the most carefully positioned and straightest; covering a lateral distance of 218 m they appear to divide the area into four sections (62 m, 49 m, 58 m, 49 m), two of which are further subdivided (36 m and 26 m, 24 m and 34 m) by somewhat shorter walls.

At the foot of these walls are numerous short walls, which lie parallel to the long hillside walls or at right angles to them. The areas they incorporate do not overlap the ground between the long walls, thus although they form a different pattern they may well have been built with the long walls in mind. They consist of at least 24 stone rows, 5 stone mounds incorporated into corners or ends of walls, and 4 lengths of single boulder alignment. The latter are made from different sized boulders and do not have the neat regular appearance of the alignments at the Washpool. Although there are no complete enclosures, that is with four rows or alignments surrounding them, there are at least 12 small rectangular patches marked on three sides by stone walls. These range in estimated area from 126 m^2 to 910 m^2 . About half are oriented parallel to the long rows, and half at right angles. This association of long wall systems with small semi-enclosures on the seaward side is not restricted to North Kawakawa: it occurs at the Washpool, Mangatoetoe, and Black Rocks, where the areas enclosed are of similar size and orientation.

One small additional area of walls at North Kawakawa is only visible from the 'pa'. It consists of three walls running down the hillside on the eastern, inland side of the 'pa' ridge. Two of the rows are roughly parallel but not particularly straight, while the third which is much larger is offset about 45° and has a definite kink in its base.

8. SOUTH KAWAKAWA

This title covers several small groups of walls on the south bank of the Kawakawa River and on the coastal platform between the river and the next major group at the mouth of the Waiwhero stream.

The first of these (Figure 12) occupies the river terraces directly in front of the modern Kawakawa homestead (600 m upstream from the sea). The terraces make up three levels, and what seem to be prehistoric features are present on the lower two. The highest terrace is the site of a number of buildings, yards and a garden, and although there are traces of stone alignments, there is some reason to suspect they are of European origin. Firstly, the alignments are actually curbstones marking the edge of two rectangular raised platforms paved with tightly fitting cobblestones. Secondly the upper platform curbing has semi-circular indentations surrounding completely empty post holes. Directly in front of these two platforms, a row of 16 partly filled depressions indicates that a line of large posts formerly stood there, perhaps part of cattle yards. It is in this spot that early European farming structures become confused and entangled with prehistoric walls, for immediately on the north side of the depressions two stone rows become visible, running down toward the river. At first glance it looks as though the stone walls are joined up by the line of depressions, but in fact the holes terminate a few metres beyond the northeast wall. Another four rows run parallel to these walls, and all are similar in construction, size, length and spacing with the North Kawakawa walls. Only the proximity of European stone work sets them apart. There are indications of one transverse wall roughly bisecting the parallel walls, and joining up with the middle terrace scarp; closer to the river are traces of another transverse wall and a stone row oriented at right angles to the adjacent river bank. All the other walls run at right angles to the edge of the hill behind. It is of some significance that none of these walls terminates at the river itself, although the main channel is at present eroding the bank. If this is taken as an indication that the terraces have been untouched by the river since the walls were built, it becomes difficult to explain why the topsoil is no more than a few centimetres thick on the lower two terraces and rests on a hard mass of angular alluvial gravel and stone, the materials from which the walls have been built. The deflated appearance of this area may in fact result from wind rather than water action.

The next group of walls (Figure 13) can be found on the south bank 600 m further upstream. A large active fan and low-lying

FIGURE 12

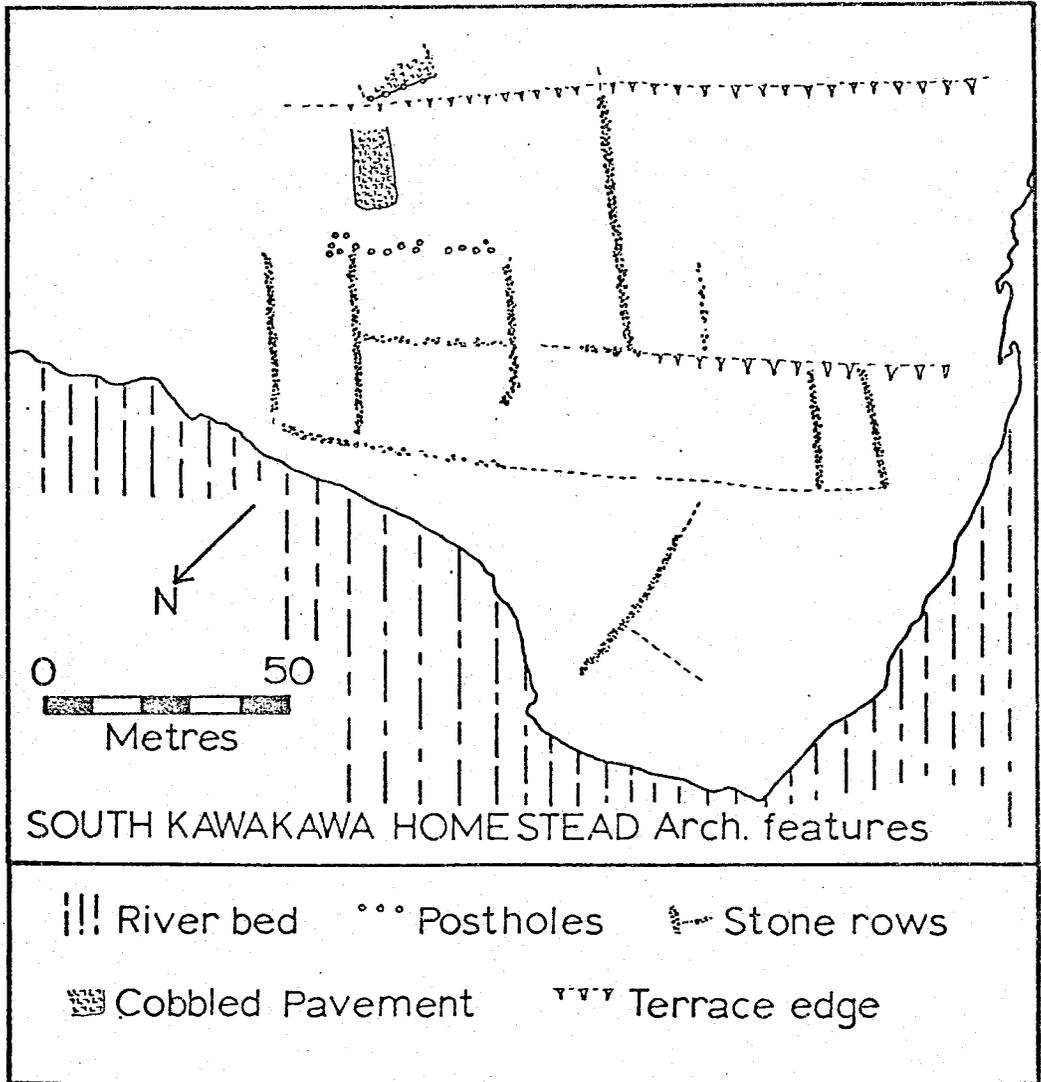
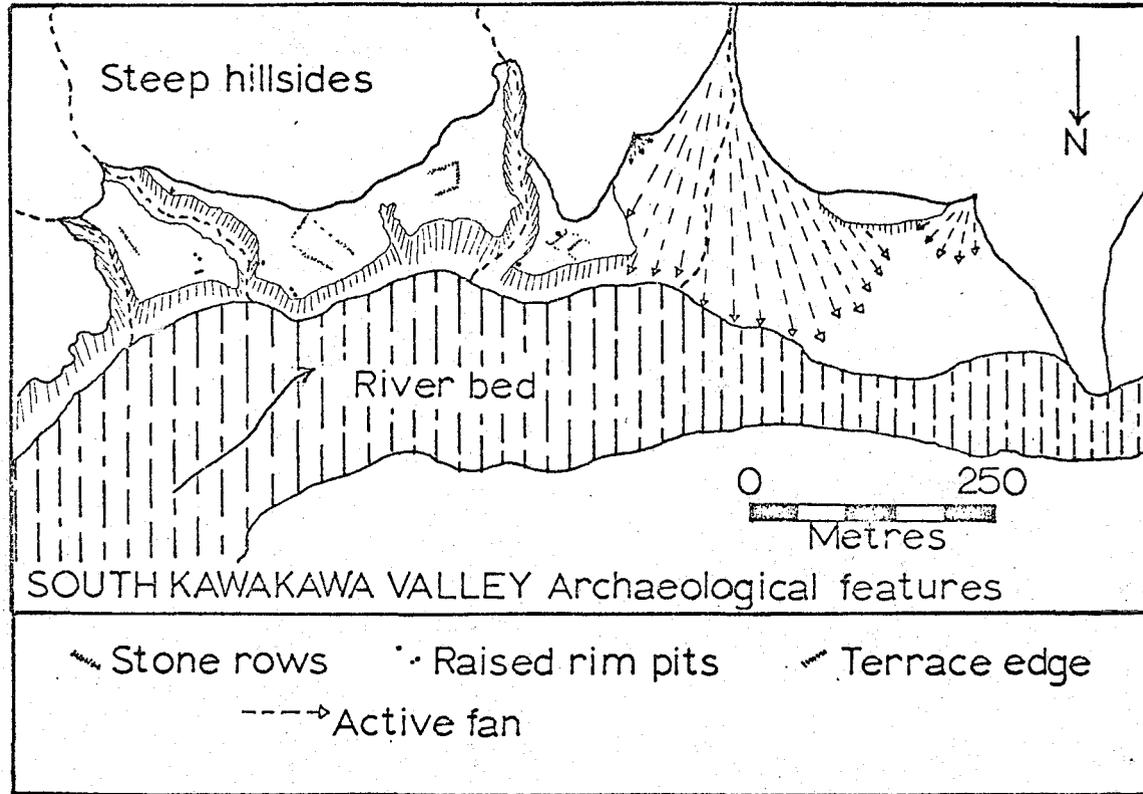


FIGURE 13



river terrace prone to flooding intervene between the two groups. The walls are situated on an old river terrace now about 15 - 20 m above the river and on the consolidated fans which accumulated on the terrace surface. In a geologically recent period the river has cut down rapidly to its present level and the tributary streams have deeply incised both terrace and fans. As a result this terrace has been dissected into three sections with deep eroded gullies between them. The first section lies east of the active fan and consists of a consolidated fan into which several terraces have been cut. The uppermost terrace (approximately 28 x 8 m) has a large raised-rim rectangular pit cut into it, with what appears to be a drain around the outside of the pit*. The next terrace (about 23 x 6 m) has a patchy surface which may indicate the presence of filled-in pits. Below this the fan has been cut back from the eroded river edge to make a rectangle of flat ground 17 x 18 m. Another raised-rim pit is found on this section, at the extreme eastern edge overlooking a gully mouth.

On the eastern side of the gully consolidated fan sediments slope down on to the next section of terrace. From the junction, which exhibits a marked change of slope, two parallel stone rows composed of angular fan and water-worn river-bed stones run out in an easterly direction. The longer wall is 55 m long, the shorter about 25 m, and they are spaced 20 m apart. One hundred metres further along this river terrace two more roughly parallel walls occur (80 and 90 m in length) with a transverse wall of 35 m. These rows are oriented in a northwest direction. More pits are situated along the eastern edge of this section overlooking the next deep gully. They occur in three groups: two side by side at the northeast edge of the terrace, another two 50 m upstream, and one large pit on a high terrace remnant a further 120 m along the gully edge. All are raised-rim rectangular pits.

Across this gully a small section of river terrace has three pits on high ground overlooking the gully and a single stone row 55 m long (with a possible 20 m extension on the far side of a natural mound).

*Footnote:

The drain-surrounding-pit feature is found at the Putangirua pit sites, N165/7, 8, the Tauanui pa N165/1 and Parikaranga N165/42 (see B.F. Leach, 1976:Fig.6). It is believed to reflect later rather than early occupation by virtue of its association with fortifications.

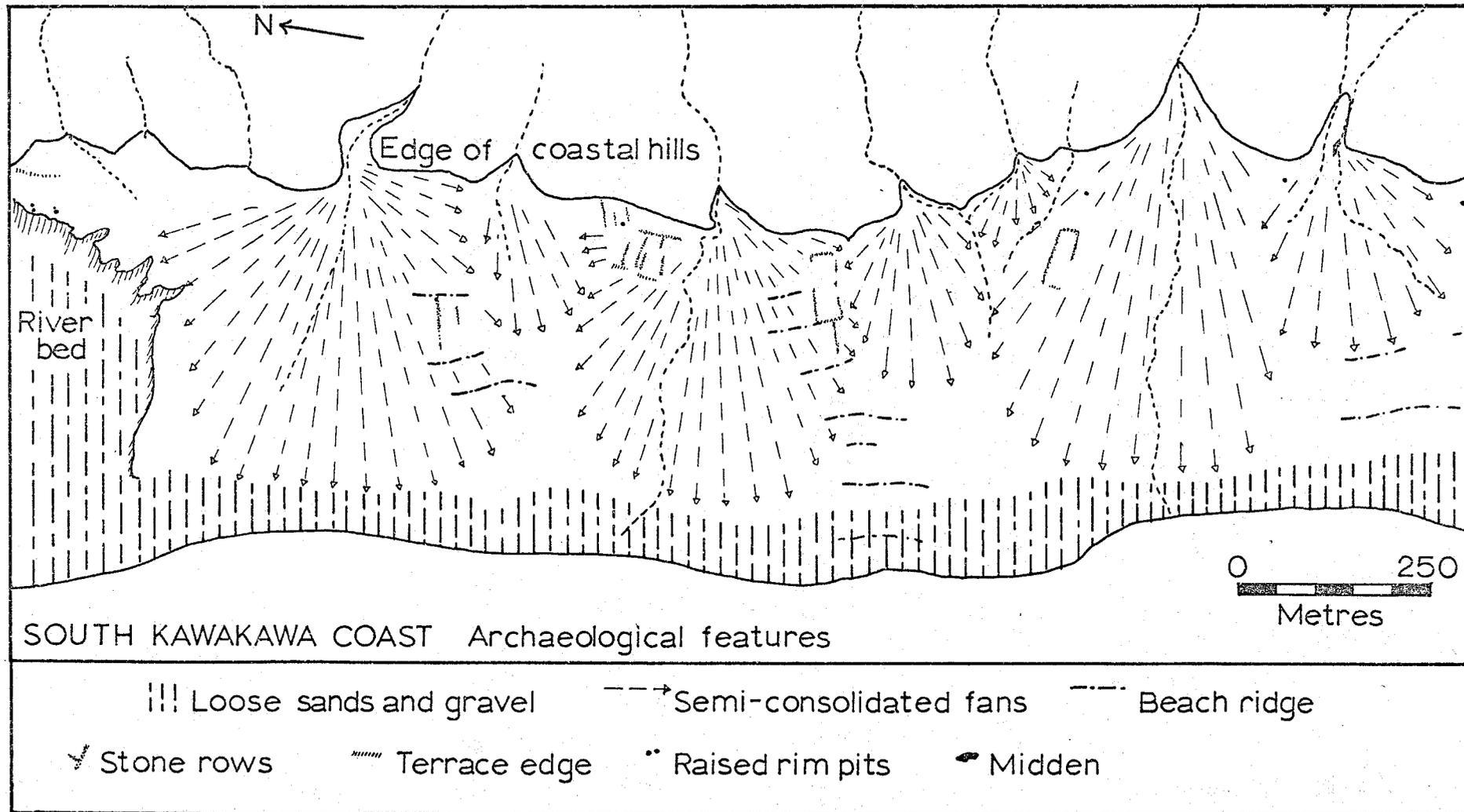
Although no other row was visible from the ground, aerial photographs reveal a wall-like mark running for some 25 m parallel to the row and some 25 m to the west of it. The pits here are arranged in a right angle and have two interesting features: one pit about 7 m long has what appears to be a buttress in the centre, while the largest, nearly 10 m long seems to have an internal wall bisecting it. Also present on these terraces are mounds of various sizes which may be related to dimpling, a common natural feature in the Kawakawa Valley. Alternatively they may be a cultural adjunct to wall building.

Returning to the coast, for several km south of the Kawakawa River the coastal platform is covered by large interlocking fans which are mostly semi-active and appear in places to be cutting down. Few definite signs of beach ridges appear until the Waihero wall area is reached. Nevertheless wall building has taken place at various locations on the consolidated parts of fans and against the foothills between fans (Figure 14).

The northernmost evidence is to be found on a truncated consolidated fan overlooking the river only 300 m south of the Kawakawa homestead. On the upper surface of the fan some long, low mounds may have represented prehistoric walls but these are not conclusive even in the aerial photographs. However, on the gently sloping ground below, close to the river terrace edge are three raised-rim pits. The first group of two is situated right beside the edge, a position reminiscent of the pits further up the valley. They are about the same size, but one has a more prominent rim. Thirty metres south is a much larger pit with a high rim and obvious hollows at various points around the perimeter. From the ground they look like 'borrow pits' for increasing the height of the rim, but the recent aerial photographs suggest that the largest hollow had itself been a pit, probably partly filled in before the large pit was excavated. There are other suggestive features around these pits, such as low 'walls', mounds, and terrace-like features against the foot of the fan, but these are not clearly defined.

Five hundred metres south, on the southern flanks of a massive fan are two 'walls' of equally doubtful status. On-foot inspection is not a satisfactory means of deciding whether they are cultural features because of the natural mounds, hollows, and elongated stone piles

FIGURE 14



which abound on these fans and reflect the changing patterns of water-courses. However, the aerial photographs show these walls to be parallel, about 30 m apart, 30 m and 10 m in length, and demonstrating a degree of straightness suggesting deliberate construction. At this location the fan has been cut into three tiers by irregular scarps (about 1.5 - 2.5 m high) which lie roughly parallel to the beach. These are believed to be of natural origin, and may be equivalent to the upper beach ridges found elsewhere on the coast. If this is the correct interpretation, then the South Kawakawa fans have been forming continuously over many thousands of years, and the surfaces of the various segments of each fan are of quite different ages. The next fan to the south also has three scarp lines cut into its southern slopes, which are similarly oriented. Seaward of these are four short lengths of beach ridge apparently corresponding to ridges 1 to 4 at Waihero. The number of ridges and scarps taken together (7) tallies with the maximum number recorded for the coastline.

The next group of walls is located about 230 m southeast of these two rows, against the foot of the hills. One wall runs down a consolidated section of fan parallel to the edge of the hillside, but separated from it by an old water channel. It is about 40 m long and has another wall 20 m long coming off its western side. Roughly parallel to this latter wall is a third of 25 m which may have joined the long wall. Both the shorter walls are situated on a terrace cut into the fan, with dimensions 35 x 50 m. A somewhat smaller terrace has been formed below it (17 x 52 m) and it too has the long wall as its eastern boundary. The precise coincidence of walls and terraces is good evidence that the terraces have been constructed by man. In fact there are slight indications in the aerial photographs that another two terraces may have existed above and below those described. At least four other features seem associated with this complex: about 18 m north of the end of the long wall is a large pit with a rather eroded raised-rim; between this pit and the steep hillside at least three parallel stone rows have been constructed from taluvial deposits. The longest is about 50 m, they are spaced 12 and 16 m apart, and they run down the slope towards the pit in an east-west direction. Overall, signs of prehistoric activity at this site cover about 0.5 ha.

On the southern side of this fan, where the seven beach levels are observable, is a rectangular enclosure about 36 x 87 m with an additional wall running out from its seaward edge a distance of at least 40 m. From ground level it is difficult to follow the walls since they are not of uniform height nor continuous. The western wall is the most prominent and it runs along the edge of the sixth beach level. The upper wall at the eastern end is also well marked and it separates the high ground of the enclosure from the dry water courses which flank the hillside behind. However both north and south edges are interrupted at various points and it seems possible that an old channel which runs across the enclosure was cut after the walls were built. It is also possible that one or more pits were associated with these walls, but there are so many hollows on this section of the fan that a pit without a well-defined rim would not readily be distinguished.

Another 250 m to the south are two walls and a terrace scarp occupying a position on the north side of a large consolidated fan. A wall about 25 m long is oriented parallel to the coast and forms the eastern edge of the terrace. The northern boundary is marked by a long wall (70 m) behind which the terrace soils are banked up, while a terrace scarp defines part of the southern boundary. At present a channel runs diagonally across the western edge of the feature. However, traces of a wall beyond this channel appear on the aerial photographs; so it is possible that the area was laid out as a rectangular terrace with three walls and a terrace scarp marking the edges. In this case the overall dimensions would have been 25 x 80 m. Fifty metres east of this enclosure is a large pit-like hollow with a raised-rim on two sides. Its regularity of outline suggests that it is a cultural feature, and its proximity may indicate that it was built in association with the walled terrace.

No other walls are recognizable in the next 750 m of coastal platform between this enclosure and the large area of walls at Waihero. However, two hollows situated close to the foothills on consolidated sections of fans are similar in appearance to the pits recorded above, and occupy similar positions. The first, only 260 m south from the terraced enclosure is close to the apex of a fan where recent down-cutting has exposed a lens of Haliotis iris shell and

charcoal. The other possible pit is located 180 m south in the hollow between two fans. When first examined it was waterlogged and without any sign of a rim. In addition to these, another two rectangular pit-like features were observed on aerial photographs after the fieldwork was completed. These are situated on a knob overlooking the coast immediately north of the gully mouth midden site. The knob is about 100 m above sea level and can only be reached on the inland side along a steep razor-back.

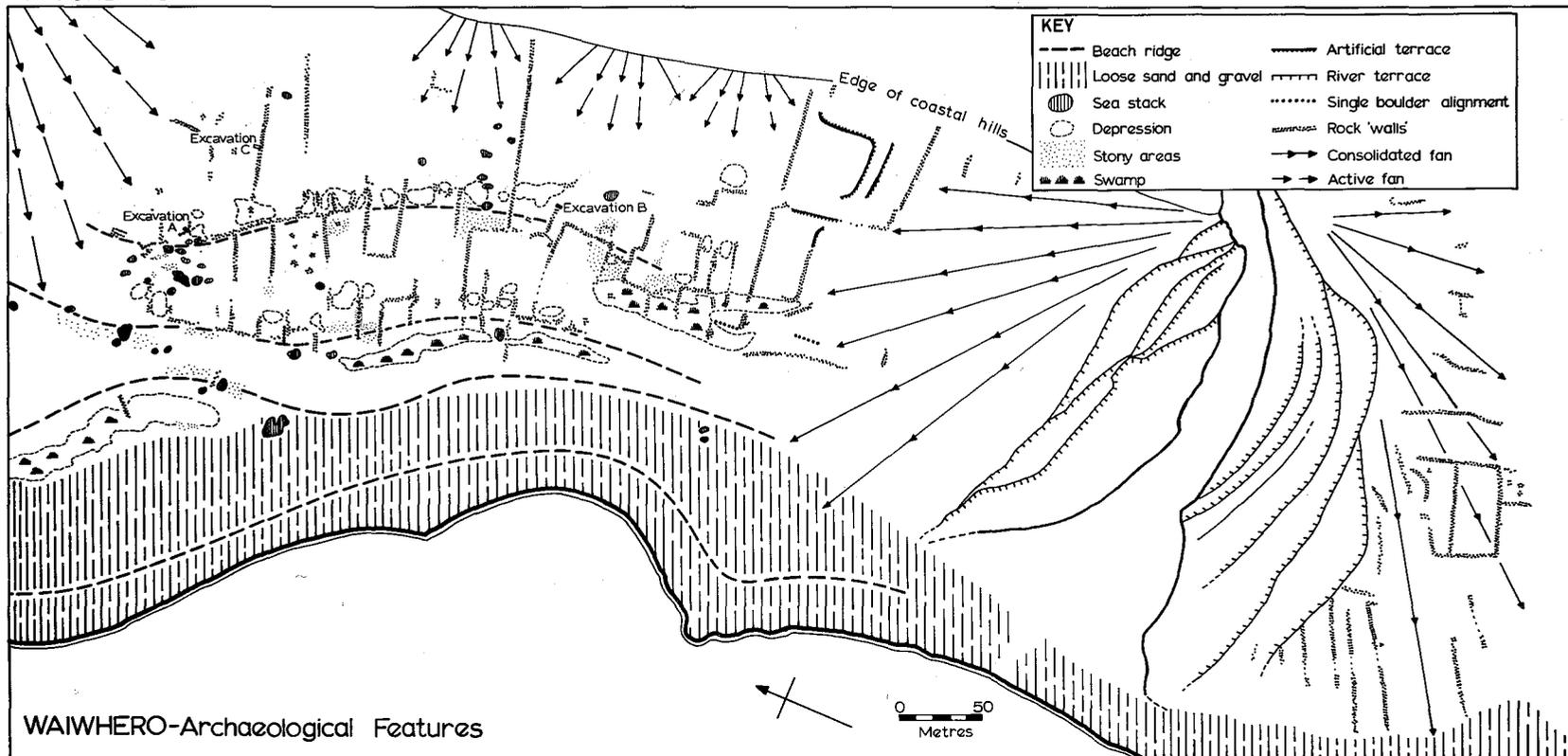
The South Kawakawa walls present a somewhat different pattern from the Pararaki and Te Humenga walls. Not only are they built on fans but they seem to be commonly associated with pits. Furthermore there seems to be no midden or oven debris along the shore and lower beach ridges directly in front of them. The walls are constructed as might be expected from alluvial gravels and stones, but they appear to form larger and simpler enclosures than at the other areas. The same characteristics are noticeable in the case of the Kawakawa Valley walls, in particular the association with large raised-rim pits. The possibility that these differences have a chronological basis will be considered in a later chapter.

9. NORTH WAIWHERO (Figure 15)

Although he probably did not see the walls at Waiwhero, Adkin believed that they covered "perhaps the largest area of all" (Adkin, 1955:461). However, the walls on the north side of the stream cover only 7.49 ha while those on the south bank are scattered over 2.35 ha. Even the combined total does not come close to the South Pararaki wall area. Nevertheless they form an impressive complex by contrast with the rubble wall enclosures on the fans to the north of Waiwhero, which are virtually unrecognizable to a person on foot. At Waiwhero, stone rows, single boulder alignments, 'pathways', upright stones, and mounds are encountered in the course of a ground survey.

In recent geological times the Waiwhero Stream built out a massive fan at its mouth which it then proceeded to cut down through the centre forming paired terraces (six on each side) which may be related to coastal uplift. If this is the case the fan surface must be of considerable age. On the south side it has been extensively

FIGURE 15



utilised for wall building, but on the north only two rows and a stone alignment are to be found on the finer sediments of its toe. Most of the walls in its proximity run as far as the fan but peter out within a few metres. Since there is no question of burial of walls by the fan, the explanation must lie with the preference of the wall builders of Waiwhero for raised beaches. Indeed the northern boundary of the Waiwhero walls also happens to be a large fan, and only one rather curved wall extends on to it.

Between these two fans there is an area 400 m long of ridges and hollows, abundant sea stacks, swamps and springs, with the eastern boundary formed by the coastal hills and the western by the beach. Four beach ridges are particularly prominent. The first and closest to the sea has no evidence of any prehistoric activity, while the second has two fragmentary rows. At the northern end of the wall complex and some 200 m beyond it several ponds form after heavy rain to the east and west of this second ridge, and these may persist for several months in winter and spring. Surprisingly the more substantial stone row runs down into one of these hollows, raising the possibility that the pond did not form in this place in prehistoric times, or, more likely, the activity to which wall building was an adjunct was restricted to the summer months. When the surface survey was conducted there was no sign of eroded oven mounds, artefacts, or midden on or close to the lower beach ridges in front of the walls. This seemed surprising in view of the evidence of such an association at all but one of the other major wall areas. It has been found that at North Kawakawa ovens had been clustered around the seasonal ponds, so a close inspection was made of their counterparts at Waiwhero. For two years searching at regular intervals revealed nothing, then after a period of storms and gales, sand and fine shingle was shifted from around the northern pond exposing large areas of heat-cracked stones and artefacts. Judging by the condition of the oven mounds, this area has been exposed before, resulting in deflation of surface deposits.

The Waiwhero walls are concentrated on the third and fourth beach ridges which are well marked, very stony, and pock-marked by natural, irregular-shaped hollows. These are very similar to those encountered at North Pararaki and range in size from 8 to 30 m across,

and 1 to 4 m deep, the deepest lying beside four sea stacks in the centre of the wall area. Invariably at Waihero these hollows are situated on the landward side of the beach ridge crest. Visitors to the area have often asked whether these could have been man-made 'borrow pits', but the idea of removing stone and gravel material from a beach ridge to modify the stone and gravel soil adjacent to the ridge is ludicrous. Although the process by which they are formed is uncertain, their presence behind beach ridges in locations without any visible sign of prehistoric activity must be seen as strong support for a natural origin. Large examples can be found approximately 1 km northeast of Te Kaukau Point and 1.8 km south of the Tora Station on the Wairarapa East Coast.

Although some Waihero walls run parallel to the coast, usually along the top of the third or fourth ridges, the majority run across these ridges and peter out in the hollow between them or in the less stony ground behind the fourth ridge. Only two rows run continuously from the fourth ridge to the beginning of the hillslope. Judging by the appearance of several other walls in this area, the closer they are located to the foot of the slope the more massive they must be to remain visible, for two small, but actively eroding gullies are situated on the hillside behind the walls, and with each period of heavy rainfall silt and fine gravel outwash spreads over the ground at the northern end of the wall complex. The two walls which run the full distance across the flat ground are situated in the southern half where there is far less silt on top of the beach ridge sands and gravels, but even here there are far fewer walls behind the fourth ridge than in front of it. It seems likely that only a few large walls were built across this ground originally, but they extended as far as the foot of the coastal hills.

The fate of the walls which run down into the hollow between the third and fourth ridges is also hard to assess. At the northern end there are clear signs of silt deposition, but only at the base of the hollow. Some walls can be traced right across between the ridges, others can be joined up to make a straight line on paper, but at least eight have no counterpart on the opposite ridge or could only be joined by a curved line. The solution seems to lie in a close look at the transverse walls on or adjacent to the fourth ridge. At the northern end of the

area the transverse wall lies on the edge of the beach ridge - long walls join on to it at various points but no wall crosses it. Then the ridge seems to become the central part of an 'enclosure' with a stone alignment suggesting an eastern boundary 15 m from the ridge and a low row making a western boundary 28 m west of it. Judging from the distribution of surface stone the eastern boundary skirts the hollows behind the fourth ridge for another 100 m. For half of this distance a western boundary can be observed about 10 m west of the ridge. Over the southern-most portion of the ridge the transverse walls run along the crest for 44 m, then 16 m to the west of it for another 20 m. The ridge then ceases to be a recognizable topographical feature and the remaining transverse walls are aligned to the edges of a swamp fed by a perennial spring. The positions of transverse walls on the third beach ridge also vary. From the northern end a low somewhat scattered row follows the ridge for 70 m, then for the next 52 m an even more dispersed row is located 4 - 8 m to the east of the ridge. A position 10 m east of the crest seems to be the case over the next 45 m, and after a gap of 30 m the wall returns to the ridge position. It seems then that certain pairs of walls on the ridges were never intended to be joined and in fact belonged to different subsystems.

The orientation of the various sub groups of walls is also quite variable but it correlates with the differing position of the transverse walls in a number of cases. An overall picture is gained from both sets of evidence that the Waihero walls like those at the mouth of the Pararaki reflect a process of wall building in separate blocks. Changes in orientation are most readily seen at the southern end of the complex. Two rows close to the fan make angles of 87° and 91° to the N - S axis. The next two rows to the north, including one very long and straight example make angles of 83° and 84° . Then a group of two alignments and three rows lie between 75° and 77° , while the angles of five rows in the next group vary between 88° and 91° . Overall there seem to be at least eight sub groups based on orientation and transverse wall position. There is also some evidence of overlap especially near the spring at the southern end where it seems that some sections of walls may have been dismantled and others realigned when the 75° - 77° group was laid out overlapping the 90° - 91° group immediately to the north. The four groups at this end of the complex

occupy parcels of land with a range of area from 4000 m² to 5400 m². Unfortunately the process of estimating block size at the northern end is made much more difficult by only minor shifts in orientation and the problem of deciding the positions of the western and eastern boundaries of each group.

A number of stone features at Waiwhero deserve special consideration: in particular, a double alignment at the extreme northern end which turns a right angle corner up from the edge of the fourth beach ridge and runs parallel to it for a distance of 8 m. It may join up with two sections of single alignment which skirt various natural features such as sea stacks and hollows close by. These features were examined in more detail by excavation (see p. 98). Another double line occurs just inland of a massive stack 80 m south along the third beach ridge. It is composed of a single boulder alignment and a stone row, running parallel to each other over a distance of 7 m, and spaced about 1.5 m apart. Also of interest at Waiwhero is the frequent use of small sea stacks up to 1.5 m high as wall terminations, especially at the northern end of the third beach ridge and in the vicinity of the southern swamp. Upright stones are visible in two walls that run across the third beach ridge. The northern example is basically a single boulder alignment with stones set edge to edge in an upright position. Other stones have been heaped around it partly obscuring the original alignment in several places. The southern example utilizes much more stone but seems to have been constructed in the same fashion. Without a careful inspection it is easily mistaken for an ordinary stone row. Finally, a group of six circular mounds of stones occurs in a 34 x 34 m area between rows in the hollow between the third and fourth beach ridges. Mounds are not common features in coastal wall systems (c.f. the Makotukutuku Valley site M4 with its 53 mounds) but their appearance in a number of major and minor complexes in groups suggests strongly that they constituted a recognizable alternative to wall building, or may have had a particular function of their own.

In many respects this complex of walls is reminiscent of the Pararaki Mouth walls, especially for the variety of wall types and other stone constructions. With the exception of the oven area it is much better preserved and is subject to silting up rather than deflation, a process

which bodes well for the long term protection of the walls.

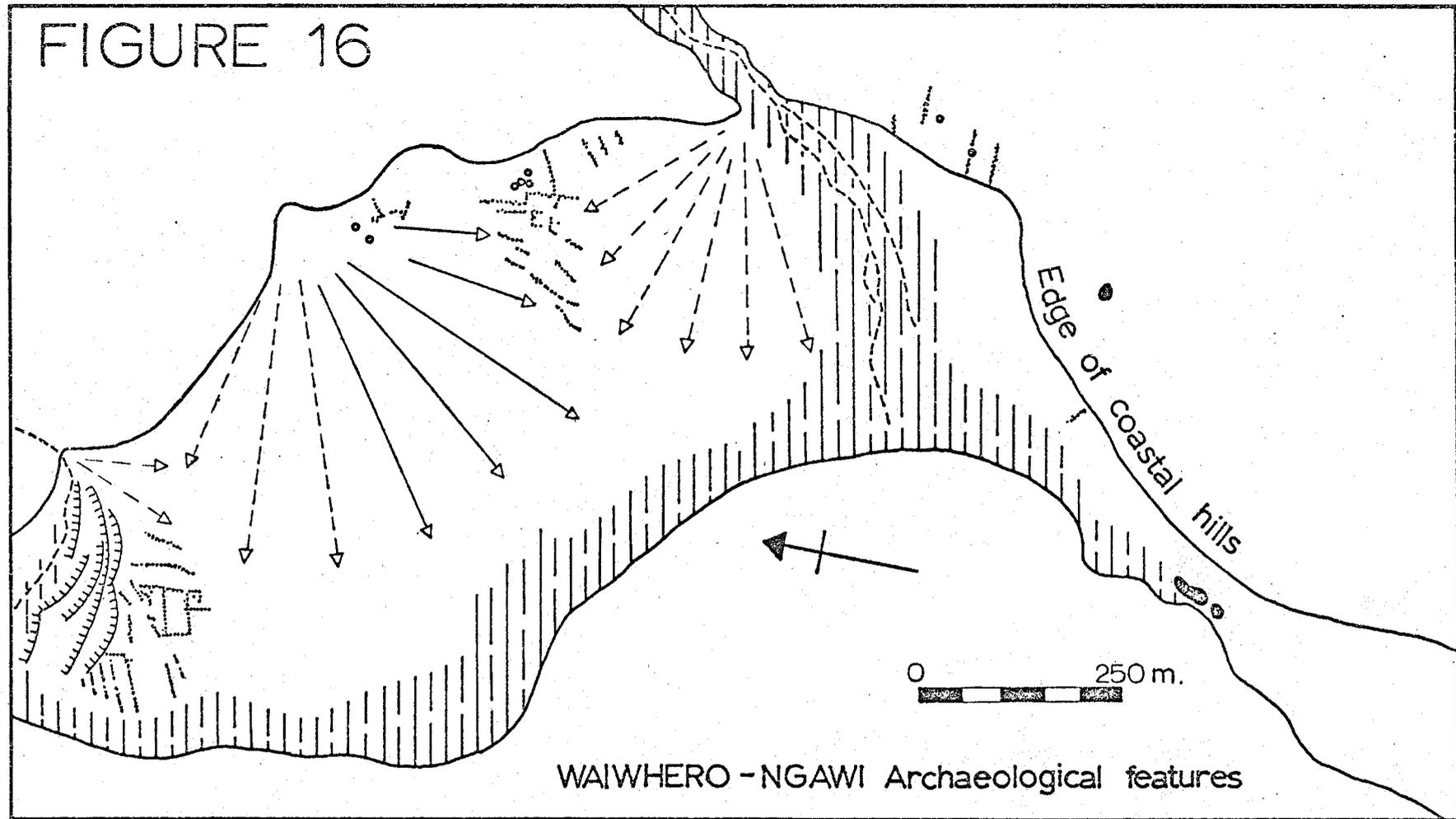
10. SOUTH WAIWHERO (Figure 16)

Between the Waiwhero Stream and Black Rocks Point is a semi-sheltered bay which offers a suitable landing place for craft when strong southerly winds are blowing. This characteristic which is shared by the bay where the Te Kopi harbour was located in the 19th century is undoubtedly the reason for the establishment of a European settlement here. It is known as Ngawi (occasionally written Ngawihi) and is situated on small semi-consolidated fans on a westward facing slope overlooking the bay. The northern and eastern edges of the bay are made up of gently sloping alluvial fan sediments belonging to three very large interlocking fans. The northern most is the consolidated Waiwhero Stream fan. The middle fan which is 600 m wide is active over its northern slopes and judging from the soil and vegetation pattern visible in the aerial photographs the channel has swung progressively to the north in recent times. The southern fan seems to be the youngest of the three and all parts of it were being actively built up until quite recently when downcutting began. It can be seen, therefore, that the oldest soil surfaces around the bay are at the foot of the hills between the fans, and on the southern flanks of the Waiwhero Stream fan and its immediate neighbour. It is interesting to note that all these surfaces have been utilized for wall building.

The first group of walls is situated on the lower slopes of the Waiwhero fan. Fourteen rows are oriented at right angles to the shore while another ten less substantial rows run at right angles to the southern edge of the fan. Four circular mounds are present as well, three of which are to be found in an area 12 x 16 m outlined by three stone rows and the southern edge of the fan. An unusual feature in this group is a complete enclosure 27 x 54 m (note that the long side is exactly twice the length of the short). Also worthy of note are five rows at the sea edge of the fan which divide off long narrow strips 15, 10, 18 and 12 m wide. The coastal road bisects this group and the resultant section shows that these rows are composed of quite small alluvial stones formed into low elongated heaps.

Four hundred metres to the southeast near the apex of the middle fan is a small cluster of walls forming two right angled corners, and two very large raised-rim pits, the largest just under 10 m from rim

FIGURE 16



- Loose sand and gravel
- Active fan
- Consolidated fan
- Midden
- Rock Walls
- Pits
- Terraces

to rim. Another 130 m south of the pits is the first row of a group of 14 near the southern edge of the fan, which are remarkable on this coast for their lack of straightness. Apart from three short sections of transverse wall which also mark changes in height, the rows run in a southwesterly direction. The slope of the fan at this point is north-west - southeast so effectively these walls run along the outside edges of long terraces, a feature reminiscent of the South Kawakawa coastal complexes. On the hillside overlooking the walls is a natural terrace into which two, possibly three pits have been dug. They have only low raised rims and are noticeably rectangular. Immediately below them, situated in an extremely stony hollow between the fans are another five or six pits of similar appearance. Three of these hold water after heavy rain. On the hillside to the southeast are traces of five conventional rows running down the slope parallel to one another.

A similar arrangement of walls and pits is encountered on high ground between the southern fan and a rocky gully marking the northern boundary of the Ngawi township. Here, too, a natural terrace remnant has two pits along its outer edge while a few stone rows run down the slope below it. A pit with a more prominent rim is located about 50 m north and this is associated with another two walls.

During the course of bulldozer excavations of house foundations at Ngawi, shell midden in association with a possible stone row was uncovered from under a metre of fan debris. One cannot argue from this discovery that a group of walls lies buried beneath the various fans on which the township is built, for the burial of the midden could have taken place as a result of European attempts to channel the six seasonal streams which, after heavy rain, flow down from the rocky face above with considerable movement of shingle. No system of walls is apparent on the 1944 aerial photographs which were prepared before the settlement began; so it seems likely that if large scale burial is ruled out only a few walls were built on the Ngawi fans in prehistoric times.

The southern edge of the bay is quite rocky and was obviously well endowed with shellfish. A large area of midden is at present being eroded by the sea and occasional floods just north of the Ngawi farm homestead. This area is also well known for its perennial

spring. The midden site may be associated with the Ngawi-South Waihero walls, but it should also be remembered that it is positioned about half way between the nearest Ngawi pit-wall complex and the northern group of the Black Rocks walls which does not have an associated midden area of its own.

11. BLACK ROCKS POINT (Figure 17)

The 16.2 ha wall complex at Black Rocks is not only the largest single complex in eastern Palliser Bay but it extends over the full range of topographical positions encountered elsewhere: consolidated fans, raised beach ridges, and the lower slopes of the coastal hills. It is made up of 11 distinct wall clusters, separated from one another by such features as a stony hollow between fans, a row of beach ridge hollows, a swamp and a group of sea stacks. This spatial separation which is not marked at the other areas gives a misleading impression of the amount of ground enclosed by the walls. In fact, wall building at Black Rocks probably involved a similar amount of effort and actual area cleared as at South Pararaki.

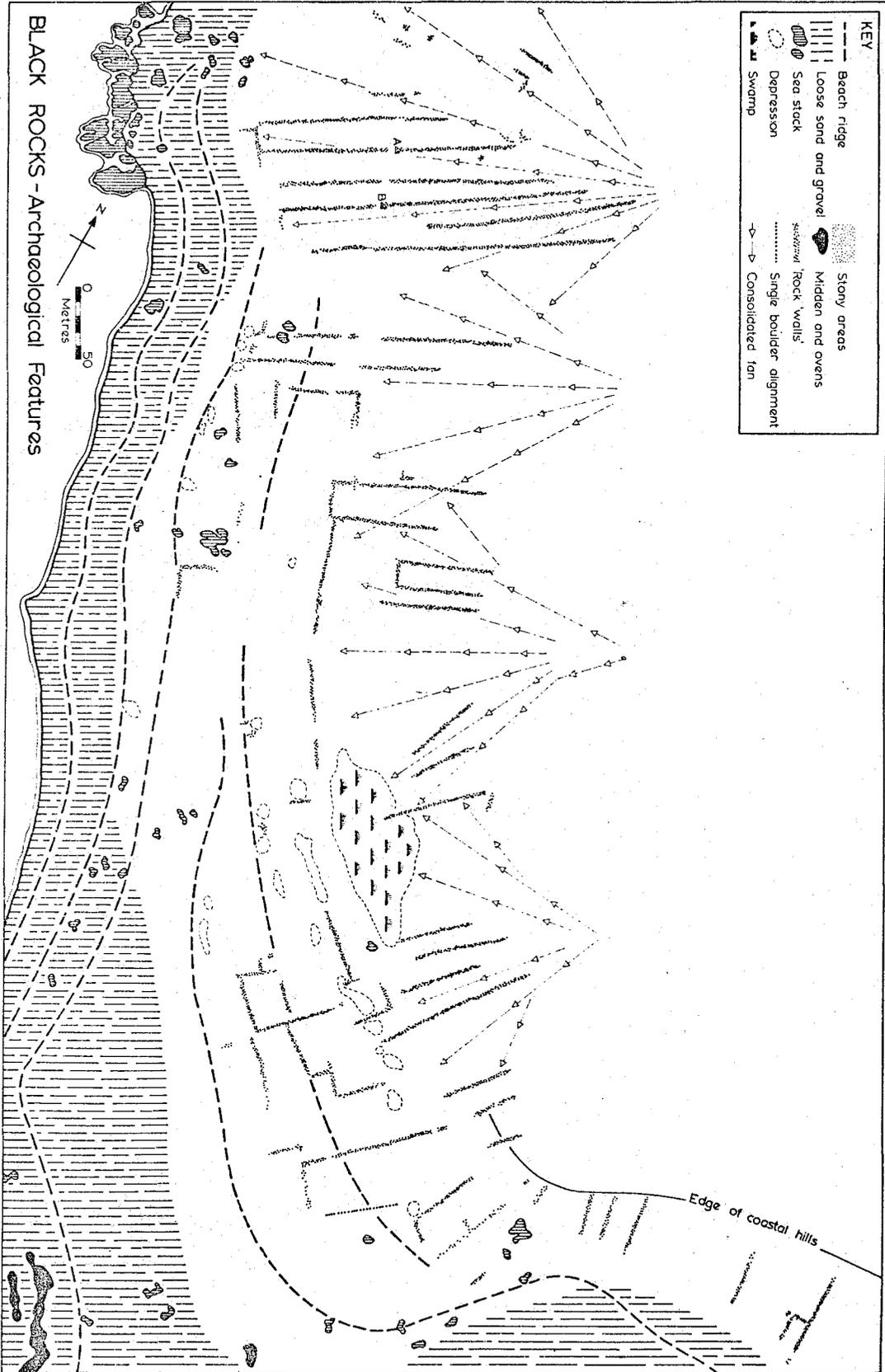
Black Rocks Point was built up around a spine of hard rock which runs from the ridge inland, across the coastal plain where it is apparent as massive sea stacks, and finally takes the form of a two-pronged parallel reef which terminates some 600 m offshore (Anderson, 1973:93). Over time marine debris was piled up against this spine, making up at least five separate beach ridges. Anderson notes that

"Coarse windblown sand probably migrating westward, as it is doing today, has covered the whole area with the exception of the most recent ridge, and has been lightly weathered."

(ibid.)

East of the rocky spine the transition area between raised beach and steep hillside is a zone of mixed alluvial and taluvial material, mostly fine-grained but with a few angular stones derived from the rocky slope above. West of the spine this zone is occupied by four large consolidated fans which are generally steeper than those of the Waihero or South Makotukutuku area. The northernmost fan of the series is actively cutting down along its northern edge while the other three display a long established vegetation pattern. While it is clear that

FIGURE 17



no fan formation has taken place for some centuries on any of these fans, it is possible that the largest fan was only recently consolidated when wall building began. In support of this view is the fact that the first and second beach ridges are continuous and well marked around the toe of this fan while the third, fourth, and fifth ridges appear to be buried by it.

Situated on this northern fan are two groups of rows, the smaller oriented about 98° E, and the larger 54° - 59° E. In the first group two rows 14 m apart run only a short distance down the fan. Another length of row makes a right angle corner with one of these. Some 60 m below are two mounds and some elongated scatters of stones, oriented in a similar fashion. There is little possibility of burial of features on this fan and as there is no sign of recent channel formation it must be concluded that wall building was never more than a short lived exercise on this part of the fan. In contrast the larger group which occupies the southwest slopes of the fan is remarkable for the amount of wall building in evidence. Apart from a rough corner of stones, two small piles, and a short transverse wall, the walls here were obviously intended to be parallel rows. Spaced from 10 to 24 m apart they are exceptionally long and four out of the total of seven walls exceed the dimensions of the longest walls of any other complex: they measure 212, 208, 186 and 178 m. The longest walls originate high on the fan near its apex, and five of the walls run as far as the toe of the fan. Only one seems to have continued on to the beach ridge area, probably because of the presence of a deep hollow in front of the southwest corner of the fan. Although the individual walls are impressively straight, they are not strictly parallel to one another. This is most marked with the fourth, fifth and sixth walls (counted from the northern boundary). The fourth, fifth and seventh walls are roughly parallel on the lower slopes of the fan, suggesting perhaps that the initial division of land took place at the seaward end. The fourth wall, however, was obliged to veer to the south in its higher reaches to avoid an irregular and stony hollow in the fan surface. The fifth wall beside it is straight in comparison and lies parallel to the seventh. Between them, what appears to be an unfinished wall is noticeably offset. The lowest portion of this wall seems to bisect the ground between the fifth and seventh walls, while the upper section veers to the north. There is reason to believe

that the wall-builders marked out the amount of separation they required between the walls at the bottom of the complex, and in the case of the sixth wall at its lowest point. The impression is also given that parallelism was not checked by measuring off the distance between the walls at various points along them, but by positioning a cord or row of stakes by eye from the base of the complex. Only in this way can individual walls run in a straight line and yet gradually veer away or towards one another. Everyone is aware of the difficulty of setting out truly parallel lines on a slope; indeed the tendency to judge divergent lines as being parallel is the basis of many optical illusions. If the lines are closer together at the top of the slope then it is likely that the observer was positioned there. In this case the increasing uphill divergence of the fifth and seventh and sixth and seventh walls indicates an origin at the base of the slope. This does not necessarily imply that the construction of these walls took place in an uphill direction (although this is the method followed in European dry stone walling), but that the future position of each wall was decided and probably marked out by cord or stakes, with reference to the seaward end of the complex. This hypothesis gains further support from the variety of heights at which the walls terminate on the upper portions of the fan. In contrast their lower boundaries are the lines formed by the third and fourth beach ridges. It seems that with the exception of the sixth wall each wall was built up from the seaward boundary as far as was required.

Separated from this group by an old watercourse running down the northern boundary of the next fan is another group of long walls accompanied by three transverse walls. The longest wall (168 m) begins at the edge of the fourth beach ridge, incorporates a sea stack, crosses the low swell of the fifth ridge and the flat land behind and runs for some distance up a consolidated fan. About 18 m south, another wall arises just behind the third ridge in the vicinity of typical beach ridge hollows. It runs for 140 m including a 40 m stretch on the fan. Another 18 m south of this a much shorter wall joins two sections of transverse wall situated on and behind the fifth ridge. Parallel to the western transverse wall is a 40 m wall. Its relationship to the beach ridges is difficult to assess for the fourth ridge is not able to be defined at any point

along the next 250 m of coastline.

This group may have been joined by the innermost transverse wall to the next group of walls which occupies the hollow between the second and third fans and the northern slopes of the third fan. There is some evidence that this transverse wall is buried for part of its length, and there are also traces of a transverse wall in a corresponding position crossing the longest wall of the adjacent group. Even if this proved to be correct, the positions of the western boundaries of the two clusters are so far apart (70 m) that it is hard to imagine that they were laid out as one group.

The fourth complex consists of five long walls, two pairs of which are joined by short transverse walls. In addition a transverse wall at least 170 m long runs out from the foot of the second long wall, curving slightly around the base of the third fan in a similar fashion to the long transverse wall at South Pararaki and the south section at Te Humenga. Clearly this marks the western boundary of the group. On the seaward side the land is flat and along the fifth beach ridge it is extremely stony. Apart from a corner marked out by two rows in the vicinity of the third ridge there are no signs of wall building in this stony area. The choice of the fan slopes as a site for the third complex was obviously not made because the beach ridges in front were already utilized, nor because the fans possessed a better supply of wall-building material. In fact the beach ridge area is furnished with enough stone for the construction of really massive walls. The solution to this problem is apparent if the walls are viewed as a bi-product of some activity concentrated on the land between the walls. If the fan was chosen because it was less stony, then the walls are in the same category as 'consumption dykes'. It will be remembered that at the South Pararaki there was a similar example where wall builders had avoided particularly stony land.

The fifth group is built on the southwest slopes of the same consolidated fan. It consists of three main rows, a stone pile and another possible row. The longest wall runs down beside the hollow between this fan and the next and then extends nearly 16 m out into a permanent swamp, perhaps allowing access to a pool of clear water.

The three walls exhibit marked divergence in angle, but this is clearly influenced by topography: the positions of the first and third walls are dictated by the orientation of old water channels, while the middle wall roughly bisects the angle between them.

Immediately to the southeast of the swamp a group of five long and two transverse walls occupies an extensive area of land on the fourth fan and the flat ground in front of it. The western boundary of this group is composed of two transverse walls and a line of hollows behind the fifth beach ridge which is now so modified that it is more a broad swell than a clearly defined ridge. As with the other groups situated on fans there is no well-defined eastern boundary. Two of the five long walls extend more than 20 m further uphill than their immediate neighbours. Although there is a gap of 55 m between this group and the three walls on the hillslope just to the south, the cleared appearance of the intervening ground surface and the parallelism of the walls suggest that they belong together. The middle wall of this group is interesting for the incorporation of a natural sea stack about half way along the row. This practice has been noted in other complexes and may be taken as further evidence of a tendency to use natural markers in processes of land division.

The flat ground in front of these hillside walls is occupied by two further groups which although adjacent to one another exhibit quite different angles of orientation: the northern group 44° - 46° E, the southern group 24° E. The northern group extends from the broad shallow hollow between the fourth and fifth beach ridges on to the fifth ridge. It is composed of seven walls lying at right angles to the hillside and seven parallel to the neighbouring beach ridges. In many other localities it has been shown that 'long' walls predominate numerically over shorter transverse walls and this is particularly true on the fans of Black Rocks. However this group is not directly bounded or delimited by fans, steep hillsides, or sharply defined beach ridges, and so it seems that greater emphasis has been placed on artificial boundaries in the form of transverse walls to indicate the western and eastern edges of the 'enclosures'. Despite this increase in transverse walls, the long walls are still dominant in terms of total length (about 307 m as opposed to 226 m). The southernmost wall of this group is the only

alignment to be seen at Black Rocks. It does not have the appearance of carefully selected stones as at the Washpool, but is reminiscent of the two Waiwhero alignments which have had extra stones placed against them. There are indications from the aerial photographs that some sections of the long walls have been buried, especially towards the centre of the hollow. In particular the third and fourth long walls from the north end seem to have been affected. In contrast there are signs of deflation in the smaller group of walls just south of the alignment. Although the area is quite well grassed today all but one of the four long walls are low and scattered.

The next two groups (of three and four walls respectively) are situated at the foot of the hillslope between 40 and 200 m from the massive sea stack which marks part of the 'spine' of Black Rocks Point. Although these groups are close to those previously described they face southsoutheast and are much more exposed to cold, spray-laden winds. There are two small consolidated fans on this strip of coast just beyond the walls, and traces of midden were found on the northernmost fan exposed in the side of a channel. Only a few metres east of the second fan a zone of wind-blown sand begins. This covers both the narrowing coastal platform and the hillslopes above and extends as far as the mouth of the Mangatoetoe River.

The 22 separate middens of Black Rocks Point were investigated by Anderson (1973); they are concentrated between the second and fourth beach ridges close to the northern edge of the central spine and behind the southeastern ridge. None occur in front of the groups of walls on the consolidated fans. This represents an unusual clustering of middens when compared with the Pararaki, Washpool or North Kawakawa situation where the middens run along the front of the wall areas. A consideration of food collecting strategy, however, reveals that the rocky shore shellfish and other marine creatures being sought could have been taken with least travelling and in greater abundance on the point. This rocky prominence offers nearly three times the collecting area than an equivalent strip of straight coastline. The innermost midden is only 100 m from the nearest wall and it was C-14 dated to 1147 ± 54 A.D. Another large midden can be assigned to the period before 1400 A.D. and it is believed that many of the remaining unexcavated mounds belong in this period. Such a finding is consistent with dates and artefactual material obtained from

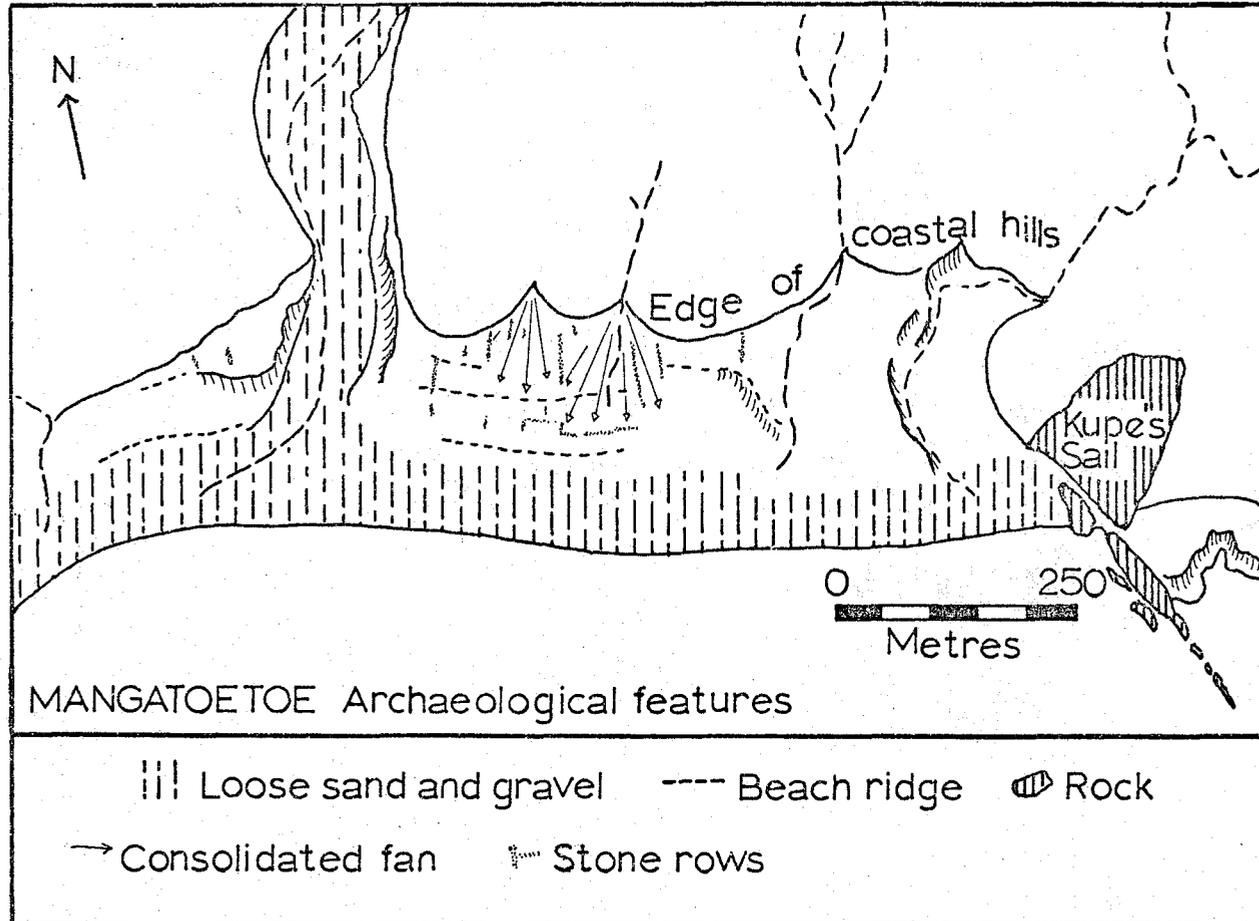
other Palliser Bay middens.

12. MANGATOETOE (Figure 18)

Just over 1 km southeast of Black Rocks Point the Mangatoetoe River flows into the sea via a ponding area and bar which is typical of other river mouths in eastern Palliser Bay. On the north bank two stone rows occur on a triangular river-cut terrace at the foot of the hillslope. On the south bank a larger area of walls occupies a strip of coastal platform showing traces of three beach ridges. The type of vegetation on the prominent ridge closest to the sea indicates that it is almost certainly older than the first ridge at Black Rocks or the Pararaki River mouth, and indeed it is even more consolidated than the second ridge at either locality. Behind it is a deep hollow into which a spring drains, and then the next ridge - behind this two small alluvial fans have covered the middle portion of the highest ridge. The Mangatoetoe walls cover an area of 3.64 ha from the river mouth to the edge of a small water course near the Mangatoetoe stockyards and woolshed. They consist of nine rows running down the sloping ground behind the upper ridge, five shorter rows occupying drier portions of the hollow, and an irregular transverse wall which runs along the bottom of the hollow and is divided into a number of segments. The longest wall (80 m) begins on the larger consolidated fan and extends into the hollow. It is not built directly over the beach ridges for at this location they are well buried by fan sediments. The other upper rows stop at the inner beach ridge. The practice of using a natural beach ridge as a termination point has been found to be a common feature in Palliser Bay. Also remarked on elsewhere were small semi-enclosures situated at the foot of long wall complexes (e.g. North Kawakawa). Two similar features occur at Mangatoetoe at the southeastern end of the hollow: one is a three-sided rectangular figure open towards the beach, the other consists of two short rows meeting at right angles about 12 m to the south.

No midden is visible in the vicinity of these walls. To the north the nearest midden occurs on the fan marking the southeastern boundary of the Black Rocks walls, over a kilometre distant. The nearest midden to the south occurs in association with walls in the next bay, Cape Palliser, also more than a kilometre distant. There is of course a possibility that an occupation site with midden and oven debris was

FIGURE 18



present near the mouth of the river as might be expected from the Washpool, Pararaki and Kawakawa examples, but that it has subsequently been eroded. One further possibility should be considered: in the course of a coastal survey conducted between 1958 and 1962, Wellman recorded oven stones and moa bone (Euryapteryx geranoides) at a depth of approximately 30 cm in a section at Kupe's Sail, a rock formation 300 m southeast of the Mangatoetoe walls. The author spent some time searching for this midden but the task was complicated by a number of conflicting points in the published description:

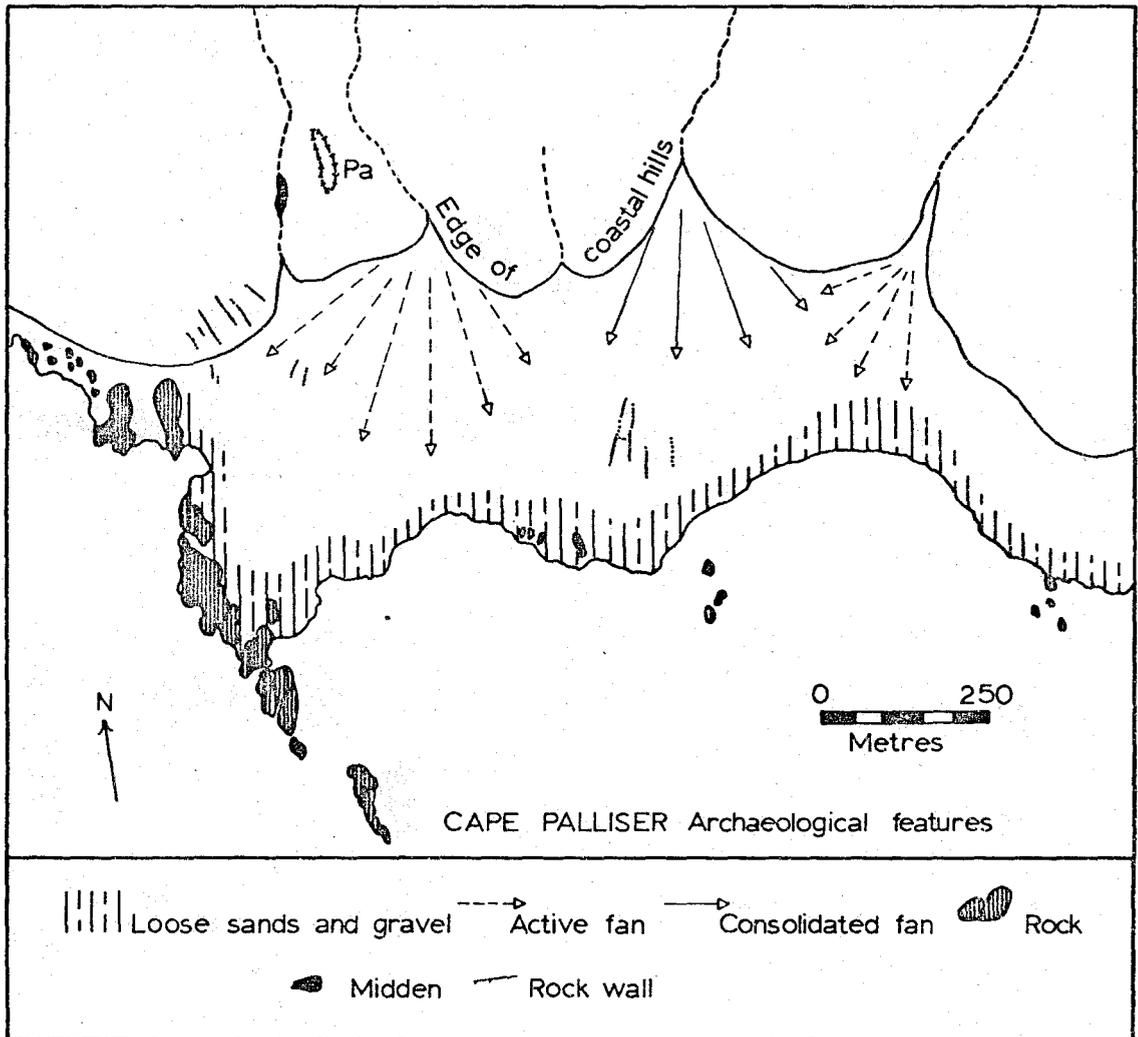
1. The grid reference given is N168, 798827 which is a point on the coast 0.8 miles southeast of Kupe's Sail
2. The section is said to be "two miles west of Cape Palliser lighthouse at the point where the Tertiary sediments of Kupe's Sail reach the coast" (Wellman, 1962:38). In fact Kupe's Sail is 1.4 miles northwest of the lighthouse, while the Mangatoetoe River is exactly two miles away.

From a geological and topographical point of view the location of the small bay where the section was exposed had to be immediately adjacent to Kupe's Sail at grid reference 787834. This bay is the only bay where a ten foot deposit of sand and beach boulders on top of sandstone is exposed. Unfortunately although this section was examined closely no oven stones, moa bones or other midden were visible at the time of the 1970 survey. If Wellman's identification of oven stones is correct, this site might qualify as a possible occupation site associated with the Mangatoetoe walls. The absence of shell midden is surprising, however, as is the presence of moa bone which has proved to be an extremely rare component of Palliser Bay middens.

13. CAPE PALLISER (Figure 19)

Equidistant between Kupe's Sail and the lighthouse on Rocky Point is the jagged reef known as Cape Palliser and often referred to as the Matakītāki-a-Kupe Fishing Reserve. This reef marks the western end of a rather exposed bay (Kirikiri Bay). The first group of walls is encountered among the houses on a south-facing hillside directly behind the reef. This slope is one of the few areas in the bay which has not been covered by alluvial fan debris. There are six clearly defined stone rows running down the hillside and a further two rows partly obliterated by European activities. In a gully immediately east of the walls a quantity of midden (Haliotis shell

FIGURE 19



and dog bone) has been observed at the foot of mature karaka trees which grow in the shelter of the steep hills. Overlooking this gully the end of a spur shows clear signs of modification by terracing and the construction of a shallow transverse ditch. At least three rectangular pits occur within the 'defended' portion, one with a definite raised rim. This 'pa' seems to be a little more elaborate than the terraced spur overlooking the North Kawakawa walls, but it does not seem big enough for regular habitation nor strong enough to withstand attack. Like the majority of coastal pa of the southeast North Island it seems to have been built as a 'lookout' and 'hideaway' for storage pits and possibly a few houses (qv. Leach, B.F. 1976:103-4).

Two stone rows are visible on the semi-consolidated fan in front of this 'pa'. Occupying a similar position at the southwest corner of the second fan in the bay is a small group of four rather irregular rows. The longest pair (100 and 85 m) enclose fairly rough sloping ground which is divided into two portions by a low terrace. These walls have been sectioned by the modern road revealing fine alluvial debris and some charcoal.

In general none of the walls at Cape Palliser exhibits the same precision of layout seen at Black Rocks Point. They are much more like the river terrace walls of the Kawakawa Valley and the fan walls of South Waiwhero. It may prove to be significant that the majority of irregular walls in Palliser Bay are in close proximity to raised rim pits. Certainly the Cape Palliser walls fall into this category. Another feature which characterizes these groups is their utilization of a relatively small portion of a much larger expanse of apparently suitable ground. In the Cape Palliser case only a small area of the two semi-consolidated fans has been used. Together these features suggest a variation in standards of wall building and land use which may be of chronological significance.

Although the survey and detailed mapping was terminated at the Cape Palliser lighthouse, this was no more than an arbitrary boundary settled on because of the more difficult road conditions beyond the lighthouse. On the other hand the northern boundary of the coastal walls in Palliser Bay is determined by the absence of the coastal platform north of Whatarangi and the presence of a belt of papa or soft rock

country, both factors of some significance to wall builders. It was decided to investigate the coastal platform beyond the lighthouse to determine whether any such boundary occurred at the opposite end.

Immediately east of the lighthouse begins a series of massive alluvial fans, many of which are active over all parts of their surfaces. The remaining semi-consolidated fans show almost no signs of wall building. Prehistoric sites have been recorded in a few places.

At a point 1.1 km east of the lighthouse, a truncated fan with several terraces and raised-rim pits (N168/84) was located. About 0.2 km east of N168/84 a few stone rows occupy a triangle of ground between two fans. It proved difficult to determine the extent of these walls because of scrub growth and encroachment by alluvial debris (N168/85). A further 1.85 km from N168/85 on the west bank of the Waitutuma Stream several stone rows occur near a free-standing stone wall (locally known as The Stone Wall). The latter may have been built to mark the Ngapotiki - Matakītaki boundary in the late 19th century. In several places it has been constructed over the top of the stone rows. This area is one of the few localities on this strip of coast which is not encroached on by shingle fans, and which exhibits some depth of soil. Another favourable feature is a clear, abundant stream and a two-tier waterfall (N168/86). About 3.2 km from the Stone Wall two very large pits were recorded at the base of the coastal hills opposite Te Rakauwhakamatuku Point (N168/87). Ngapotiki, 1.3 km north of this point, is the centre of a number of small sites. The first (N168/88) is a single stone wall and pit located beside a stream on the coastal flat. The largest group of walls (N168/89) occupies a terrace of the Waiarakeke Stream separated from the coast by low hills. A ditch and bank feature (N168/90) has been observed on these hills. More walls were visible in 1944 at the mouth of the stream (N168/91), while 0.5 - 1.2 km further along the coast several walls, mounds and pits occur on raised beach ridges (N168/92-95). No more walls occur for 5.3 km although pits, ovens, a pa site and middens occur in the White Rock-Opouawe area. Walls in the Oroī-Pukemuri coastal strip are typically isolated in small groups. N168/98 consists of four walls and possible pits while N168/100 on the south bank of the Oroī Stream is the largest complex with ten walls, stone mounds, and at least two pits. The next group, nearly 1 km to the north is

made up from four walls enclosing a rectangle of cleared ground (N168/106). Three walls and three pits are associated at N168/109, and the same association is recorded for N168/114, 117, 118.

There is no need to discuss stone wall evidence from locations north of Pukemuri Stream for the pattern of distribution should be clear: there are far fewer stone walls northeast of the lighthouse than on the eastern shores of Palliser Bay. Between Whatarangi and Cape Palliser over 80 ha of wall complexes have been described, comprising an estimated 600 walls. The coastline from the lighthouse to Pukemuri Stream is nearly $1\frac{1}{2}$ times the length, yet a generous estimate of wall numbers is less than 150. Of course there are large areas of soft rock on this coast and this would explain the complete absence of walls at White Rock, which otherwise has abundant prehistoric sites. Nevertheless some explanation will be needed for the paucity of walls on the rock-strewn coast between the lighthouse and Ngapotiki. Clearly beyond the lighthouse (and in fact beyond Black Rocks Point) the wall-builders were not prepared to devote the same effort to these operations as in Palliser Bay itself.

CHAPTER THREE

THE ARCHAEOLOGICAL EVIDENCE

The Objectives of Excavation

In Chapter Two the stone wall complexes and the methods used to plot them were described in detail. This chapter examines the results of a number of excavations conducted at stone wall sites. Since many walls were free from post-construction soil deposition, particular attention could be paid to their areal distribution, without the need for excavation; however, there are still aspects of excavation which contribute more than a site plan. Constructional details of walls can be learnt only from sections, while stratigraphical details necessary for assessing contemporaneity of features only become apparent by methodical removal and analysis of soil layers. Stratigraphical control is also essential for sorting out the chronology of the walls by carbon dating charcoal pieces found within and below them, or by using various artefacts found in association as 'culture markers'. Similarly, the significance of any associated faunal or floral remains depends on accurate positioning by layer.

Given the overall objectives of the project, the excavations were designed to obtain charcoal for C-14 analysis from stratigraphically secure locations, to clarify the chronological relationship of the various types of wall to one another and to the intervening soils, to establish the range of construction methods, to seek out midden and artefact deposits incorporated within walls in order to elucidate the identity of the wall builders; and to discover any evidence, either aspects of wall building procedure or actual plant or animal remains which might suggest particular functions. To these ends a variety of excavation procedures were followed, from area excavation (often removal of turf and post-occupation soil layers only) to sectioning walls with trenches or even trimming existing sections cut by bulldozers and graders along roadside edges. The excavation technique stresses sections rather than exposure in plan, due to the degree of surface visibility of the features. One large area excavation was undertaken at the Washpool to provide information about the soils between the walls, as well as the usual wall details.

Just as an understanding of the geological history of Palliser Bay and the Wairarapa Valley assists in the study of wall distribution and layout, it is also useful to understand the basic processes of soil development using the various local parent materials, and to have some knowledge of local soil types.

Soils of Palliser Bay and the southern Wairarapa

No detailed soil descriptions of the Wairarapa have appeared, with the exception of a survey of soils and horticulture of the Greytown area in the Wairarapa Valley (Cowie and Money, 1965). A general picture emerges, however, from the economic survey conducted by the Department of Industries and Commerce (Anon., 1968), from the North Island section of the recent New Zealand-wide survey (Gibbs, et.al., 1968) and from its fore-runner (Anon., 1954).

Two major zonal soil groups are to be found in the Wairarapa. The central yellow-grey earths have formed where a well-defined dry season exists, with annual rainfall less than 1143 mm. According to Gibbs et.al. (1968:57) "they are derived mainly from lightly consolidated alluvial, marine, or wind-blown sediments". Their topsoils are greyish brown and friable, with firm pale-yellow subsoils, in some areas compacted to a fragipan at a depth of 40 cm or more. Their friability and moderate fertility would have made them suitable for prehistoric cultivation, but this advantage may have been offset by seasonal dryness. The central yellow-brown earths occupy locations receiving higher rainfall and are believed to have originated under forest. Their topsoils vary from greyish-brown to brown loams, while the subsoils are yellowish-brown firm clay loams. In Taylor's view, they were not suitable for prehistoric horticulture because they contain too much silt and "tend to pack down and seal with cultivation" (N.H.Taylor, 1958:73). The parent materials of the yellow-brown earths range from siltstones and mudstones high in nutrients to argillites and greywackes of moderate fertility. Where these soils supported broadleaf-podocarp forest, nutrients washed into the subsoil were continuously returned to the surface, maintaining fertility. However the yellow-brown earths formed on hard sandstones, seem to have carried beech forest which fails to restore nutrients lost by leaching.

Azonal soils are chiefly represented in the Wairarapa by

central recent soils formed from alluvium deposited on valley floors. They are moderately to highly fertile and range from slow-draining clay and silt loams to free-draining and friable alluvial sands, the latter highly suited to horticulture.

The distribution of these soil types closely follows the topography of the southern Wairarapa. Soils of the western range are yellowish brown stony loams derived from and thinly mantling hard greywacke material. The valley floor is covered by central lowland soils, which can be divided into three groups: floodplain, river terrace, and rolling lowland soils of the eastern fringes of the valley. The flood plain soils were formed from flood-borne deposits of sand, silt and clay particles, varying in their properties according to the predominant grain size. Above flood level, the river terraces carry yellow-grey earths, "formed by dust blown from dry river beds accumulating over river gravels and stones" (Anon., 1968:44). Where the wind-borne material is thinly spread, drought effects appear rapidly. On the rolling lowlands, the yellow-grey earths take the form of yellow silt loams of powdery consistency lying over a strongly compact subsoil. This subsoil frequently impedes drainage of winter and spring rain and causes water-logging.

The eastern hill country presents a patchwork of yellow-grey and yellow-brown earths. Those soils of the former group lying within the dry season zone exhibit greyish brown fine sand-silt loams underlain by over-compacted clay loam subsoils. In summer they are prone to drought, while in winter surface pugging and erosion result from impeded drainage (Anon., 1968:45). In the cool high rainfall areas of the Aorangi Range, climatic factors cause only slow decomposition of vegetable matter which builds up as a peaty mor, contributing to high acidity and low fertility of the underlying soils.

Although this picture is relevant to wider issues such as the possibility of successful prehistoric horticulture in various parts of the southern Wairarapa, the archaeologist excavating in the coastal sites in eastern Palliser Bay does not encounter the zonal soils which extend over so much of the soil map. Most coastal sites occupy azonal soils formed on beach deposits ranging from coarse sands to gravels, with abundant waterworn greywacke stones. These soils

have a poorly formed 'A' horizon resting directly on a 'C' horizon of unweathered gravels. The depth of the 'A' horizon increases with the period of exposure of each beach ridge since initial uplift or sea level change. This soil type has not been described in the context of Wairarapa soil studies, but is similar to Taumutu (very) gravelly sandy loam which occupies an old shoreline of Lake Ellesmere in Canterbury, and to the synonymous Taumutu stony gravels mapped at Wairau Bar, Lake Grassmere, the Kowhai River mouth and Conway River mouth on the Kaikoura Coast. The Taumutu topsoil consists of a loose, dark greyish-brown sandy loam or gravelly loamy sand lying on olive grey loose sand or fine gravels (Ward et al., 1964:18-19). Those of the Kaikoura and Blenheim areas have topsoils which are

"commonly black in colour and 9 to 12 in. deep. The colour and deep penetration of the humus is attributed chiefly to the effects of large amounts of salt spray blown on to these soils during heavy storms"

(Gibbs and Beggs, 1953:23)

In Palliser Bay these former beach sands and gravels may have an additional deposit of silt overlying them. In places this appears as a compact light yellowish-grey silt or sandy loam; it may be of wind-borne origin or a result of high intensity rainfall washing topsoil off adjacent hills. In some locations the silt is derived from riverine flooding.

The consolidated fans which cover large parts of the eastern Palliser Bay coastal platform have a different type of azonal soil formed on them. Generally the topsoil is a shallow brown sandy loam or stony silt loam resting directly on alluvial gravels and stones (referred to as Tukituki sandy loam by Anon., 1954). Near the toe of the fan the history of build-up may show as a series of alluvial gravels, sand or silt layers on which some topsoil development has taken place before new unweathered material has been washed over it.

The Excavations

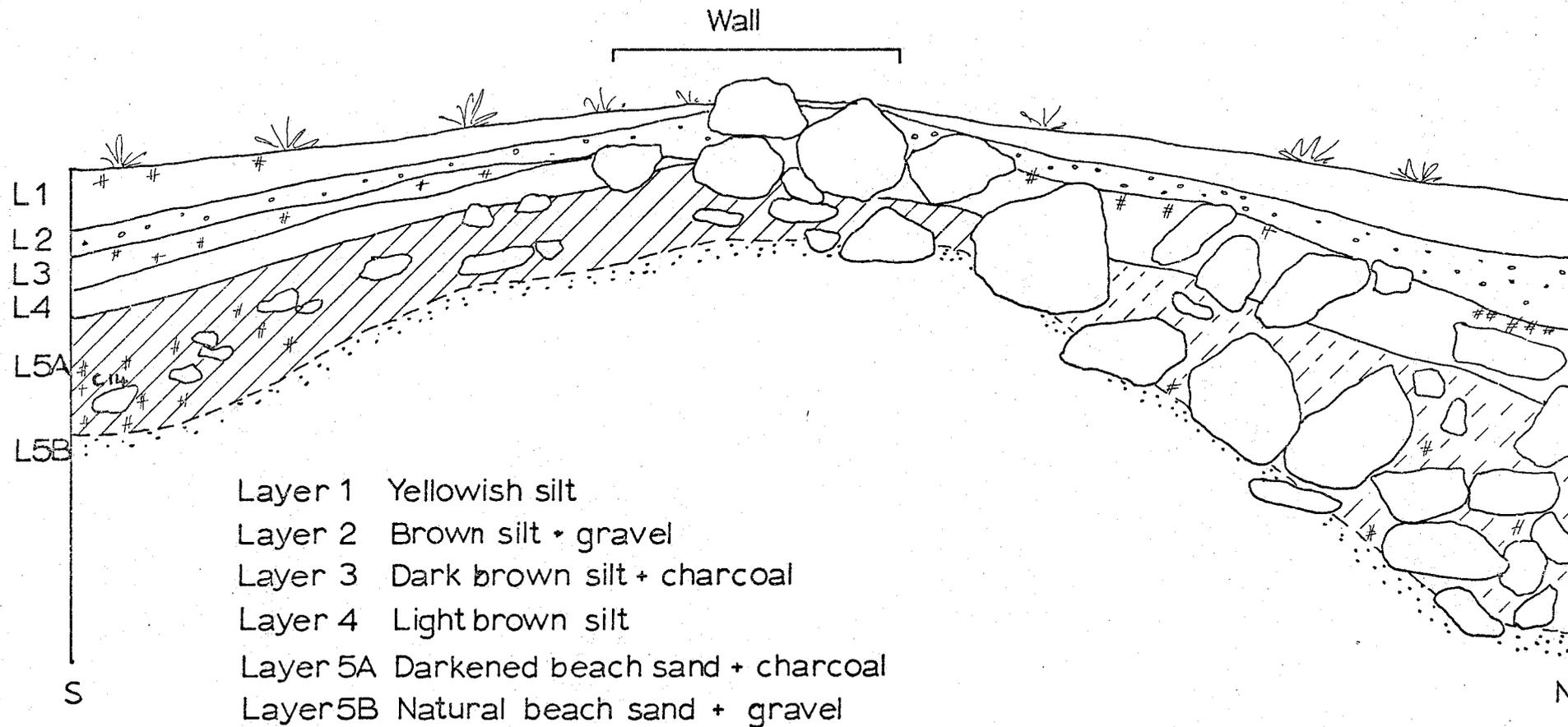
To facilitate comparison with the surface feature descriptions of Chapter Two, the excavations will also be discussed according to their location on the coast, proceeding from north to south.

WHATARANGI

Because of the sea and wind-induced erosion of the northern "Great Wall of Whatarangi" area and the disturbances caused by fencing

and road building near the midden area, it was decided to excavate a section of wall 120 m north of the Whatarangi Stream road ford, near the southern limit of the complex. Here, because of topographical factors, it was expected that the soil layer contemporary with the wall construction would be buried under silt outwash and any charcoal within it well sealed. The wall chosen for excavation was about 20 m long and of uncertain width. It appeared as a low mound barely rising above the surrounding silty ground. It runs between the two stony beach ridges which have themselves been modified by wall building both on the crests of the ridges and by the butting on of short walls at right angles to the ridge. In the case of the ridge walls any assessment of the extent of cultural modifications would be difficult to make, but with the 20 m wall running at right angles to the beach line there was no doubt as to its cultural origin. One, possibly two, other walls run across this hollow but their increasing proximity to the fan had resulted in a greater quantity of silt cover. A trench, 3.0 m by 1.0 m in area was laid out (N168-9/16), Excavation A on Figure 2) in order to expose the ground on both sides of the wall. Initially the southern 60 cm was excavated as a test pit, but the variety of silt layers encountered required them to be studied over a greater area.

Four discrete silt layers had built up against the wall on the southern side (see Figure 20). Although they were not level, water deposition seems the most likely explanation for their presence, especially considering the proximity of the Whatarangi Stream which has flooded frequently enough in the European era to make the construction of boulder barriers worthwhile. The process of silt deposition under water usually leaves a band of silt clinging to the submerged surface, whether this is flat or gently sloping, and although more silt may accumulate in the hollows, a distinct and relatively even layer can be observed on gently sloping surfaces after the water retreats. In this case, the uppermost layer, a light yellowish compact silt, has been laid down in recent years, since a piece of wire was found lying at its base, and there has been minimal humus development within the layer. The next silt layer is brown in colour and contains small pieces of water-worn grit evenly distributed through the deposit. Whereas the uppermost layer looks as though it is the product of sheet erosion of clays and silts, which settled under relatively calm conditions, as in a pond, the gritty silt of the second layer is indicative of riverine flooding



WHATARANGI WALL SECTION N168-9/16 (A)

FIGURE 20

and movement of the sediments as they settled out. The third layer was dark-brown, fine and even textured silt which contained small fragments of charcoal, while the fourth was a thicker layer of silt, light brown in colour, and without charcoal.

Beneath these silt layers the original beach sand-derived 'A' horizon was encountered. This was unquestionably modified by man by the incorporation of quantities of charcoal, by the removal of the larger water-worn stones to the wall, and by what seemed to be artificial deepening of the 'A' horizon away from the wall. This layer was humus-enriched and contained pumice pieces. The natural 'C' horizon beneath it is a light brown beach gravel with minimal humus staining.

The charcoal in this layer was most abundant at the southern end of the section, where the old 'A' horizon was most modified, and so it was decided to take the C-14 sample from this area. It consisted of 28.56 gm of small pieces of wood charcoal, much of which was obviously small diameter branches and twigs. The sample, which gave a date of 1405 AD \pm 68 (NZ 1309), dates the modification of the old 'A' horizon, and by stratigraphical association the construction of the wall one metre away.

On the north side of the wall, only three silt layers were superimposed on the gravel matrix, but in appearance they correspond to the three upper silt layers of the southern section. The top layer is yellowish, the second brown with gravel fragments, while the third is dark brown with charcoal pieces. Despite the colour and component similarities, these silt layers have a quite different texture. The southern layers were compact and relatively dry, while the corresponding northern layers were crumbly, broke apart in lumps, and had clearly been periodically water-logged. The large stones which are abundant in the northern gravel layer were all found to be coated by silt washed down from the upper layers. A little charcoal occurred in this gravel layer among the stones but not in the same quantity. Because of this difference it is not thought that ground on this side of the wall was cultivated (see below).

The presence of numerous stones on the north side of the wall raises the problem of whether they are natural or cultural accumulation. Natural hollows do occur between beach ridges and these are frequently lined by stones. However, the filling of natural or

artificial hollows with excess stones is also a recognised cultural activity in Palliser Bay. In this case the natural stone-filled hollow seems more plausible since the largest stones lie beneath the surface of the old 'A' horizon, directly on the unweathered gravels. For a man to have placed them in this position he would have had to remove the existing topsoil and then to have replaced it over the stones, an apparently pointless exercise. It will be noted that some smaller stones lie within the dark-brown silt horizon above the gravel layer (see Figure 20). In the light of other wall excavations, it is reasonably certain that these derive from the top of the wall and represent erosion of the wall contemporary with the presumed local flooding.

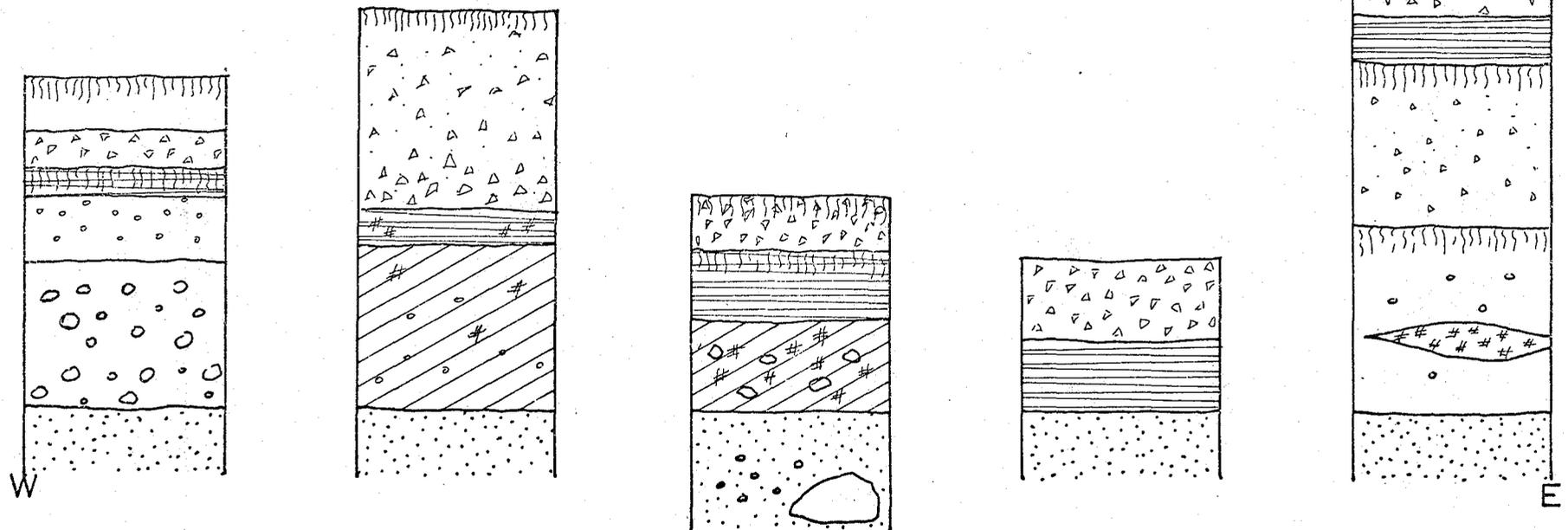
The wall itself is a typical low stone row, and at this point the original dimensions could not have been more than 50 cm high, and 1 m wide. The stones used in its construction are small beach boulders, heavily waterworn and almost certainly derived from the gravel 'A' horizon on the southern side. It is most noticeable that the stones remaining in this layer are all less than about 12 by 6 cm, too small, it appears, to be gathered up and incorporated in the wall. Although the wall is little more than an elongated heap, some trouble has been taken to make the southern face relatively straight; this suggests too that it was built from the southern side, and that it acted as a barrier between a cleared and uncleared area.

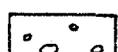
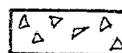
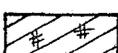
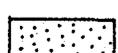
A series of sections (Figure 21) recorded along the banks of the dry creek bed of the Whatarangi woolshed fan (N168-9/19) illustrates the complex character of erosion in this area. Consistently the base of each section is light brown sand and gravel with occasional water-worn boulders, clearly of beach ridge origin. In all but one section there is evidence that a darker sandy loam has formed on this gravel layer, and charcoal is a frequent component, either in lenses or more frequently as finely divided fragments well mixed into the loam. This sandy loam appears identical to the old topsoil recorded in the Whatarangi wall excavation. Along the upper reaches of the Whatarangi woolshed fan creek an additional layer has formed on top of the loam. It contains fine gravel and another 'A' horizon has started to form on it. This process seems to have been interrupted by the deposition of a silt layer over much of the area at the commencement of a period of accelerated erosion, evident in the sections by alternating bands of

FIGURE 21

WHATARANGI WOOLSHED FAN SECTIONS N168-9/19

20cm



- | | | | | | |
|---|----------------|---|---------------|---|------------------|
|  | Humus staining |  | Silt |  | Sandy loam |
|  | Angular gravel |  | Modified soil |  | Light brown sand |

alluvial gravel and silty outwash. Naturally these are not uniform over the fan. The silt may have accumulated during periods of heavy rain when the main water course was depositing gravel over another part of the fan surface, while the appearance of the gravel band indicates that the channel has swung across the fan and was flowing close by.

It might be suggested that this fan was of minimal size during prehistoric occupation of the area, that is if the charcoal addition to the sandy loam was a result of some cultural activity. Furthermore, the period of accelerated build-up may have interrupted this prehistoric activity as in places charcoal has been washed down in the first major silt layer. If the date of the Whatarangi charcoal is any guide this erosion seems to have taken place in the last 400 years, and to have followed a period of relative stability.

WASHPOOL

A number of site types found on the coastal strip north of the Makotukutuku River mouth were examined by the Otago University archaeological team. This was the area of integration between B.F. Leach's field project in the Makotukutuku Valley and the author's research into coastal wall systems. Although the actual wall and enclosure excavation was directed by the author, B.F. Leach was responsible for the excavation of a circular raised-rim pit and D.G. Sutton an artificial terrace, both situated between the walls and the river bank. Because of the possible link between the activities at these sites, the pit and terrace excavation results will be brought into the discussion in Chapter Four.

In order to clarify the relationship between stone rows and alignments, 18 squares, each 5 m by 5 m, were laid out in an area of walls where there appeared to be several alignments running parallel to low rows, and where soil conditions showed partial burial and thus protection of the archaeological features (N168-9/20, Excavation A on Figure 3). The 18 squares, set out in a rectangle 6 squares in length along the north-south axis and 3 squares wide, were surveyed before the turf was removed and soil samples were taken every metre from a depth of 10 cm to establish a grid of pH values (see Appendix 2).

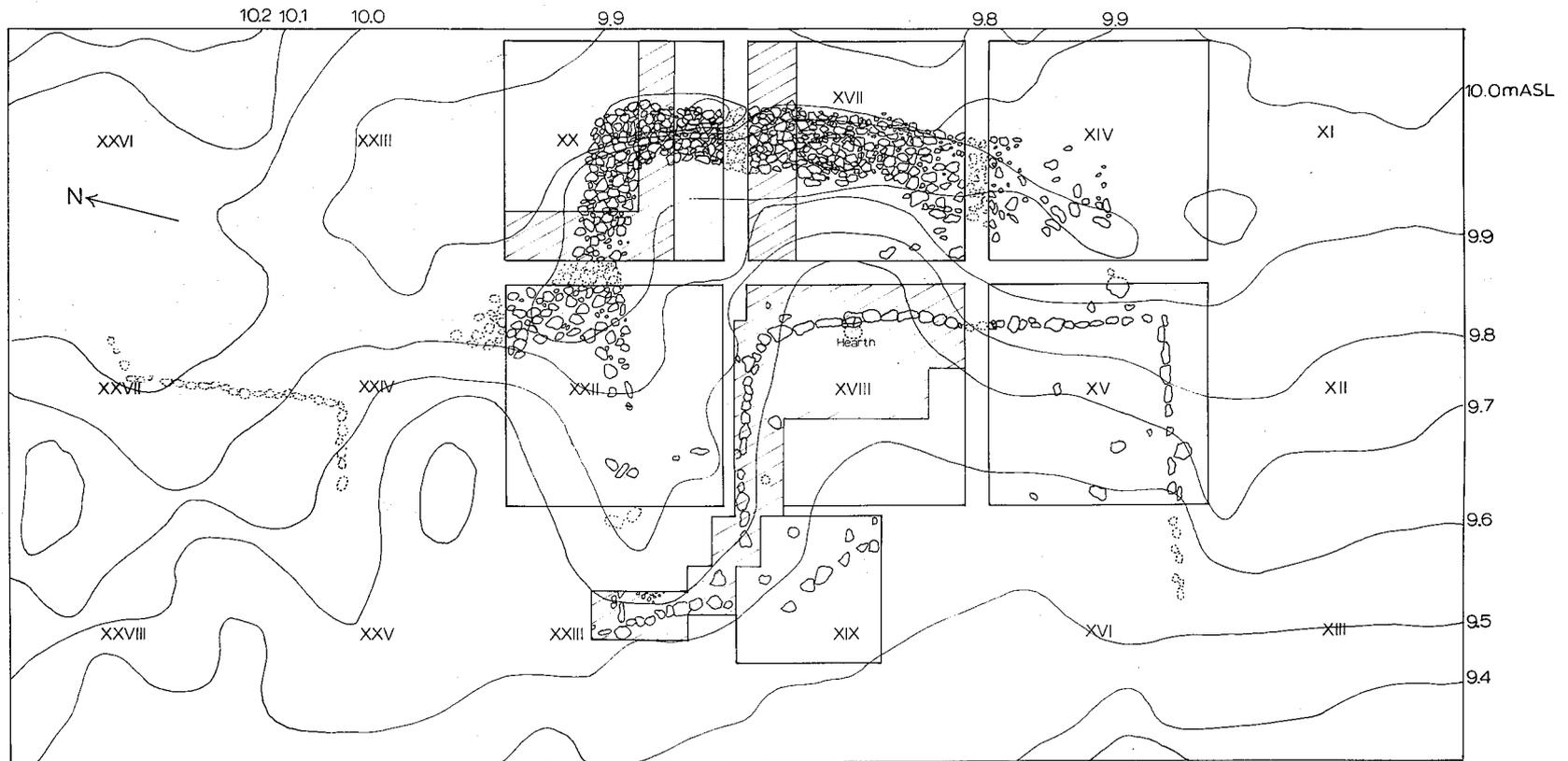
In the first season (January 1970) 6 squares (see Figure 22)

FIGURE 22 WASHPOOL WALLS M1/XI-XXVIII

Layer 2 removed

Area turfed

0 1 2 3m



were turfed leaving a 25 cm baulk around each (XIV, XV, XVII, XVIII, XX and XXI). These squares were chosen because they extended over the visible sections of the single boulder alignment and the massive stone row. The task of turfing was not straightforward except in square XV where the stones of the alignment stood out prominently against the stone-free brown sandy loam. Visually the alignment was rendered more striking but no new information concerning its layout and component stones was revealed; in fact since the stones were first set in place no significant soil build-up had occurred in this square. A similar situation prevailed in the neighbouring square XIV, where turfing revealed no unsuspected arrangement of stones. Although stones did not protrude through the grass cover in this square, the grass was desiccated over them and many could be felt underfoot. This collection of stones was correctly assumed to mark the southern border of the stone row. Square XVII, immediately to the north, could not be turfed readily with the spade because of the quantity of stones embedded in the grass and shrub mats. Over most of the square turfing was undertaken therefore with sharpened trowels and the surface stone was removed simultaneously. Soon it became apparent that this stone row had been built with well defined western and eastern boundaries subsequently concealed by the movement of rocks from the highest portions of the row, spilling down into the hollows on both sides of the wall. Although the western boundary had lost stones at a relatively early stage (the stones were thoroughly embedded in the top of the culturally modified layer), in several places the front of the wall was 'faced' by the use of the flattish surfaces of very large boulders carefully aligned to create a straight edge and possibly originally laid in two or three courses. Large waterworn boulders also occurred behind this edge but the majority of stones in the bulk of the wall were broken angular and smaller waterworn examples. The eastern section of the wall sloped down gradually to a rather more uneven but definite edge composed of smaller stones. This difference in construction complexity between the two edges of the row suggests that it was built from the western side, by first laying down an alignment of large boulders and filling in behind, and that it was intended to be viewed from the western side. In other words the centre of interest lay somewhere to the west of the wall, perhaps within the area edged by the single boulder alignment.

The next square to the west, square XVIII, contains a hollow

where small stones have accumulated in recent times, probably derived from the adjacent sections of stone row. It is interesting to note that most of the rock movement from the walls has taken place in post-European times. During the course of the excavations the erosion process was observed, when a mob of rams which had been grazing this holding paddock were rounded up for transportation elsewhere. In a short space of time the mob ran over the walls several times and despite the low shrubby cover, stones were displaced by up to 3 m on both sides of the wall. In square XVIII, this accumulation of stones was removed with the surrounding turf and a moist dark brown sandy loam was exposed, stone-free except for the tops of elongated boulders which clearly formed a continuation of the alignment already exposed in square XV.

Also turfed at this time, square XX included part of the main section of the row and the beginning of its western extension. On the eastern and northern edges recently displaced stones were cleared away to show a reasonably clear, rounded right-angled corner. On the western boundary of the main section particularly large stones were again visible but less trouble seems to have been taken with the front of the western extension. Although it maintains a relatively straight edge, stones are generally fewer and no large boulders were utilized.

The final square turfed, square XXI, suggested that the row divided in two, with one short leg turning north, another continuing in a westward direction. Stones were encountered directly under the turf on the eastern side of the square but few were visible on the brown sandy loam surface of the supposed westward leg. There was a definite mound, however, which continued into the next square XXII. During subsequent excavations in XXII this supposition was confirmed.

In addition to revealing the plan of the stone walls and any other concealed structural features, the Washpool excavations were designed to obtain stratigraphical information relating to the construction of the walls. Accordingly 2 trenches were laid out for excavation in squares XVII and XX, 75 cm and 1 m wide respectively. Layer 2A (see below) was removed from the first trench in square XVII, to expose the original layout of the wall, in particular 2 courses of large stones on the western face. Three large stones lay partly embedded in the culturally modified layer 2 in front of the wall, suggesting that a 3rd course had once been in place. Since this was the only part of the

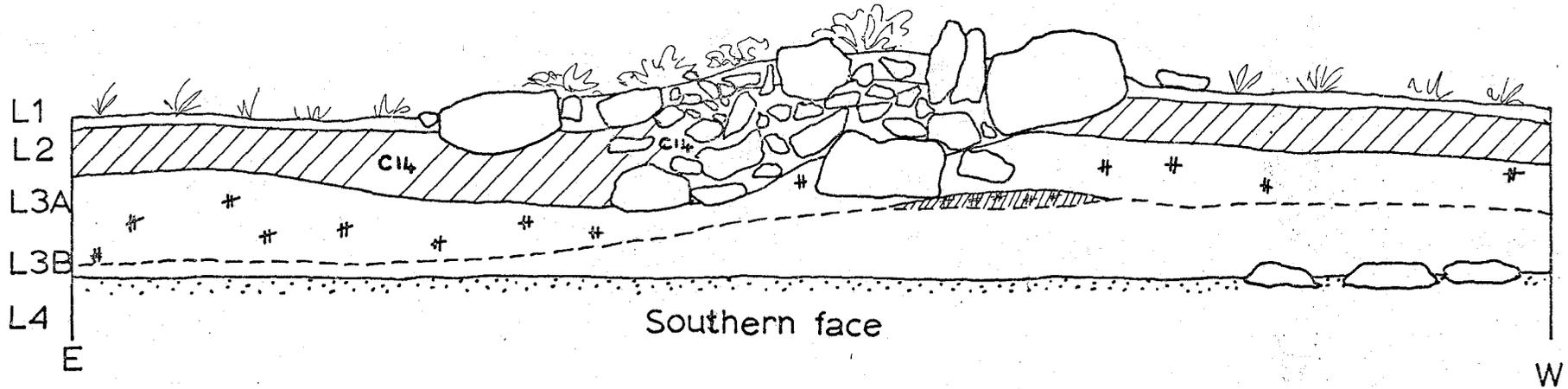
wall face in this square where the 2nd course was still present, the section was abandoned in favour of two trenches in square XX. Nevertheless sufficient loose stone and root mats were removed to show charcoal enriched patches along the eastern edge of the wall, and just behind the facing of the western edge. Samples were taken and the trench was filled in quickly to provide support for the facing stones.

Excavation of the second trench, in square XX, commenced in February 1970 (Figure 23). Work began at the eastern end of the wall and it was found that once the turf and root layer had been removed, along with numerous fallen stones there was a clearly marked division between the wall and the stone-free sandy loam beside it. This sandy loam (Layer 2) ranged in colour from light-brown to black according to the quantity of charcoal incorporated. In this trench it was found that the density of charcoal increased markedly towards the wall; quite large pieces were found at the base of the layer where a yellowish-brown sand was stratified. Even more charcoal, made up of larger pieces was present in the wall matrix, and blackened sand along with reddened, cracked stones and waterworn boulders. This may constitute evidence of the stones having been fired in situ, and the quantity of charcoal pieces tends to add support; however it must be pointed out that the greywacke stones in question crack into angular fragments under normal weathering conditions, and the red colouring could also be produced in this way. This phase of excavation terminated with the removal of layer 2 and the majority of stones embedded in it. Charcoal samples were obtained from the wall matrix itself and the black sandy loam immediately east of the wall.

The trench excavation was completed in August 1970 with the removal of the light brown sand (layer 3) which was found to contain lenses of charcoal lumps in its upper section. Beneath this sand, a level of coarser sediments was reached, with numerous red-stained beach boulders set in a pebble and sand matrix. Over a distance of 6 m the height of this surface varied a maximum of 8 cm. There is some reason to believe that this level marks a former tidal platform horizon, similar to one identified by E.F. Leach (1976:131) closer to the sea.

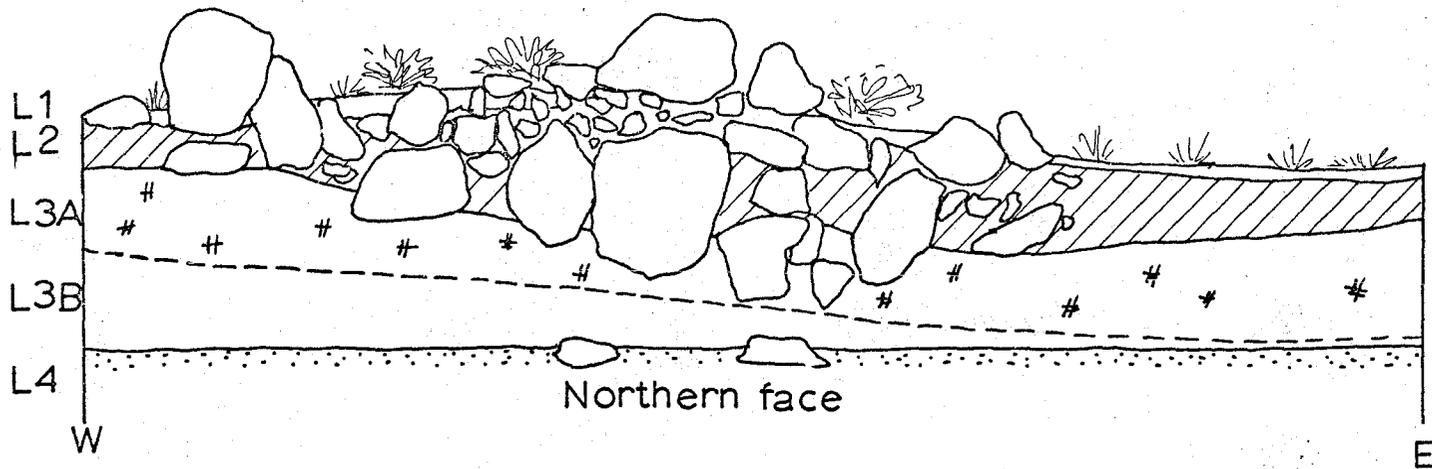
One other trench, running at right angles to the westward extension of the wall, was excavated in square XX (Figure 24). As

FIGURE 23



WASHPool WALLS M1/XX/6-10 E-W SECTION

20cm
└───┘



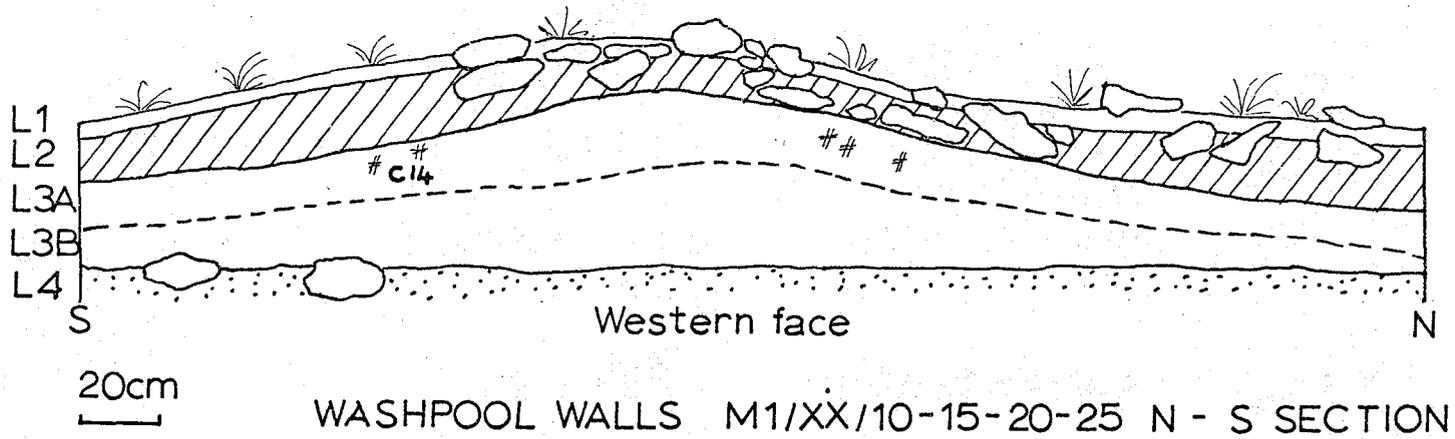


FIGURE 24

predicted the row was found to have definite edges, but these were not composed of large carefully placed boulders. In fact at this location the row consisted of a cap of stones (rarely two stones deep) covering a sandy ridge. The stratigraphy was similar to that recorded in the other trench:

- Layer 1 Turf and root zone, decaying grasses and low shrubs, fine angular fragments of rock resulting from weathering of wall stones
- Layer 2 Brown to black sandy loam or sand; where layer 2 is part of the wall matrix it is a black, charcoal-enriched, sand with little humus, while away from the wall it is manifest as a brown sandy loam
- Layer 3A Light brown sand with reddish brown staining in patches and lenses of charcoal
- Layer 3B Greyish sterile sand
- Layer 4 Waterworn boulders, red stained pebbles and coarse sand with near level upper surface; may constitute old tidal platform

These sections illustrate clearly that the walls were built up at the same time as the existing topsoil (the lower portions of the present layer 2) was modified by incorporation of charcoal. Where wall construction peters out, as in the second trench the stones have obviously been placed on top of the thin topsoil covering a natural sandy ridge. The presence of charcoal in a few places in layer 3A suggests a small amount of disturbance of the underlying sand at the time the stones were placed in position. Subsequently stones have slipped down from the top of the mound and a new topsoil has begun to form, characterised by wind-blown sand and silt, bound by dense roots. In the more substantial parts of the row there is evidence that the topsoil (base of layer 2) may have been dug into in order to lay the foundations of the row. At the same time charcoal became incorporated into adjacent areas of the exposed sand. The looseness of both layers 3 and 2 rules out any possibility of significant time differences between the incorporation of charcoal in layer 3 and the accumulation of stones in the wall above.

Three C-14 dates are available for charcoal samples collected from these trenches. From the wall matrix layer 2 in the east-west trench a 15.8 gm sample gave a date of 1608 AD \pm 78 (NZ1513), while a 11.5 gm charcoal sample from layer 2 to the east of the wall was dated to 1442 AD

± 79 (NZ1514). A 15.8 gm sample from the charcoal patch in layer 3 in the north-south trench was dated to 1562 AD ± 79 (NZ1512). Although the radiocarbon ages range fairly widely they are not significantly different (B.F. Leach, 1972), and can be combined to give a best estimate date of 1538 AD ± 49 for the soil modification and contemporary wall construction.

With the sections completed attention was turned to squares XVIII, XIX and XXII where the course of the single boulder alignment could be traced by removing the thick topsoil covering the stones. Another objective was to determine the composition and nature of soil layers enclosed by the alignment. Proceeding from the southern section of the alignment in square XVIII, it was found that the base of layer 2 dipped sharply and the stones of the alignment which had been embedded in the lower part of this layer followed the slope down into the hollow. It was particularly noticeable that the stones selected for this part of the alignment were much longer, more regular in shape and better fitted than in square XV. However, once the corner was reached smaller stones were again employed. Midway across the hollow it was found that a fire had been built up against the alignment on the seaward side, which was represented by patches of charcoal surrounding an ash deposit adjoining one of the boulders. Partly superimposed on the ash, and supported by this boulder was a flat-sided stone which had been positioned apparently deliberately to smother the fire. In support of this view two facts could be cited: the covering stone had cracked in situ along several planes directly above the ash implying the presence of heat, and furthermore, ash would almost certainly have been blown away on this windy coastline if left exposed more than a few hours after the fire had burnt down. Possible reasons for this behaviour will be examined below.

Just as the alignment turned a right-angled corner in square XV, it was found that a similar corner was located in square XVIII, where the boulders turn towards the sea again and run along the edge of the hollow. This was to some extent predictable for it appeared that the alignment and the row had been deliberately placed parallel to one another. The southernmost corner of the alignment appeared to have been disturbed, while the newly uncovered corner, by virtue of protection offered by the overlying layers, exhibited a smooth, carefully executed

curve of boulders indicating skill in positioning and choosing the component pieces.

In square XIX another change of direction was encountered, but here the corner stones are missing for a distance of 1 m, or, alternatively were never laid. Instead a new piece of alignment was discovered which runs a short distance at an angle to the main alignment and then peters out. In contrast to the latter, this example is made up of rather angular stones, which are not contiguous, nor, it appears, deliberately placed. It will be seen from the plan that less than half of square XIV was excavated, so it may be thought possible that this alignment joins the long one in square XVI. However, the systematic probing to a depth of 30 cm which first revealed this short section, also showed that there was no other recognizable pattern of stones either in this square XIX or XVI. The main alignment in fact reappears in XXII where it was discovered to bifurcate, with one branch continuing in a northward direction, the other turning sharply to run alongside the terminal leg of the stone row, the presence of which had been suspected from the elongated mound running through square XXI. At this point any doubts concerning the inter-relationship of the row and the alignment were completely dispelled: they were obviously contemporary features, planned and executed within a single programme of wall-building.

One can only guess at the course taken by these two branches of the alignment. However the tops of the alignment stones were observed partly obscured by turf in squares XXIV and XXVII, again turning a roughly right-angled corner. It seems likely that this joins up with the northward branch of the excavated alignment, with a further corner in XXV. As for the branch which turns in towards the stone row, there is a strong possibility that it was conceived of as a facing or edging for that portion of the row. In fact a similar situation was observed 22 m to the north where an alignment (which may well join up with the main alignment) was seen to run into a substantial stone row, one of the largest recorded at the Washpool. A testpit excavated at the junction showed clearly that the stones of the alignment became a well-defined northern edging of the row, behind which much smaller stones had been piled.

Stratigraphically the soil layers adjacent to the main

alignment were similar to the profile recorded adjacent to the stone row, except for much greater thickness in layer 1 and layer 2. Obviously to the wall builders the alignment of stones was meant to be visible while still firmly embedded, so it must be concluded that not only has layer 1 built up since the construction of the alignment but also 10 - 20 cm of layer 2. The mechanism of build-up is likely to have involved transport of particles by wind and water action from higher ground. Although the upper portions of layer 2 post-date the alignment there was no recognizable stratigraphic change to assist archaeological recording. As a result layer 2 was removed in 2 arbitrary spits, and over the seaward part of square XVIII only the top spit was trowelled off. Beneath layer 2 the typical light-brown layer 3A was encountered and over the 20 m² it was exposed in squares XVIII, XIX and XXII, a careful examination was made to detect possible post holes. Apart from the hearth only a 4½ cm deep charcoal-filled depression was present. Within the hollow, levels taken of the base of layer 2-surface of layer 3 indicated an interface varying from horizontal by a maximum of 17 cm over 6 m. It also became apparent that this interface was a few centimetres lower than the supposed old beach level. If the beach theory is correct, it must be supposed that layer 2 has been formed at this depth as a result of human interference, that is artificial deepening of the humus bearing layers by systematic mixing of the sediments and the incorporation of charcoal. Indeed if the beach layer with its waterworn boulders had been encountered in the course of this activity it may have become an important source of large waterworn stones for use in the alignment and the facing for the row.

The contents of these layers proved both exciting in terms of the quantity of industrial debris and puzzling by virtue of the absence of debris relating to other economic activities. Apart from assorted European materials such as sheep bones, wire, and shotgun cartridge cases which were found in the turf zone, the presumed prehistoric items were 508 pieces of stone material (including 5 small lumps of ochre, the shell of a fossil gastropod of ? Struthiolaria sp., and a lump of concentrated lime) and only 1 piece of bone. The latter was a small fragment of dense shiny bone, possibly human, which had a

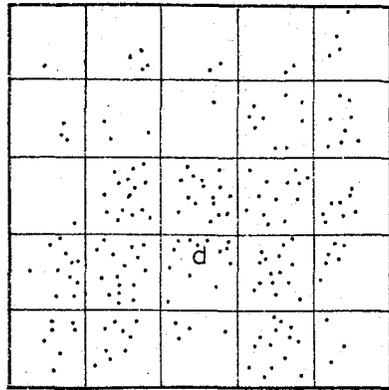
ground end. This was found in square XVIII along with 80% of the stone material. The distribution of the stone material while reflecting unevenness of excavation extent from one square to the next, nevertheless indicates a concentration of material in square XVIII. This concentration may be of natural mechanical origin, the result of wind and water action moving flakes from higher ground around the stone row into the hollow of square XVIII, or of cultural origin; that is, some activity involving deposition of stone flakes and tools was centred in the hollow. In favour of the first explanation is the presence of such material in the hollow on both sides of the boulder alignment. However, the material does occur on higher ground in the surrounding squares, including tiny flakes which might be expected to be prone to wind and water transportation. Furthermore the distribution pattern within square XVIII does not show the greatest density of stone material at the lowest point, but a semi-circular scatter of flakes around subsquares 11 and 12 which occupy the base of the hollow. This semicircular arrangement applies to the distribution of waste flakes, and, more significantly, a large collection of what might be described as drills, saws, grindstones and files (see Figure 25). Only a few flakes were to be found in the central squares. A plausible interpretation of this distribution is that the artisan (possibly two) was seated in these squares at the bottom of the hollow facing seaward and the industrial debris accumulated in front of him and to each side. It may be no coincidence that the small hearth built against the side of the boulder alignment was also at the base of the hollow in sub-square 12.

The distribution of material by squares was as follows:

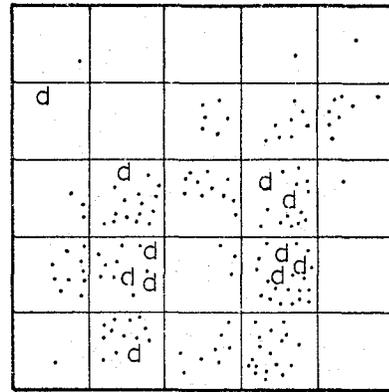
<u>Square</u>	<u>Stone</u>	<u>Bone</u>
XV	2	
XVII	1	
XVIII	437	1
XIX	18	
XX	10	
XXII	<u>40</u>	<u> </u>
<u>Totals</u>	508	1

It should be noted that only a few items were found in

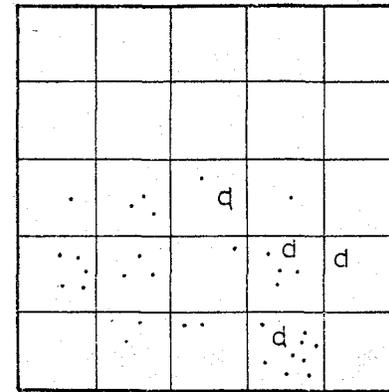
FIGURE 25



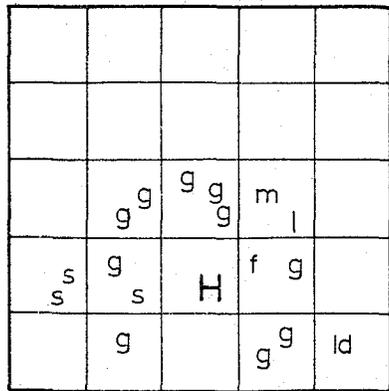
Obsidian



Chert



Argillite



- ∴ Flakes
- d Drill point
- m Unfinished minnow lure
- g Greywacke flakes & cutters
- l Limestone flake
- f Schist file
- s Sandstone fragments
- H Hearth



DISTRIBUTION OF STONE ARTEFACTS IN SQUARE XVIII WASHPOOL WALLS

association with the stone row: 8 waste flakes, 1 utilized flake, and two chert nuclei. These two cores were incorporated within the stone wall matrix and they strongly suggest that some industrial activity, namely the production of chert flakes, took place close by before or during the period of wall construction.

The stone material comprised a variety of rock types derived from sources as far afield as the Coromandel Peninsula and possibly central Otago (see K.Prickett, 1975, for a detailed discussion of source identification).

Obsidian was the most numerous category and was grouped according to colour of transmitted light into green, grey and red obsidian. Of the 202 pieces of green obsidian, 61 were clearly utilized flakes and 1 had been fashioned into a drill point. A further 40 flakes showed minor edge damage which might have occurred after burial in the sand or during excavation. Of the 33 flakes of grey obsidian 16 had marked edge modification. Red and brown coloured obsidian was represented by 2 flakes, both with edge damage. An important part of the analysis of Wairarapa stone material was identification of the sources of the various obsidians by X-ray fluorescence spectrography following on the work of Ward (1972). The sample submitted from this site consisted of 22 flakes (green 18, grey 2, red 2), 18 from Mayor Island, and the balance from Cooks Bay, Coromandel (B.F.Leach, 1976: Appendix 5). In this respect the site was typical of the Palliser Bay area.

The next most abundant material was chert, of which there were 194 fragments comprising 7 cores, 12 drill points, and 42 utilized flakes. Although no trace element or petrographic analysis was carried out on chert samples from this site, a preliminary study of North and South Island chert sources indicated the great similarity of Palliser Bay chert flakes and cores to chert outcropping and occurring in stream beds on the White Rock-Oroi-Tora area of the eastern Wairarapa coast (Walls, 1971), a distance of 22 km in a straight line from the mouth of the Makotukutuku River.

The metamorphosed argillite, on the other hand, was almost certainly of South Island origin. Indeed some pieces can be confidently ascribed to the Ohana quarry area on D'Urville Island (K.Prickett, 1975). There were 38 pieces of Nelson - D'Urville argillite in this site, all but 1 found in square XVIII. Included in this total are 5

utilized flakes, and 5 drill points. A high proportion of the argillite assemblage bore traces of hammer dressing or polishing indicative of breaking up and reworking of argillite adzes. At least 17 flakes were clearly struck from adzes and it is likely that the remainder had a similar origin, if colour and textural comparison is any guide. Using these criteria it is possible to state that a minimum of three adzes were involved. The best represented was a dark grey argillite adze, probably of rectangular section, with polishing over much of the surface except for the butt which was left hammer dressed. Twelve pieces of this adze including bevel, side and butt flakes were present. The butt and side flakes negate the possibility that the flakes were the biproduct of either damage during use or re-sharpening, both of which would give rise to bevel flakes only. A second adze of Ohana argillite was represented by 4 pieces bearing signs of polishing and hammerdressing. The third adze of greyish green argillite is represented by at least 4 items. The striking platform for one flake was the edge of a complete transverse fracture through the adze, further proof that broken adzes were being used as sources of raw material for utilizable flakes. It is not surprising that the argillite tools, although not all possessing remnants of polish and bruising, match closely those flakes which are recognizable adze flakes. This utilization of broken adzes for drill and flake tool manufacture suggests that even damaged adzes were valuable to these people, a value enhanced by distance from sources of fine-grained and durable materials. The presence of numbers of adze flakes at many sites in Palliser Bay suggests that these people were unable to 'rejuvenate' damaged adzes in the skilful fashion evident in the South Island, but rather used them as cores for the rudimentary production of small chips for flake tools. This strengthens B.F. Leach's (1976:310) suggestion that the Palliser Bay communities were not skilled in conchoidal flaking, and imported partly made adzes from South Island artisans.

Probably the only material available in any quantity locally was greywacke which occurs in boulders on the beach and in river and stream beds. Despite its ubiquity it was obviously of little value in this site for only 14 pieces were found. Three of these bore traces of polish overlying hammer dressing, and one of these flakes showed the intersection of surfaces of a quadrilateral adze (front wider than back). In fact these pieces and several of the greywacke waste flakes could derive from one adze. Another 3 greywacke items could

be described as 'attrition saws', 1 as a hammerstone, and 1 as a 'grinder'. All were made from waterworn boulders of greywacke, of poorer quality than the material used for the polished tools.

Seven other types of stone were present in this assemblage in small quantities. Siliceous limestone (probably from the White Rock area) was present as a large drill and 4 waste flakes. Schist was represented by a small 'file' and a broken unfinished minnow lure. The latter item was obviously intended to have a triangular cross section but had snapped transversely before the two longitudinal grooves met up. Interestingly the grooves accommodated one of the greywacke 'saws' very neatly and both the lure and the 'saw' were found in the same metre square (XVIII/16). It is likely that this schist was obtained from the Nelson-Marlborough area (K.Prickett, 1975:156). One utilized flake of serpentine may have originated in the same area. Both sandstone (3 fragments 2 from a grindstone) and unbaked argillite (1 utilized flake made from a polished rounded edged tool such as a chisel) could have been obtained in the Aorangi Mountains. Three flakes of quartz crystal were recovered and three of a white material which in hand specimen was identified as silcrete (orthoquartzite). The nearest source of this material would have been the South Canterbury-North Otago interior.

The overall impression given by this assemblage is of a great variety of imported materials and relatively few items of local origin. In its variety it resembles the assemblage from the upper layers of the neighbouring Washpool Midden site (N168-9/22) which are believed to be contemporary with this wall complex (B.F.Leach, 1976:Figure 39).

Detailed analysis of stone flakes from this site (Appendix 3) has shown that it is possible to identify the following usages:

- scraping narrow (< 10 mm), flat or circular surfaces, in a relatively soft, grit-free material like wood (the majority of obsidian and chert flakes were put to this use)
- cutting or slicing soft materials (a few obsidian edges were used in this way)
- sawing somewhat tougher material (a few chert edges were involved)
- incising or chiseling in a confined groove (only obsidian flakes were used)

It is also suggested (Appendix 3) that the drill points were employed making fairly large perforations in wood, while a few cutters and other tools indicate manufacture of one or more small stone items. Perhaps the most noticeable aspect of this assemblage is the lack of 'breaking down' tools, for example large rough cutters, saws or adzes. The emphasis appears to be chiefly on the finishing of small wooden objects which may have been perforated. Such objects would have been brought to this spot together with the finishing tools. If this is a correct assumption the question arises why this location was chosen. At this stage the most plausible explanation might be that previous land clearing operations had created a patch of open ground in a sheltered hollow, and this was an ideal location for a small open-air workshop. The manufacturing activity was certainly subsequent to the wall-building and soil modification, but probably not much later, since the depth of incorporation of the flakes suggest that the vegetation on the area had not yet regenerated.

TE HUMENGA

Two small excavations were made within this complex. The first consisted of a 2 x 0.5 m trench positioned so as to section a stone row just south of the large sea stack (Excavation A on Figure 7, N168-9/39). It was hoped that sufficient small-diameter charcoal would be obtained from this trench for dating purposes, but it proved to be in finely comminuted form unsuitable for collection. Consequently a second area was opened adjacent to a stone wall sectioned by the road at the southern end of the complex (Excavation B on Figure 7). Discrete pieces of charcoal were visible in the road section offering a good prospect for a further excavation.

The trench excavation A was of a very low stone row demarcated by Hymenanchera cushions and well covered by turf. Removal of the root mat (Layer 1a) revealed a moist, humus-enriched sandy loam, constituting the bulk of the modern 'A' horizon which had formed to a depth of 2 - 3 cm over the wall stones (Layer 1b). When this was scraped away it was found that water-worn stones covered almost the full length of the trench. These were interpreted as the collapsed portions of the originally higher stone row. At the southern end of the trench the stones were butted by a thin layer of loose, coarse gravel (Layer 2), believed to

be outwash from an adjacent fan, now consolidated and used as a gravel quarry. Layer 3a was a brown-black sandy loam containing gravel and comminuted charcoal. It was very well mixed, with heaviest charcoal staining in the centre of the stone row. The stratigraphy indicated that this cultural layer was modified at the same time as the stones were mounded up. Furthermore the row began to collapse outward before the gravel outwash occurred and the modern soil began to develop. This modified layer has been formed over Layer 3b, a light-brown gravel and sand, the original 'C' horizon of the raised beach ridge. The section drawing (Figure 26) shows that the upper surface of 'natural' dips down on both sides of the stone row. Of course the row could have been constructed on a natural longitudinal ridge, but a far more realistic explanation is that the presence of the mound of stones protected the top of this natural layer from the soil disturbance which took place on either side, and which effectively deepened Layer 3a. This process is illustrated in Figure 27.

Without an absolute date one can only guess at the age of this wall building and soil modification. Judging from the extent of wall collapse and the thickness of the modern 'A' horizon on top of the wall (in an area which is particularly windswept and not prone to rapid soil buildup), there is no reason to believe it is any younger than the other dated wall of this complex or those at the Pararaki Mouth.

The second excavation at Te Humenga was a 0.7 x 0.4 m pit (Figure 28) 300 m south of the sea stack, at a point where the major transverse wall of the southern section of the complex is cut by the road (Excavation B on Figure 7). Beneath the turf was a 12 - 15 cm layer of light-brown compact silty-sandy loam containing only a few stones and no charcoal. The carbon-14 sample, taken at a depth of 25 cm from the surface, was part of a cultural layer 11 - 14 cm thick, composed of fire-cracked stones quite tightly packed together in a black sandy matrix with abundant charcoal. From an examination of the adjacent road section there was no doubt that this was the centre of a substantial stone row. Beneath the stones was a light-brown sand and gravel 'natural' with a few waterworn stones, comparable to Layer 3b of the first excavation. The carbon-14 sample was 39.71 gm of small diameter charcoal pieces and gave a date of 1173 ± 56 AD (NZ1310).

FIGURE 26

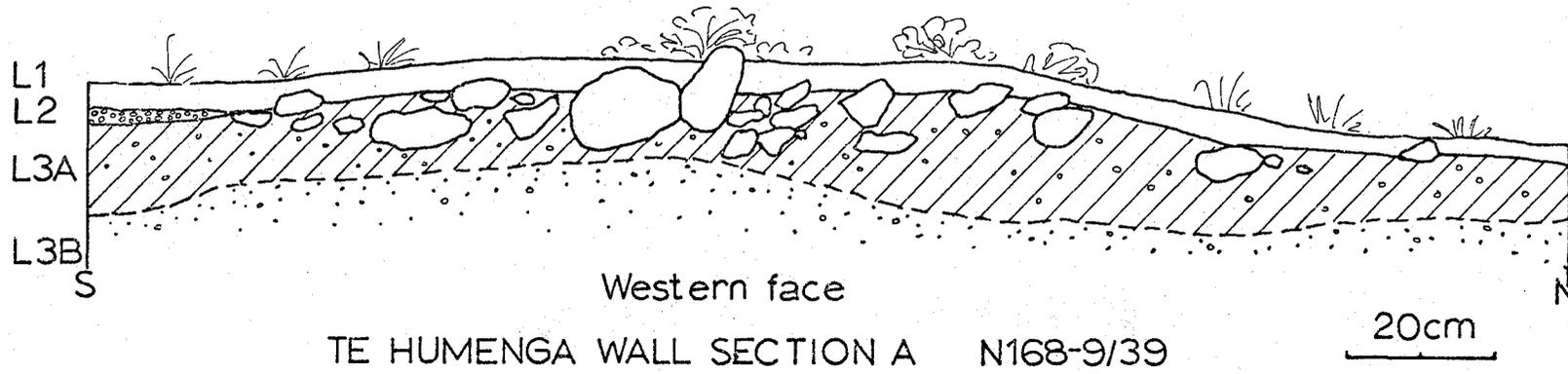


FIGURE 27

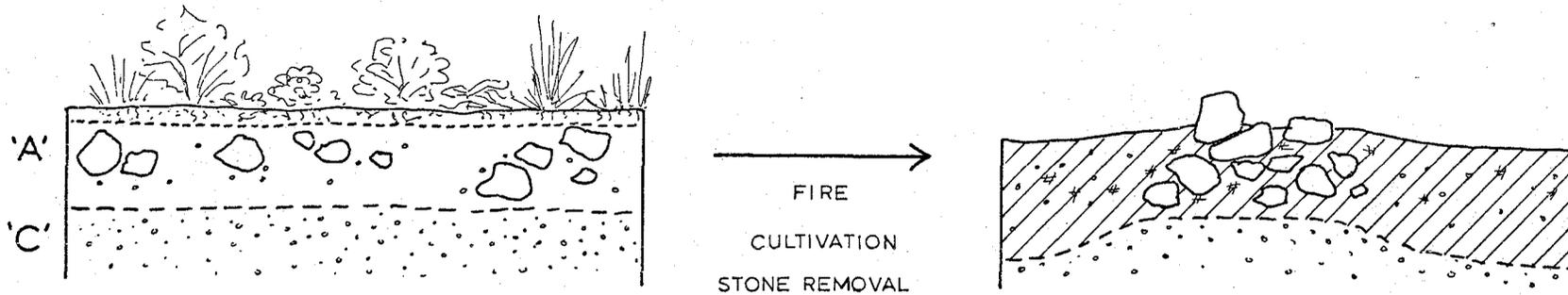
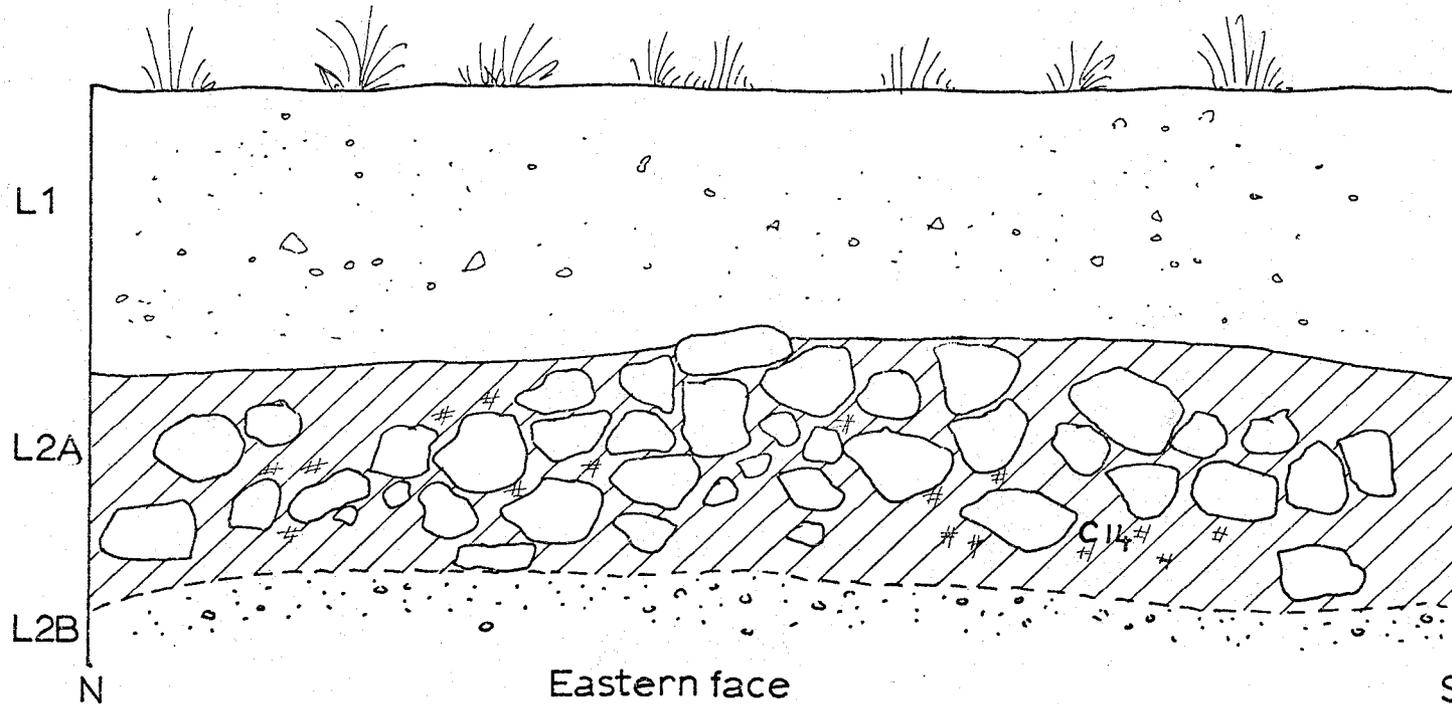


DIAGRAM OF PREHISTORIC TOPSOIL MODIFICATION

FIGURE 28



10 cm

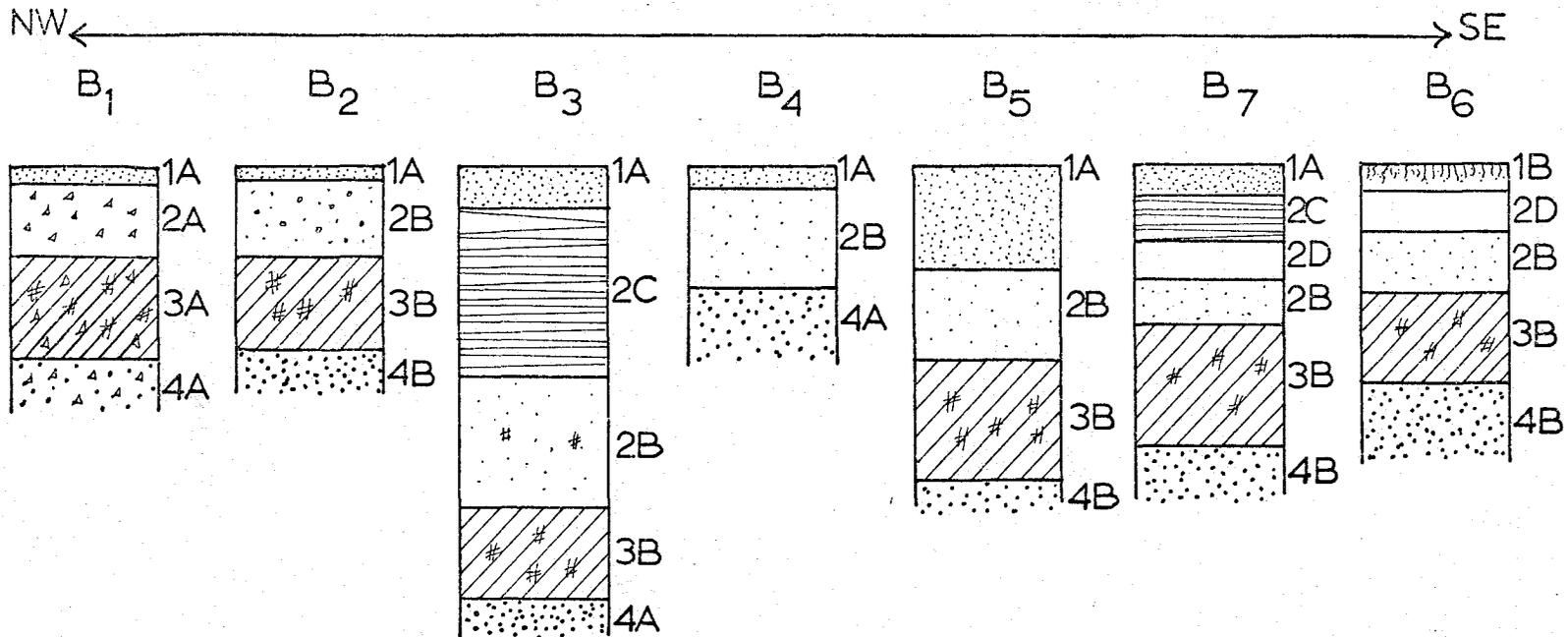
TE HUMENGA WALL SECTION B N168-9/39

It is interesting to note the depth of the silty-sandy layer which had sealed over the top of this transverse stone row. It is believed to have originated from fan activity to the east of the complex, with the sediments being deposited by a combination of wind and water action. There is a strong possibility that other unrecorded transverse rows existed in this section and are now buried by this layer. Considering the evidence of gravel outwash near the sea stack, it is clear that a period of erosion and increased fan activity followed the wall-building phase at Te Humenga, just as it did at Whatarangi.

NORTH PARARAKI

Excavations in this area consisted of a trench through a stone row on the crest of the fourth beach ridge (N168-9/41, Excavation A on Figure 8), a series of 7 test-pits on the line taken by the new bridge access road which crossed the third ridge (Excavations B1 - B7 on Figure 8), and a large trench cut through a midden-filled stone row on the third ridge (Excavation C on Figure 8). The initial objective behind the two section excavations was to recover charcoal for dating and to check whether there was any major discrepancy in the age of walls on different beach ridges.

The test-pits (Figure 29) were dug to obtain a series of soil profiles on and adjacent to the third ridge. There was considerable uniformity in the sequence of soil layers from one test-pit to the next, despite differences in the various matrix materials. With the exception of test-pit B4 on top of the ridge all possessed a dark-brown or black layer usually well buried, and containing quantities of small diameter charcoal pieces. This was invariably stratified over a light-brown or yellowish 'natural', and was itself covered by a brown sandy loam. Test-pit B4 probably presents the unmodified soil sequence with the same brown sandy loam ('A' horizon) stratified directly on the yellowish sand ('C' horizon). The differences in the layer components were clearly related to the position of the test-pits. Test-pit B1 lying in the hollow near the toe of the large fan, revealed angular gravels right through the brown, black and yellowish horizons. The fact that the black layer had been formed at this point is a clear indication that soil modification by man had extended on to existing consolidated fan sediments. Test-pit B3 was situated in a deep hollow



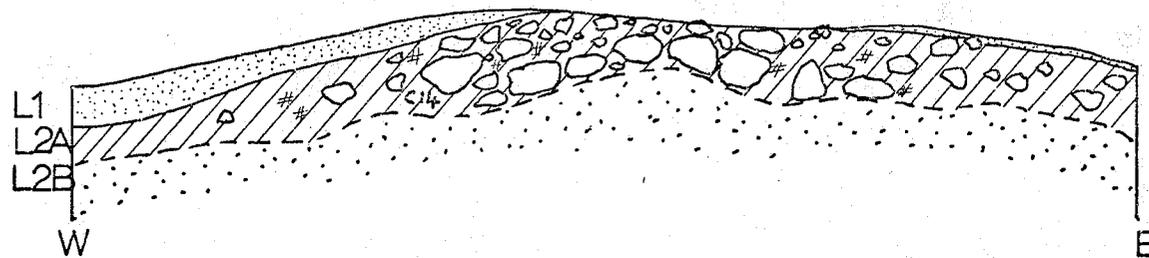
- 1A WIND-BLOWN SAND
- 1B TURF
- 2A BROWN LOAM WITH ANGULAR GRAVEL
- 2B BROWN SANDY LOAM
- 2C BROWN SILT
- 2D WHITE SILT
- 3A BLACK SANDY LOAM WITH ANGULAR GRAVEL
- 3B BLACK SANDY GRAVELLY LOAM
- 4A YELLOW-GREY SAND AND GRAVEL
- 4B LIGHT BROWN SAND AND GRAVEL

20cm

FIGURE 29 NORTH PARARAKI TEST PITS B₁- B₇ N168-9/41

between two stone rows; in addition to the usual three horizons it revealed a thick overburden of a brown, silty material, believed to be the finer sediments of the brown sandy loam layer washed down into the hollow from surrounding higher ground. In both test-pits B6 and B7, which were situated on the low river terrace behind the third beach ridge, the brown sandy loam was half the usual thickness and was covered by a 3 cm band of white silt, undoubtedly deposited by a flood. Test-pit B7 also had a brown silt layer covering the white horizon. The general impression given by these test-pits is that after the period of soil modification by charcoal incorporation quite a long period of soil build-up occurred with wind and vegetation acting together to produce a brown sandy loam of fairly uniform thickness both on the ridge and in the adjacent hollows. Then the low-lying land appears to have suffered both riverine and surface flooding, followed by a period of loose sand deposition, indicative of loss of vegetation nearby. This 'dune' phase continues to the present day and may have been initiated or accelerated by grazing animals in the historic era. The most significant point is that the brown loam was probably built up during a period of abandonment by man, and that the abandonment took place some time before local erosion accelerated.

The 2 x 2.8 m trench (Figure 30) cut through the stone row on the crest of the fourth beach ridge showed all but the crest of the row to be overlain by a thin layer of dry black sand believed to be derived from local exposures of the black sandy loam deflated by wind. Beneath it the wall consisted of weathered rock fragments grading down to large waterworn stones. Charcoal was present in both the overlying sand and the wall matrix. Several fragments of Cookia sulcata shell were also recovered from the wall. The underlying 'C' horizon was a light grey-brown sand which formed a low mound at this point before dipping down steeply into the hollow between the fourth and fifth beach ridges. A sample of 36.78 gm of charcoal pieces selected for their small diameter from a 1 x 1 m square of wall matrix gave a carbon-14 age of $1242 \pm 72AD$ (NZ1313). This estimation dates burning of brushwood presumably from the immediate vicinity and its subsequent incorporation in the stone row. The possibility that the wood was burnt in situ was considered because of the cracked and reddened appearance of stones in the top of the row, but the shell fragments showed no trace of fire (see discussion of this phenomenon p. 74).



Layer 1 Windblown sand
 Layer 2A Black sand with charcoal
 Layer 2B Grey - brown sand

20cm

NORTH PARARAKI WALL SECTION 4TH BEACH RIDGE N168-9/41(A)

FIGURE 30

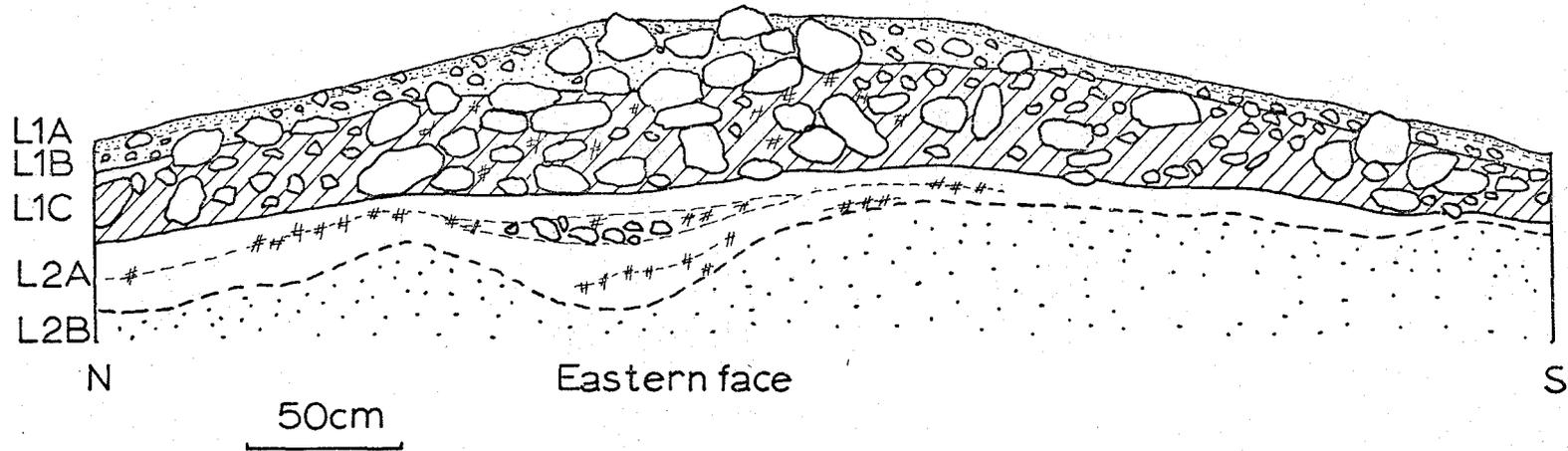
Shell midden was found in quantity in the excavation of a stone row on the third ridge. Thus, in addition to the need to acquire charcoal samples for dating, a different set of questions had to be answered: was this contemporary food refuse which happened to have been incorporated in the wall, was it deliberately placed for some special function associated with the function of the wall itself, or was it derived from some previous occupation of the area?

The excavation was located at an eroding portion of the wall where a bulldozer had formed a rough track over the beach ridge. A section, 4.75 m long, cut the wall at right angles and was cleared back by stratigraphical excavation a distance of 2.25 m (Figure 31). As a result cultural material within and below the wall was bagged by layer with each layer's material labelled 'disturbed' until the excavation was well beyond the effects of drag and dislocation caused by the bulldozer blade.

The surface of the row was mantled by loose grey wind-blown sand (Layer 1a) which had also trickled down between the stones in the uppermost part of the wall, there mixing with fragmented paua shell, cracked apparently weathered stones, and brown root hairs (Layer 1b). This was interpreted as an erosion zone from which the black wall matrix has been removed and replaced by dry sand. Layer 1c was the unaltered wall matrix, a black sandy loam containing shells, artefacts, water-worn stones, much charcoal and some fish remains. The good state of preservation of the bone and shell indicated that this midden had been incorporated in the wall while fresh and comparatively strong. Old, weathered midden would probably have been pulverised by the action of heaping up the stones. On these grounds the possibility of the midden being some years earlier than the wall can be dismissed.

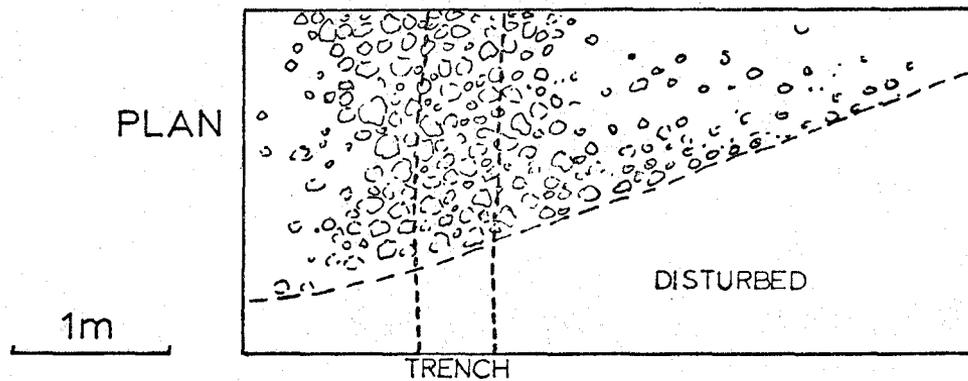
The stones had been piled on a layer of brown sand which contained a number of small lenses of fish bone, charcoal and some flakes. These patches of midden were not continuous and were restricted to the surface of the brown sand. Although bagged separately they are believed to be contemporary with the wall midden. Beneath this brown sand horizon at the southern end of the section was the natural light-grey to yellowish sand recognised elsewhere. Towards the northern end it became clear that this was cut into and filled by a second cultural deposit characterised by broken stones, fish bone, shells, flakes and

FIGURE 31



NORTH PARARAKI MIDDEN WALL N168-9/41 (C)

FIGURE 32



charcoal. This midden was concentrated in an elongated scoop in the sand filled with broken stones, and it also spilled out in a number of thin lenses on the northern side of the hollow.

The scoop appeared to lie directly beneath the long axis of the wall and it was followed as far as the eastern edge of the trench without detecting any change in depth or fill (Figure 32). At this stage of the study the feature was difficult to interpret: was it coincidence that it was aligned with the wall above; if not why was it separated from the wall by a thin layer of brown sand? The excavation did not provide an answer to these questions because it did not expose sufficient area in plan; however within a few months a bulldozer engaged in road construction on the other side of this beach ridge sectioned the same stone row approximately 20 m away and revealed a midden-filled scoop directly below the wall. Similarly at North Kawakawa an even deeper trench filled with stone and charcoal was found to lie below a stone row. It is concluded, therefore, that the stone-filled trench is intimately related to stone wall construction at these locations.

In the case of the North Pararaki Midden Wall excavation, the intervening sand layer between scoop and row requires some further explanation, particularly since it was at first interpreted as evidence of a distinct break in activity. A comparison with the bulldozer cut of the same row reveals that the brown sand there had drifted partly into the scoop from the south but was even thinner than in the excavation. In fact the bulldozed section showed that midden was present from the base of the scoop to the uppermost portions of the wall. It seems then that the brown layer was deposited during a single period of trench digging, midden dumping and wall building activities.

For an estimate of the duration of this period, the carbon-14 dates for the wall and lower cultural layer suggest virtual contemporaneity. A 27.71 gm sample of small diameter charcoal fragments was obtained from 35 cm below the wall crest within the wall matrix, and this gave a date of 1279 ± 72 AD (NZ1311). The 44.24 gm sample which dated the trench beneath to 1219 ± 70 AD (NZ1312) was taken at a depth of 65 cm. These dates are not significantly different, but they do not rule out the possibility that the modification and construction period extended over several decades.

One unequivocal proof of contemporaneity would have been the matching of adze flakes found in the two cultural layers. This would not be possible, however, without detailed petrographic comparison. At present it should be recorded that the 14 metasomatised argillite flakes with signs of polishing or hammer dressing which were recovered in the excavation derive from at least 4 adzes and that they were equally divided between the layers. Matching the predominantly mid-grey and dark-grey material by superficial examination suggests that flakes from one of these adzes found their way into both layers.

There appears to be no significant difference in the overall stone assemblage from above and below the brown sand horizon. The same materials are represented (except for one piece of volcanic argillite and a lump of the skeleton of a bryozoan) and similar tool types appear. Chert flakes predominate in the total collection of 182 flakes, with 19 out of 62 showing signs of edge utilization. In size they were indistinguishable from the Washpool Walls collection. The 42 obsidian flakes were in the proportions of 19 utilized to 23 waste. Their colour in transmitted light was green except for 2 grey flakes. The XRF analysis of 11 obsidian flakes from this site indicated that 10 were from Mayor Island, and the remaining grey flake was assigned to Cook's Bay, Coromandel. Argillite was well represented and the 30 flakes were mainly grey with 2 green and 3 black pieces. As in the Washpool Walls site the impression was given that the argillite flakes were derived from the breaking down of adzes. This was reinforced by the discovery of the butt of a large grey adze in the wall matrix and 3 argillite drills in the lower layer, 2 of which showed traces of polish. The adze butt was still in a flaked state with only a few signs of hammer dressing. It is difficult to determine from its cross section whether it was a quadrangular or triangular adze, for the former type often possesses a rounded triangular section as a form of butt reduction. Although hammer dressing had only just commenced when the adze broke, the artefact had been used sufficiently often for haft polish to become marked on one surface. This was the clue needed to determine the original adze shape, for examination of numerous adzes in the Otago Museum collection showed that this type of haft polish only occurs on the back of the butt of the triangular adze, that is, on the surface constituting the base of the triangle. Thus a characteristic wear pattern can be used to indicate

the shape of the complete object.

Greywacke was well represented in this site with 25 of the 42 pieces showing signs of use. Two discoidal hammerstones were present, in addition to 8 large flakes struck from waterworn boulders and subsequently roughly flaked into 'choppers', a type of flake not represented in the Washpool Walls assemblage. A broken sandstone file was found in the wall matrix. Two longitudinally grooved sinkers were also recovered, one from the lower cultural layer and one from the disturbed road section. Both were made of camptonite which is available in the river bed (K.Prickett, 1975:179).

The stone tools in this site range from pumice abraders, fishing sinkers, broken adzes, greywacke 'cutters' and 'choppers', to hammers, files and flake scrapers (Figure 33). This range could be described as characteristic of Archaic beach middens. It also points to diverse technological activities. Unlike the Washpool Walls assemblage, the Pararaki items suggest stone and bone as well as wood working.

The only bone tool included in the midden was a fragment of a bird ulna (4.8 cm long) split longitudinally with one end ground to a sharp but probably fragile point. It may have been used as an awl to perforate a soft material.

Moa bone was found in all the layers of this site and from one side of the excavation to the other. There were 12 rather fragile pieces as well as some fragments broken off during excavation. Identification was very difficult because none of the pieces were proximal or distal sections. Nevertheless Scarlett (1973: pers.comm.) commented:

"Where I can get any indication of size from the fragments, none is smaller than Euryapteryx geranoides or Pachyornis mappini, and some is larger

The Moa is, as usual, nearly all from tibio-tarsi, fresh, green bone when broken. All your midden moa from the various sites and levels suggest to me that it was utilised for artifacts - it may have been used for food, too, but the smallness of the pieces is more consistent with material from the sites where I know... of fish hooks, harpoons, awls, etc. made from the bone, as well as the broken artifacts and reject bone...."

Scarlett assigned one piece of moa from the wall matrix to the genus Euryapteryx. Other sites excavated in Palliser Bay have contained small

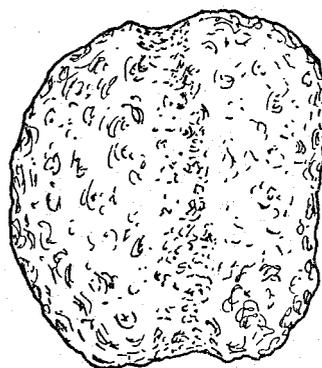
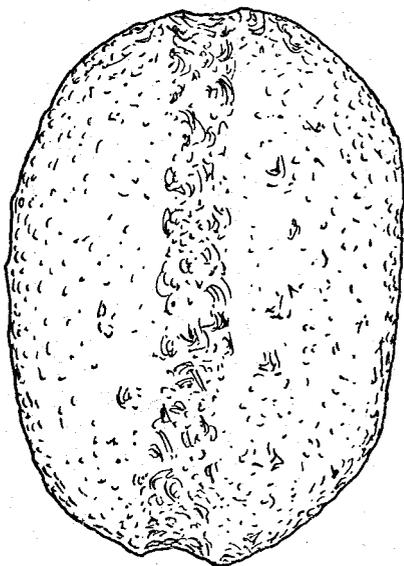
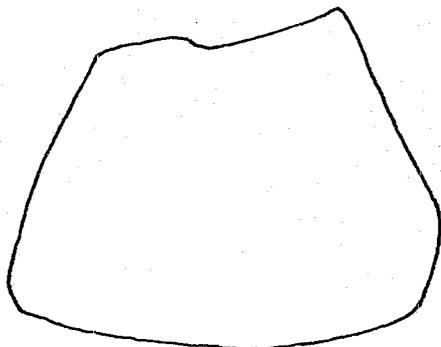
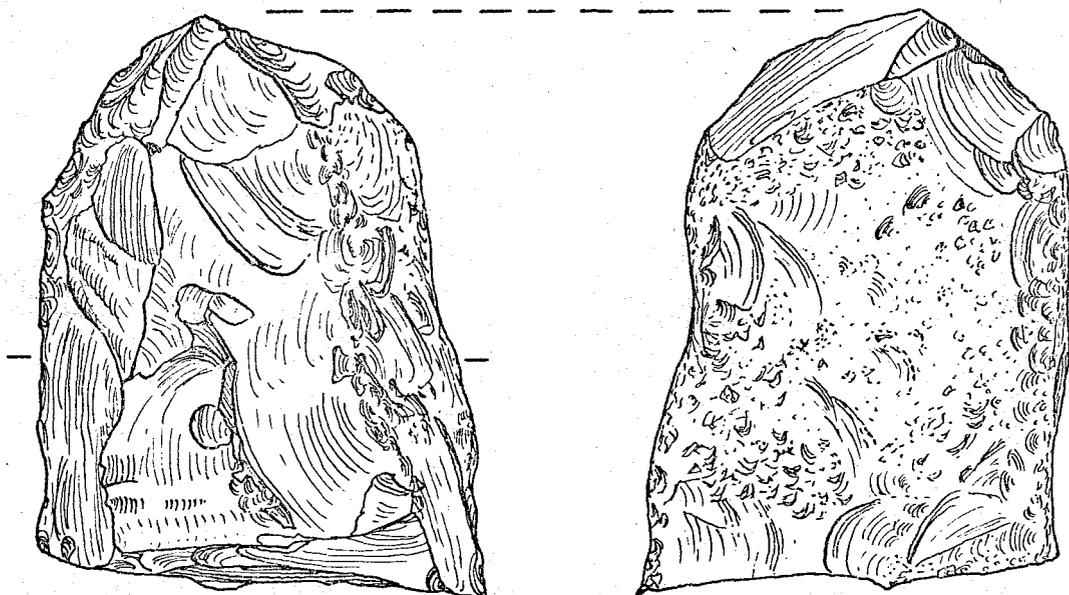


FIGURE 33

PARARAKI MIDDEN WALL
ARTEFACTS

pieces of a Dinornis species (Black Rocks), and Pachyornis mappini (Washpool Midden), as well as Euryapteryx geranoides and E. gravis. The latter identification is particularly interesting since E. gravis has not been reported in fresh condition from other North Island archaeological sites and is believed to have been restricted to the South Island throughout the prehistoric period. It is not present in the well-known sub-fossil deposits of the Martinborough Caves in the north of the Aorangi Range, where Dinornis, Pachyornis, and Anomalopteryx moas died at some time during the post-glacial period prior to the arrival of man (see detailed discussion of these deposits p. 170). Nor has it been identified in the East Coast and Cape Palliser sites of Wellman (1962) and McFadgen (1975: pers.comm.). There is a good possibility that it is present in Palliser Bay sites through trade in industrial moa bone with South Island communities. This suggestion is not inconsistent with Scarlett's comments, nor with the abundance of South Island rock types in these sites.

Remains of other bird species were present throughout the layers, again in rather fragile and often fragmentary condition. Consequently estimates of minimum numbers are probably very conservative. There were at least 2 tuis (Prothemadera novaeseelandiae) in addition to 2 red-crowned and 1 yellow-crowned parakeet (Cyanoramphus novaezealandiae and C. auriceps) and 1 extinct New Zealand quail (Coturnix novaezealandiae). The tuis and parakeets would have been taken in the lowland forest or forest fringe, while the quail's habitat may have been grass-covered river flats or the coastal fringe. The quail has been identified in the earliest levels at the Washpool Midden (3 individuals) and the earliest excavated midden at Black Rocks (2). Its absence in later layers and sites may indicate a small population rapidly exterminated. If this is an accurate interpretation the 12th century sites where it occurs may be viewed as among the first to be occupied on this stretch of coast.

Mammalian remains were also uncommon with one cranial fragment of a young seal (?Phocarcotus hookeri), 6 bones and 1 tooth of one possibly two young dogs (Canis familiaris), and 4 rats (Rattus exulans). One broken human incisor was recovered as well as limb bones of a small skink or gecko from the lower portion of the wall matrix.

Fish and shellfish species predominate in the faunal assemblage. Of the fish, Pseudolabrus species were most common (14 individuals) followed by the tarakihi (Cheilodactylus macropterus - 5), sea perch (Helicolenus percoides - 4), blue cod (Parapercis colias - 3), moki (Latridopsis ciliaris - 2), red cod (Physiculus bachus - 2), kahawai (Arripis trutta - 2), snapper (Chrysophrys auratus - 2), school shark (Galeorhinus australis - 2), and a small indeterminate number of red gurnard (Chelidonichthys kumu) and greenbone (Coridodax pullus). At least 2 crayfish (Jasus edwardsii) were represented. Although the total number of individuals is much less than at the Washpool Midden or the Black Rocks middens, the same fish are numerically dominant in the Pararaki Midden Wall. Most were species that can be caught by hook and line; however the presence of kahawai suggests the presence of a moving lure and the greenbone indicates that some sort of net may have been in use. The habitat preferences of these fish cover a range from inshore reefs to offshore sand banks, a good indication that canoes were used for fishing expeditions.

At least 557 shells were present in this site, of which 497 were in or immediately beneath the wall matrix. Of the 22 species identified, only 8 were numerically important. These were Lunella smaragda (35.8%), Melagraphia aethiops (20.2%), Haliotis iris (18.6%), Zediloma atrovirens (6.6%), Haustrum haustorium (5.4%), Haliotis australis (3.0%), Cellana radians (2.9%), and Cominella maculosa (2.3%). These shellfish can be obtained from intertidal rocks and rocks of the open coast. Of the remaining 14 species, 9 are also obtained from rocky ground. However 5 species represented by 13 shells are quite unexpected components of the midden: Paphies subtriangulatum (2 shells), Zenatia acinaces (1), and Protothaca crassicosta (5) occur on sandy ocean beaches, while Paphies australe (4) is found on mud and sandy flats. Micrelenchus huttoni (1) occurs only on Zostera weed in harbours. While it is feasible that single shells from sandy ocean beaches or harbour flats could be transported to Palliser Bay in the gut of a fish, this explanation is not really applicable to the 6 Paphies spp. shells found in the site. Overall Paphies australe and P. subtriangulatum are represented by 147 individuals from 4 early sites in Palliser Bay. The fine sediment beaches in which they live are not found anywhere in eastern Palliser Bay today, and so the possibility of trade in Paphies spp. shells or environmental change after the 14-15th century (the latest appearance

of these species) must be entertained. The latter interpretation is preferred in view of the evidence for changes in vegetation, avifauna and erosion patterns (see Chapter Eight).

Anderson compared the size ranges of the paua (Haliotis iris) from the Pararaki Midden Wall with paua excavated from 4 middens at Black Rocks Point. He commented:

"They indicate a situation similar to that in the early sites of Black Rocks: a heavy concentration in the medium size ranges, very few large shells, and a number of very small (summer indication ?) shells. At Black Rocks I considered this an indication of collecting in an environment already exploited but not heavily."

(Anderson, 1973: pers.comm.)

Anderson also noted that very little of the Pararaki midden appeared to have been burnt and that no rounded or beach-rolled material was included. It must be concluded, therefore, on the basis of midden composition and appearance, that the faunal and artefactual remains in this wall constituted 'normal' domestic refuse from food preparation and industrial activity. The shells were not collected from the beach, nor was the midden redeposited in the wall after a period of years. The question whether the midden was placed for some special purpose associated with the use of the wall cannot be answered from this excavation alone; however midden in stone walls is rare, and obviously most wall builders did not believe midden to be an integral or necessary part of these structures. Midden found in various places in the North Pararaki walls is probably best explained as contemporary domestic refuse cleared along with stones and burnt wood from ground surfaces in the vicinity of houses and workshops, or dumped on the walls directly during the period of wall building. With both these interpretations it follows that habitation areas were close by.

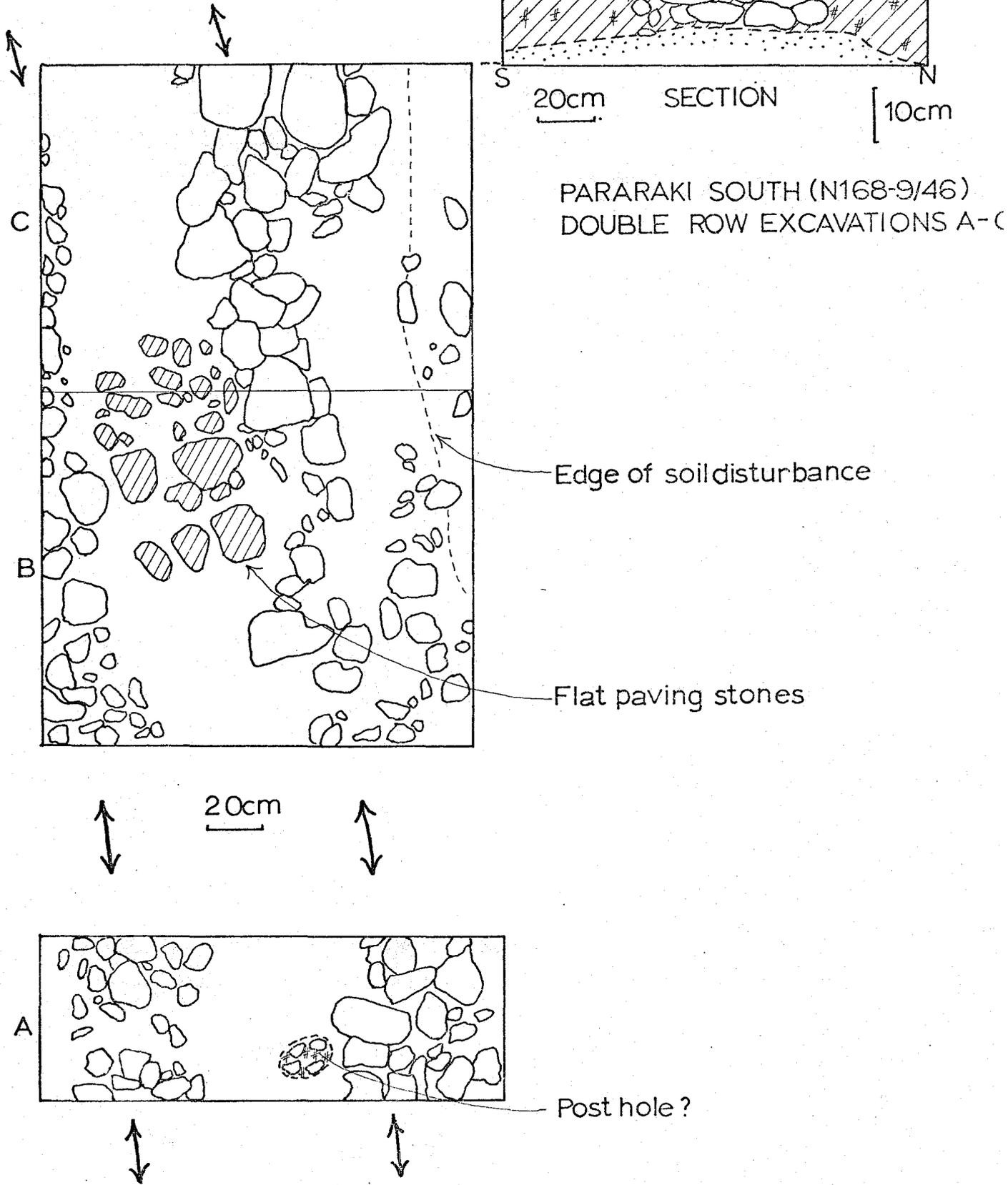
SOUTH PARARAKI

As discussed in Chapter Two, two sets of double row-alignments were visible in the group of South Pararaki walls which was oriented to the river. One set ran up from the river but had been disturbed by the creation of a vehicle track. The second set, parallel to the river, was more suited to excavation. It was hoped to determine the stratigraphical relationship between the two lines of stones, to discover the position of the structures within the soil profile, and to obtain associated charcoal for dating.

Five sections (Figure 34) totalling 6.14 m² were examined between a point midway along the double row and the western end of the feature where one line petered out and the other increased in bulk, turned a right angle corner and ran down towards the river (N168-9/46 Excavations A-E on Figure 10). The first excavation showed that the double lines were quite distinct features separated by a stone-free surface from 0.46 m to 0.6 m in width. Loose stones derived from the collapse of the rows were confined to the 4 cm of light-brown sandy loam which overlay the darker sandy loam (15 cm thick) in which the rows were embedded. This matrix contained small pieces of charcoal and was similar to the cultural layer encountered in association with stone walls elsewhere in Palliser Bay. It overlay a light-brown sand without charcoal, and this in turn overlay an old beach surface with heavily rolled stones 56 cm from the surface. As the interface between the enriched loam and the light-brown sand was exposed a circular patch of charcoal appeared lying on tightly packed stones. This proved to be the top of a 30 cm deep hole filled with stones, which was interpreted as a post-hole in which stones had been jammed to hold up the post in the soft sediments.

The second and third excavations were located at the point where the northern line of stones increased in volume while the southern line disappeared below the surface. Again the light-brown surface layer gave way to a black sandy loam in which the wall stones were embedded, and in some cases buried. This layer had clearly increased in depth after the stones had been placed in position, a phenomenon indicative of substantial soil disturbance in the vicinity of the wall soon after its construction. As the upper portion of the black loam was removed between the rows, an area of flat stones was revealed reminiscent of the paving found at the Heaphy Mouth site (Wilkes and Scarlett, 1967:Fig.6). A charcoal sample consisting of 60.1 gm of small pieces associated with the paving and adjacent curbstones was dated to 1141 ± 73 AD (NZ1314). On the northern side of the larger row the surface of the light-brown sand layer ('natural') dipped sharply along a line just beyond the edge of the stones. This phenomenon was encountered in several other sites (for example Whatarangi, p. 69) and is regarded as the product of artificial deepening of the 'A' horizon during the prehistoric period.

FIGURE 34



The fourth section was cut at the western end of the double row and was laid out at an angle to the row in order to establish whether the lower line of stones turned the corner and continued parallel to the larger stone row. For the same reason a fifth section was cut a short distance around the corner. In both excavations the outer line of stones was uncovered but the stones did not give the impression that they had been carefully positioned and it was difficult to determine the width of the central clear strip. It is possible that these features had been laid out with more precision but were disturbed soon after construction. Unfortunately modern disturbances prevented investigation of the double row closer to the river.

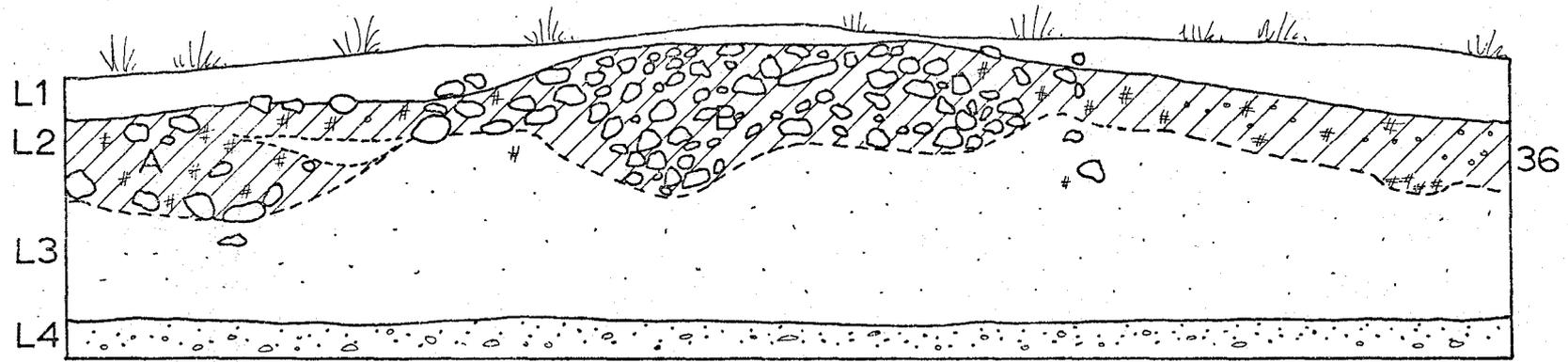
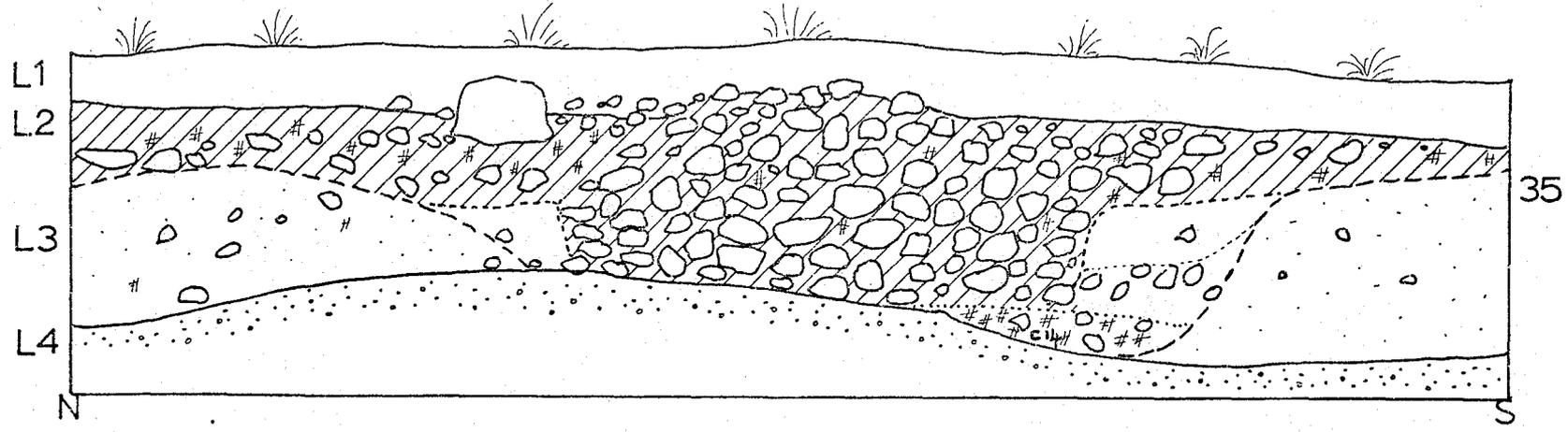
The presence of the post-hole and paving has a vital role in the interpretation of the double row. They indicate that the intervening strip was not 'dead' space between two conventional stone rows, but was put to some use to which the post and the paving contributed and which the stone rows demarcated. The conclusion, that this was a pathway, seems inescapable. The implications of placing a pathway on a flattish stretch of coastal platform will be explored later.

NORTH KAWAKAWA

The long straight walls which were constructed on the steep slopes beneath the terraced ridge are all cut at right angles by the modern road as it approaches the river. Repeated road maintenance by a grader has kept the sections free of grass and the archaeologist has only a little extra trimming of the faces to obtain clear, easily recorded wall sections. There are obvious dangers in interpreting stratigraphy from a two-dimensional exposure; however these were partly overcome by studying, photographing and drawing the relevant sections as they were slowly cut back over a period of three years. Three wall sections are discussed here. They are of the second, fourth and fifth walls of the southern hill-slope group (counted north from the river, see Figure 11, Site N168-9/52). The sections drawn were on the eastern side of the road which has now been slightly realigned and deepened to approach a new road bridge.

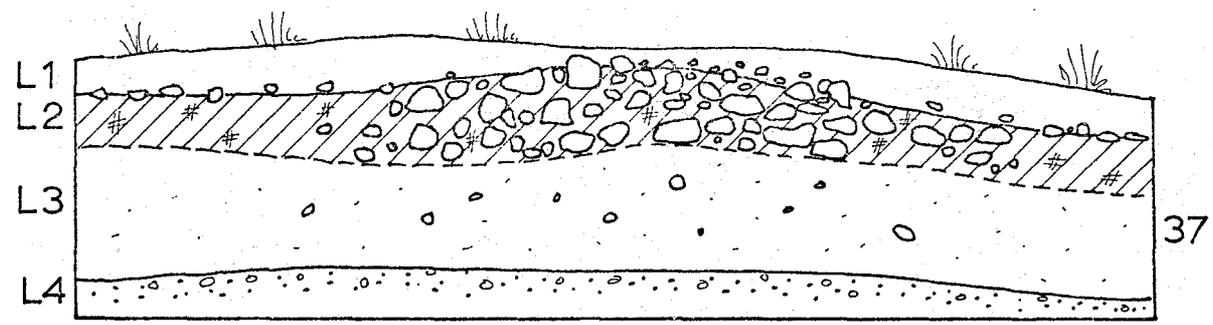
The section closest to the river (Figure 35) showed that what appeared from surface examination to be a conventional stone row,

FIGURES 35 - 37



NORTH KAWAKAWA
WALL SECTIONS
N168-9/52

50cm



rested on the foundation of a stone-filled trench. At this locality the top of the row was mantled by 16 cm of light-brown sandy loam built up after wall building activities ceased. Unlike lower layers it contained no charcoal and may be interpreted as having developed during a period when human use of the area was minimal. In structure it appeared to have formed under vegetation, but with the addition of wind-blown sand trapped by the grass or shrub cover. There are virtually no stones in this upper layer, which suggests that the steep hillside above was protected from erosion by well established vegetation. In contrast, the black sandy loam beneath contains quantities of stone and gravel derived from the hill slope. This layer is rich in charcoal and its upper portions also include stones eroded from the top of the stone row. Except in the immediate vicinity of the wall the black sandy loam is stratified on a dark-brown sand with waterworn gravel which on the northern side of the wall includes charcoal in its upper sections. This phenomenon was encountered in the Washpool Walls excavation (p. 74) and may be interpreted as disturbance of the natural 'C' horizon at the time of wall building; the incorporation of charcoal is facilitated by the loose nature of this layer. Just as at the Washpool, this horizon is in turn stratified on a yellow-grey or yellow-brown sand containing weathered beach pebbles. The surface of this basal layer is nearly level in the other two sections, but is undulating over the 4 m exposure of this section.

Two phases of activity are represented in the section: the first involved the excavation of a trench 1.8 m wide, which was cut down through the prehistoric 'A' and 'C' horizons (Layers 2 and 3) until Layer 4 was encountered. At the same time a small quantity of burnt wood and a layer of stones were deposited in the bottom of the hole. A 44.39 gm charcoal sample from this lens gave a carbon-14 age of 1261 ± 66 AD (NZ1315). A certain amount of mixed Layer 2 and 3 then eroded or was placed deliberately in the trench and this fill was cut into again to make a 1.4 m trench. On this occasion the hole was promptly filled to above ground level with stones, for the sides of the pit are nearly vertical. Unfortunately no date is available for the second pit; however erosion can be very rapid in unconsolidated sands and the two pits seem to have fulfilled a similar purpose, thereby arguing for some continuity in activity.

The second section (Figure 36) was of a long wall which was only slightly mantled by the stoneless grey-brown sandy loam. On either side of the wall this top layer reaches 12 - 16cm in thickness. The wall consists of weathered angular stones in a dark-brown sand matrix with very little charcoal (Layer 2B). Much more charcoal occurs in the black sandy loam (Layer 2A) which marks the continuation of this layer on both sides of the wall. On the north side Layer 2 also contains some angular stones, while on the south side small waterworn pebbles are encountered which are visible in the section up to 5 m from the wall. Elsewhere at North Kawakawa these pebbles are restricted to lower layers. Soil disturbance might be expected to bring some of these up towards the surface, but at this location they are not present in the underlying Layer 3 which is a light to medium-brown sand. They do occur at a depth of 70 cm from the surface in the yellowish-brown sand, but this level is quite undisturbed. The possibility that they were deliberately introduced into Layer 2 by man must be recognised.

The surface of Layer 3 was disturbed at a number of places adjacent to and below this wall. On the southern side a small lens of charcoal occurs in a shallow scoop, while to the north the surface dips down sharply. This provides another example of the phenomenon of artificial deepening of the prehistoric 'A' horizon adjacent to stone rows. Like the row discussed above, this stone wall was not built up from the base of the old topsoil, but rests in an irregular hollow excavated to a depth of 20 cm into the surface of Layer 3. The dimensions of this hollow (70 cm wide, 20 cm deep) are of similar order of magnitude to the trench cut beneath the Pararaki Midden Wall (120 cm wide, 30 cm deep). The presence of a lens of Layer 3 material within Layer 2 just north of the hollow may be an indication that the wall trench was dug after the modification of Layer 2 commenced, and that topsoil disturbance continued after the wall was built. Of course this interpretation depends on linking the lens with the excavation of the trench.

It is difficult to decide how much surface stone was present when soil modification began. The road sections indicate that the old beach sediments at this point were relatively free of stone and the angular stones in the walls are clearly not of littoral origin. The steep hillside is the most likely source of the stones. If this section does reveal a period of soil disturbance before wall-building, it is

possible that the former activity which was accompanied by burning-off brought about a marked increase in rock erosion from the hillside and that the response to this rockfall was stone row construction.

The third section (Figure 37) is of a smaller stone row and it presents a much simpler constructional history. Layer 1 is the same light-brown sandy loam found elsewhere and Layer 2 is the modified, charcoal-enriched black sandy loam which can be traced along the roadside. The stone wall consists of angular, weathered rocks built up within and on top of the old topsoil (Layer 2). After soil disturbance ceased, small stones of which this row was primarily composed, eroded off the top of the wall, and lay scattered on the surface of Layer 2. They were covered by the brown sandy loam. Layer 3, a brown sand with round beach pebbles, was not noticeably disturbed in this location.

So far as can be established by a study of the road sections, the southern group of walls at North Kawakawa belong to only one period of activity. During this period, soil modification, charcoal enrichment, trench digging and wall building operations were not conducted in rigid sequence over the entire area, and each wall section thus displays a unique constructional history. Although the road has obliterated prehistoric evidence in this area, there are compensations in the long section made available for archaeological recording. The most important observation made from this exposure is that stone rows are invariably associated with a culturally modified black sandy loam, frequently containing charcoal; this association is of considerable significance for functional interpretation of the stone walls.

NORTH WAIWHERO

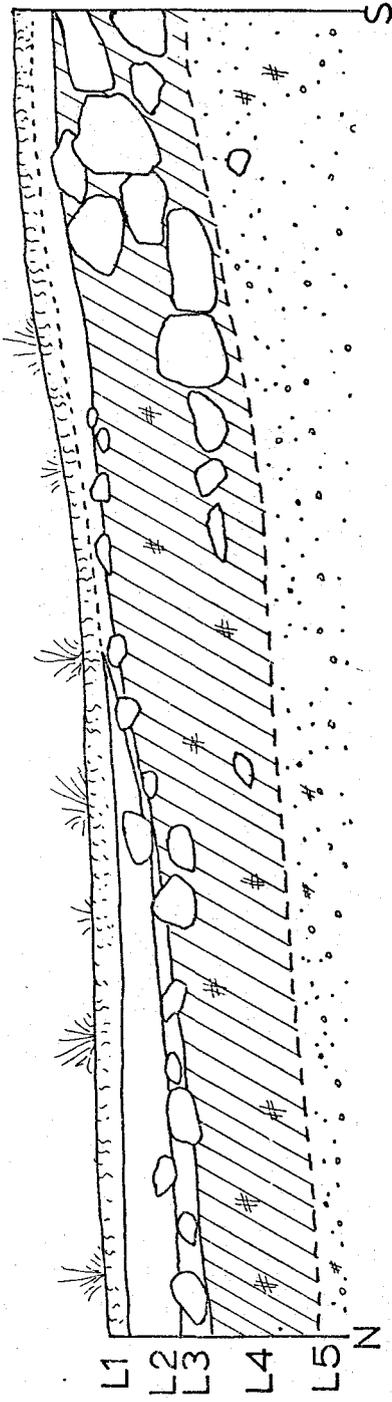
The discovery of several lengths of single boulder alignment which follow a curved route along the edge of the fourth beach ridge, prompted excavation of a small test-pit to obtain stratigraphical information and if possible charcoal samples. A square was opened to include both sides of the alignment where it curves around a small sea stack (N168-9/69, Excavation A on Figure 15). The tops of the stones were found to be virtually buried by a silt and angular gravel deposit derived from the large fan just to the north. The stones were bedded in a dark loamy gravel and sand, clearly of beach origin. Only minute fragments of charcoal were visible. Attention was then turned

to the northern part of the ridge where two parallel alignments turn a right angled corner and run towards the seaward edge of the ridge. Lack of time prevented excavation but enough of the stones were visible to allow measurement of the strip between them. Over a distance of several metres it varied in width from 55 to 70 cm. The South Pararaki 'pathway' was 46 to 60 cm wide and the similarity of the measurements is particularly striking. Structurally the Waiwhero double and single alignment is more comparable to the boulder alignment followed by excavation of the Washpool Walls, especially in the way it skirts other features, is carefully laid out, and turns right-angled corners.

Charcoal was visible in an eroded wall section adjacent to the cluster of sea stacks on the fourth ridge. An attempt was made to section this wall a short distance from the eroding portion but it was soon found that the charcoal had petered out. It was decided therefore to collect what charcoal was available. The damaged area was cleaned down and enough stones removed from the wall to expose in situ charcoal embedded among stones at the base of the row (N168-9/69, Excavation B in Figure 15). As no other charcoal pieces were obtained from the Waiwhero complex despite a thorough search and the digging of several test-pits, this charcoal, a 16.66 gm sample, was submitted for dating. The result was an age estimation for the wall of 1473 ± 56 AD (NZ1316). In view of the structural similarities with the Washpool Walls dated between 1442 ± 79 and 1608 ± 78 AD, the Waiwhero estimation is regarded as acceptable.

To determine the relationship of the northern fan with the long stone walls which run across the land behind the fourth beach ridge, a 1.7 m section was cut mid-way along the most substantial row (Figure 38, N168-9/69, Excavation C on Figure 15). Beneath the turf (Layer 1) a layer of fine, compacted white silt was encountered (Layer 2). This represented outwash from the fan and it came to within 15 cm of the top of the wall. Judging by its thickness in this location, it has probably buried a number of smaller walls. Layer 3 is a thin sandy loam containing abundant stones, which peters out towards the top of the wall. It is essentially an erosion layer of stones derived from the collapse of the row, embedded in a sandy matrix. It suggests a short period of abandonment of the area before the silt deposition commenced. Layer 4 is a thick, dark-grey sandy loam containing fine fragments of charcoal. Beyond the wall it contains

FIGURE 38



NORTH WAIWHERO N168-9/69 WALL SECTION C

few stones and is much darker than where it occurs as the wall matrix. The stone row was built up in and on top of this layer. Layer 5 is a brown sand containing waterworn pebbles of beach origin. As is the case elsewhere it occurs deeper in the section away from the wall and again artificial thickening of the dark sandy loam layer is indicated. In this section there is no abrupt change in the level of the brown sand, but the interface between Layers 4 and 5 is difficult to trace.

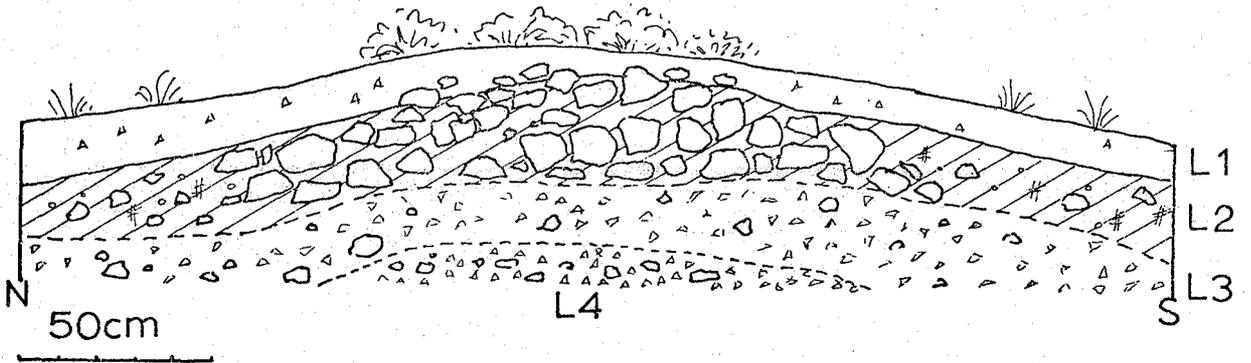
BLACK ROCKS

The exceptionally long walls built on the northern fan at Black Rocks are, like those at North Kawakawa, neatly sectioned by the modern road. Two walls exposed in the road section were examined in detail to determine constructional history and to obtain charcoal for dating.

The first (N168-9/76, Excavation A in Figure 17) is the third row from the north in the group of seven long walls. A 3 m section was cleaned down and drawn (Figure 39). Beneath the turf is an 8 - 12 cm layer of dark-brown silty, sandy loam which contains a little angular gravel. This layer has formed under vegetation since prehistoric activity ceased. Layer 2 is a 20 cm thick charcoal-blackened soil with many angular stones; surprisingly a few waterworn pebbles are included on both sides of the wall. As far as can be established without a thorough search of the cliffs above the fan, there is no source of naturally deposited pebbles from which they might be derived. As at the Kawakawa, human transportation of these pebbles from a local source like the beach, may be invoked. The wall is composed of angular stones derived from the former fan surface; it has been built up within Layer 2. Layer 3, a brown mass of stones with sparse soil represents an old 'C' horizon, which quickly grades down into a bed of fan-transported gravel with no surrounding soil matrix.

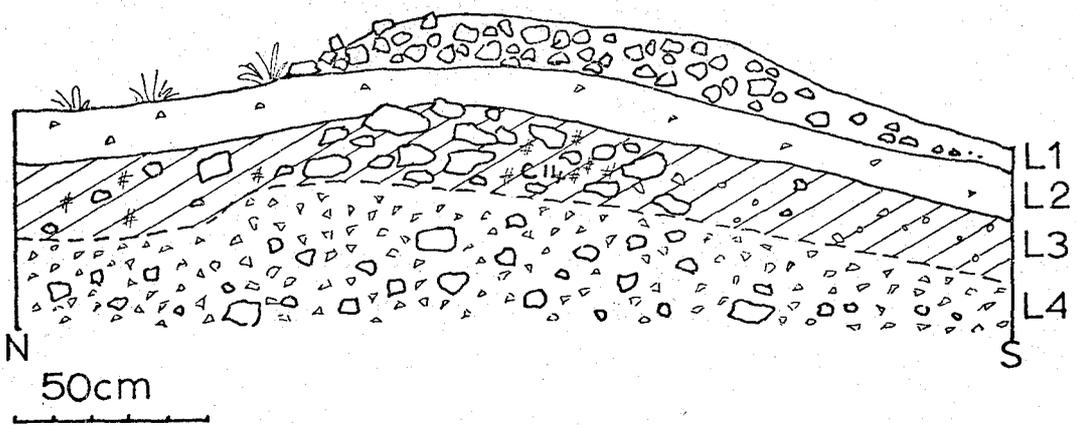
Soil formation on alluvial fans normally produces three different horizons: an underlying raw gravel and rock, weathering and chemically altering gravels with some soil, and a thin superficial layer of topsoil, usually a silt or sandy loam. This section contains an extra layer formed by the mixing of the prehistoric topsoil with the upper portions of the 'C' horizon, in addition to the incorporation of burnt wood and beach pebbles. After this disturbance ceased a new

FIGURE 39



BLACK ROCKS NORTH FAN N168-9/76
WALL SECTION A

FIGURE 40



WALL SECTION B

layer of topsoil began to develop under the surface vegetation, this time without charcoal inclusions.

Two rows further south another section was recorded in which the same processes of soil development and cultural modification were evident (N168-9/76, Excavation B in Figure 17). Here, however, the topsoil was partly covered by a mound of stones and soil scraped up to form a bulldozer loading ramp. Fortunately this activity had not damaged the underlying layers. Beneath the silty loam topsoil, the charcoal-enriched layer was again evident. It is a dark-grey stony loam and has some beach pebble inclusions on the southern side of the wall. There is good evidence of artificial deepening of this layer to the north of the wall, for the surface of the light-brown alluvial gravel dips quite sharply beside the wall (Figure 40).

In one other respect this section provided valuable information, for a quantity of midden had been incorporated in the southern portion of the wall during its construction. This not only supplied a charcoal sample of 27.53 gm, but provided marine faunal remains which could be compared with those from the dated middens on Black Rocks Point. The carbon-14 estimation for this wall is 1390 ± 71 AD (NZ1317). Shellfish were represented by 11 individuals of Zediloma atrovirens, 6 of Lunella smaragda, 4 of Cominella maculosa, 2 each of Melagraphia aethiops, Neothais scalaris, Siphonaria zelandica and Zediloma digna, and single specimens of Cellana denticulata, C. radians, and a chiton. With the exception of Neothais scalaris, these species are present in very large numbers in the Black and Crescent Middens of Black Rocks Point. Although the sample is small, Anderson (1973: pers.comm.) noted that those species which appear in greater number towards the end of occupations at the Black Rocks middens, in particular Zediloma spp., Melagraphia sp., limpets and small chitons, are quite well represented here as a group. In this deposit these 'second choice' species amount to 63%, while at the Pararaki Midden Wall the figure is 30%. The implication is that the construction of this wall on the north fan took place towards the end of a period of human occupation at Black Rocks, when pressure on marine resources was becoming very marked.

A minimum number of 19 fish are represented in this small quantity of midden. They are Pseudolabrus spp. (6 individuals),

Helicolenus papillosus (4), Cheilodactylus macropterus (2), Thyrsites atun (2), Arripis trutta (1), Coridodax pullus (1), Parapercis colias (1), as well as 2 elasmobranch individuals of dogfish size. One waste flake of silicified limestone was also recovered. This deposit may be interpreted as the remains of one or two meals procured from the adjacent marine zone and consumed during the course of wall construction.

A summary of the activities inferred from the contents and stratigraphical history of the excavated sites and from the layout and location of the wall complexes as a whole will be the subject of the following chapter.

CHAPTER FOUR

INTERPRETATION OF THE EVIDENCE

Summary of Prehistoric Activities Relating to Palliser Bay Walls

The field survey and excavations have provided much information on the stone walls, their layout, location, and cultural associations. It is now appropriate to translate the archaeological observations into a model of the human behaviour which gave rise to these structures. This step is a testing procedure, for the danger lies in over-generalization, the use of tautological reasoning, and the failure to provide an argument for each conclusion. The aim of this chapter, therefore, is to present a functional model incorporating not only wall construction but the constellation of activities associated with it.

The stone structures which make up the walls are most commonly rows and these invariably consist of locally-derived stones. Since most wall complexes occur on the coastal platform, heavily rolled and water-worn stones predominate. On fans, the more angular alluvial stones and gravels are incorporated, while at the foot of steep hillsides, angular but weathered rock fragments are encountered. Because of the shape and size differences in the rocks, walls on raised beaches and fans can have slightly different profiles. The smaller angular fragments tend to pack down and thus fan walls usually show up as long, low swells, usually covered in grass. The beach ridge walls are often higher and more irregular in profile. They are seldom completely covered by vegetation.

It is not easy to determine the original height of these rows as they were never constructed as free-standing fitted masonry walls, as in the European sense. The excavations have shown that many had very wide foundations, often 2 - 3 m, and because little stone has eroded off them since the associated soil disturbance ceased, they apparently never protruded very far out of the prehistoric topsoil. It will be recalled that some walls were found to have one, occasionally two faced edges behind which smaller stones had been piled. The maximum number of courses of these faced walls seems to have been 3 or 4, giving a height estimate of 40 - 60 cm.

It is also difficult to ascertain the original composition of the walls, apart from the stones themselves. Charcoal pieces are very common within and adjacent to walls and charcoal-stained sand is the usual matrix. However some walls and stone heaps have a brown sandy matrix or no matrix whatsoever and were clearly constructed without the incorporation of burnt wood. It is even possible that the brown sand was blown into the interstices after construction. A few walls were found to contain shell, fishbone and industrial debris, components of midden which was incorporated during the period of construction and which was apparently fresh. Since these sand, charcoal and midden inclusions are not found in all stone rows, they were obviously not essential to the functioning of the walls. On the other hand the disposition of the charcoal and midden indicates that they were not introduced by accident. If row building is seen as essentially the bi-product of clearing adjacent ground, then the rows would be expected to reflect the range of unwanted materials lying on the surface. Apart from stones, the most abundant 'rubbish' was clearly charred trees and scrub. Where charcoal pieces are abundant in rows, the existence of large shrubs or coastal forest may be indicated. Where charcoal occurs as small fragments or stains, this may reflect only a low scrub or tussock cover. Walls where midden has been dumped were probably close to habitation areas.

These attempts to clear rubbish off particular stretches of ground imply the existence of standards of neatness in land use which are evident in wall construction as well. Most rows are straight, even over distances of 200 m, and it is possible that they were laid out with the aid of a cord. If not, they must have been checked repeatedly by eye during construction. There are, however, some rows between Kawakawa and Cape Palliser which are not straight even over short distances. They occur in small, simple wall complexes, often associated with raised-rim pits. It will be argued later that these are the work of a chronologically separate group.

Single boulder alignments are the second most common stone structures in Palliser Bay. They occur as lines of contiguous stones set on edge or occasionally on end, and as spaced alignments, only at Te Humenga and North and South Pararaki. In the spaced alignments the stones are set both on edge and as uprights. Alignments are restricted to the large wall complexes built on the coastal platform

and are never associated with the irregular rows described above. Their relationship to rows has been studied extensively, and excavations and field observations have shown that they are not only contemporary with rows, but are sometimes contiguous and may form the base of a row. In locations where surface stone abundance varies naturally, for example between raised beach ridges and intervening swales, rows and alignments appear to have been used according to the quantity of stone that required clearing. On the stony ridges rows were built, while in the hollows alignments predominate. One might even view the spaced alignment as an indicator of nearly stone-free ground.

Stone mounds constitute a third type of structure relevant to this study, for although of different shape to the rows and alignments, they were nevertheless also used as repositories of unwanted stone. Their comparative scarcity on the coast seems to indicate, however, that for dumping stones stone rows were usually preferred. It may be argued from this that the rows were not merely dumps but fulfilled another more important role. In support of this view one may draw attention to the existence of single boulder spaced and contiguous alignments: since they generally occur in fairly stone-free areas why was it necessary to build them at all? It should be noted that the few mounds located in coastal areas are all within areas outlined by rows, so they are clearly adjuncts to the rows. Other uncommon structures are stone arrangements around springs (for example at Shag Rock and North Kawakawa) and stone heaps in natural hollows (for example North Pararaki). The primary purpose of the walls, for which their neatness and regularity were essential, was to delimit areas of land. For this task spaced alignments were as suitable as rows, but mounds were useless. This interpretation makes some sense of the trenches found to underlie particular walls at North Pararaki and North Kawakawa. As a boundary marker a trench is clearly as effective (initially at least) as a line of stones. The filling of these trenches with stones indicates that the boundaries of the required land were marked before stone clearance commenced.

The arrangements of the various stone structures into wall complexes suggest that various classes of boundaries were required, such as major divisions between used and unused (or unusable) land and minor internal subdivisions. Within the latter category fall the

double walls consisting of rows, alignments, or combinations of these, which are interpreted as pathways. If this is a correct interpretation some explanation has to be proposed why they were constructed within wall complexes. Conceptually, the existence of a pathway implies that people should not or could not walk across the ground in the vicinity, but that access was nevertheless required. Today there is no physical constraint evident beside these pathways, such as ponds, swamps or rough terrain, and so the possibility of former dense vegetation should be considered. This explanation, however, does not satisfactorily explain the stone borders to the pathways. After all, if a track is cut through a thicket, the route is usually perfectly plain. Perhaps the most suitable interpretation is that the prehistoric wall builders felt socially constrained to avoid certain pieces of land, but that these were sometimes not visually distinct and required marking, in these cases with stones. One obvious social constraint affecting land use relates to land ownership, or more precisely ownership of rights to use land.

Viewed as part of a land utilization system, the variety and disposition of stone structures become readily explicable. A set of rules or principles of subdivision may be inferred from these arrangements. These rules operated within a geometrical system based on the rectangle; in consequence almost all rows and alignments meet at right angles. Perhaps the most important principle was one of equal opportunity of access to the land between the beach ridges or on consolidated fans. The operation of this rule can be seen in the orientation of the majority of walls which cut the natural soil boundaries at right angles. Thus each rectangular strip in a group of apparently contemporary strips contains comparable soils, and no single land user could monopolize the deeper soils of the hollows while another used only the dry stony ground of the beach ridge. The same principle coupled with rectangular geometry meant that walls had to be laid out parallel with one another. In practice, however, the method of setting out parallel lines from a base line on only one end of the plot has led to progressive convergence or divergence which becomes more noticeable the longer the walls are.

Where divergence is marked it has proved possible to determine which end of the plot served as the base line. In wall systems where the long strips run between the beach ridges and the foot of the

coastal hills or the apex of a consolidated fan, it appears that the subdivision has usually been made from the seaward edge. At South Pararaki the river bank plots may have been set out from the sides closest to the river. The principle underlying this choice of base line seems to have been to work from a natural boundary on the lower side of the plot. River banks, swamp or pool edges, beach ridges and probably vegetation boundaries, were all utilized as base lines. The few plots set out on undifferentiated flat land without natural boundaries are all notable for their patchwork appearance and lack of major orientation, for example the river terrace area of North Pararaki, and the flat land at the foot of the North Kawakawa hillside and Black Rocks fans.

A further check on this assessment of base line is available from the study of the variation in wall endings. In a number of groups, several parallel walls originate from a base line (wall or natural boundary) but terminate at different distances from it. Clearly they could not have been constructed from these different points, but were built out in the opposite direction as far as each land user wished to clear his patch of ground. In some areas like South Pararaki these observations may be correlated with the quantity of uncleared surface stone and in all cases the results have confirmed that a base line was used for internal subdivisions.

Another more mundane principle can be detected in the stone wall arrangements, and that is the principle of 'least effort'. Where boundaries were needed, natural lines were used wherever possible. Stones were gathered up into rows only when their abundance hindered land utilization. Much of the time single boulder alignments and possibly trenches sufficed. Unfortunately the latter marker is usually invisible without excavation. There is no evidence that stones were ever carried further than the nearest row, except perhaps to construct a neat, even section of single boulder alignment. Probably most rows were built up by clearing ground on both sides, although a few have been recorded where only one side is clear.

Analysis of the location of the wall systems adds further weight to the conclusion that it was not the walls that were the focus of prehistoric attention but the ground between them. Particularly stony ground at places like South Pararaki and Black Rocks was avoided,

a strange decision if wall building was the principal objective. The preferred type of ground, which has been most frequently enclosed, is the hollow between raised beach ridges. It is noteworthy that single boulder alignments running across ridges and hollows have sometimes been constructed more carefully in the hollows, reflecting the relative value of each zone. Not all ridges and accompanying swales were suitable, in particular the two closest to the sea. While it is possible that the first ridge had not been uplifted at the time of occupation, early habitation and midden sites have been located on the second ridge. Each ridge differs from the next in the degree of topsoil development and this seems to have been the operant factor, for the most extensively utilized ridges are the two closest to the hills, which have been up-raised long enough for a good loam to form above the sand.

The distribution of wall systems on fans is also related to the degree of soil development. Only consolidated fans have been used where sufficient time has elapsed since gravel outwash occurred for vegetation to colonize the fan and begin deposition of humus. Few hillslope areas have been used, but in general these have only minimal soil development. The one exception at North Kawakawa is in the only area of extensive dune formation and sand is present in the topsoil well up the slope.

River terraces in the Makotukutuku, Moikau and Otakaha (Kawakawa) valleys feature some quite large wall complexes, but only within 3 km of the coast. Further inland apparently suitable terraces have been observed with well-drained, deep topsoils, but no signs of use. This anomaly is almost certainly related to climate, for weather records made over a period of 12 months in the Makotukutuku Valley indicated that the amelioration of temperatures typical of coastal regions falls off rapidly at a point about 2.5 km inland, and rainfall increases considerably. It seems therefore that both soil and climate are important factors in the land use systems of which the walls are part.

No obvious relationship seems to exist between stone wall complexes and water courses. The drainage pattern on this coast takes the form of several major rivers and streams with inland catchments, seasonal coastal rivulets draining the Pleistocene terraces and creating fans on the coastal platform, and perennial springs and

associated swamps and pools at various places on the coastal platform. Consequently no group of walls is far from fresh water. Despite intensive searching no sign of redirected water courses was found. It must be concluded that the type of land use did not require more water than could be supplied by normal rainfall. The land on which stone walls occur, is always particularly well drained, with light porous topsoils and free-draining sands and gravels beneath. Heavier, stone-free soils, such as those on the Pleistocene terraces, appear to have been ignored. It might be thought that the underwater walls at North Waiwhero contradict this view. However the ponds in question are only present during the months of heaviest rainfall, usually May to September. This may be taken as an indication that the land use system operated only in the summer months.

In summary, it has been shown that the walls of Palliser Bay result from a pattern of behaviour which also includes burning vegetation, clearing rubbish, modifying the topsoil, and marking plot boundaries and access routes. Furthermore these activities have been shown to be restricted to areas with a coastal climate, and a developed friable, well-drained topsoil. There are also a few indications that the activities were concentrated in the warmer part of the year.

Possible Interpretations

If the archaeologist was asked to interpret only the stone structures recorded in Palliser Bay, his knowledge of similar features in Polynesia might lead him to consider a range of explanations from religious activity to chiefly pastimes. Polynesian marae are commonly outlined by boulder alignments, paepae house foundations could erode into stone heaps, roads and villages are sometimes demarcated by low walls, and archery platforms in time might appear as broad stone mounds. However the excavations and field survey have revealed that the construction of walls is part of a constellation of activities repeated at each location. Any explanation that is offered must not only account for the walls, but also the soil modification, addition of charcoal, land subdivision, and choice of site. A religious interpretation can be ruled out because it cannot explain the topsoil modification, while viewing the wall complexes as villages immediately raises problems of size and resources. The one interpretation which accounts for all the evidence without strain is that the wall complexes are enclosed garden

plots, and that the behaviour pattern is typical of horticulture.

In fact, elimination of the other hypotheses is made even more simple given a knowledge of site distribution in eastern Palliser Bay. Although no religious structures can be identified, habitation areas adjacent to the walls are clearly visible and several have been excavated. These areas are usually situated on and between raised beach ridges on the seaward side of the walls. They were the scenes of industrial activity, food preparation and cooking, midden dumping, possibly food storage, and burial of the dead. Substantial houses have been excavated in a number of areas close to walls (Makotukutuku Valley, Moikau Valley and North Pararaki) and their characteristic remains of post-butts and stone-edged hearths are readily distinguishable from stone wall enclosures. Even the unusual curbstone-edged L-shaped 'house' at North Pararaki can be distinguished on grounds of its stone-edged hearth and small size.

Other Horticultural Features of Palliser Bay

The rows, alignments, trench boundaries, stone heaps and modified soils are not the only horticultural features encountered in Palliser Bay. Three others, pits, stone and soil mounds, and long terraces, have been recorded and a few examples excavated in the context of the Makotukutuku Valley project conducted by B.F. Leach (1976). The horticultural terrace examined at the mouth of the Makotukutuku Valley (M1/XXX) was identified as such on the grounds of marked deepening of the prehistoric topsoil, the incorporation of charcoal throughout the layer, disturbance of the underlying 'C' horizon in a manner consistent with deep cultivation, and the complete absence of domestic refuse, house timbers, post holes, and hearth (*ibid.*:224-8). A carbon sample from this terrace was dated at 1375 ± 71 AD (NZ1637).

Another horticultural terrace (M2), just inside the mouth of the Makotukutuku Valley, is associated with a few stone walls formed of taluvial debris, and 18 mounds between the walls. The terrace (9 x 5 m) occupied higher ground north of the walls, but its status as a garden is less secure than M1/XXX described above. It possessed little charcoal, and no mixing of soil layers was evident. On the other hand the same longitudinal depression was noted along the back of the terrace as at M1/XXX. Marked soil deflation has occurred just inside the mouths of the Makotukutuku and Otakaha (Kawakawa) valleys and it is possible that this terrace has lost most of the prehistoric topsoil (*ibid.*:232-3).

An unusual type of mound found at M4 should also be included as a separate horticultural feature. Some 53 mounds were closely associated with one large and six shorter stone walls occupying gently sloping ground divided by two transverse terraces. One of the mounds was excavated by B.F. Leach (ibid.:245-9). He found that before the 3 m diameter mound was built, forest clearing took place, dated to 1256 ± 72 AD (NZ1641). A typical but thin, charcoal-enriched garden soil developed and was subsequently covered by the mound which consisted of much soil and charcoal as well as stones. The quantity of included soil, the stratigraphical position of the mound, and the high proportion of the land covered by the mounds, set them apart from many simple stone dumps encountered on the coast. It was suggested that the mounds formerly contained even more soil which had been heaped up to provide an even deeper bed for plants than the relatively thin soil on the old fan beneath. A large post hole was found in the mound and it is possible that this may have acted as a support for a climbing plant such as the gourd (Lagenaria siceraria). The only other Palliser Bay sites with a large number of mounds are M2 (18 mounds) and M3 (12 mounds), both of which are in the Makotukutuku Valley.

In the 1950s and early 1960s pits were often interpreted as semi-subterranean houses, and thus their association with possible horticultural evidence remained unexplored. The alternative explanation, that they were kumara storage pits, is now widely accepted, and it has become obvious that they can be used profitably as indirect evidence for local horticulture.

In Palliser Bay the most visible type of pit is rectangular with a raised rim. This was commonly found in isolated clusters of 2 or 3 or as single examples on the edges of high river terraces (for example, M5, M6, M7, M8, M9, & South Kawakawa valley), also in association with small 'house' terraces on terraced spurs (for example, M3, M4, & North Kawakawa), and only occasionally on the coastal platform itself. Where the type does occur on the coast, as at South Kawakawa and South Waihero, it is invariably far removed from midden sites and in association with simple garden enclosures, which are unlike the garden areas adjacent to Archaic habitation sites. Large pit complexes are much more common in the Wairarapa Valley where they are often fortified with scarp or bank and ditch defences. Many of the pits within these pa

have visible external drains and the same feature occurs in Palliser Bay at M3, and in the large pit complexes overlooking the Putangirua Valley (N165/7 & 8).

The associations of the pit type thus vary from simple gardens of the less regular type, and habitation terraces on high spurs, to fully fortified pa sites. Only two such pits have been excavated and dated, but others can be assigned an age, albeit tentative, through their associations with other dated sites. B.F. Leach's excavations at M5 began as the investigation of an isolated rectangular raised-rim pit situated on a terrace edge overlooking the Makotukutuku River. In fact, this pit was found to be the last of a series of at least three pits with side and corner buttresses, a centre line of post holes, and internal hearths. The earliest was dated to 1579 ± 69 AD (NZ1640), while the latest was >1772 (NZ1639). At M4 where a pit was situated on a ridge just above a substantial house, charcoal from the house dated to 1466 ± 70 AD (NZ1643) and 1617 ± 69 AD (NZ1642) may indirectly permit an estimate for the pit of about 1539 ± 76 AD (*ibid.*: 252). Pa sites enclosing pits in the Wairarapa Valley are generally judged to be 'late' by virtue of occasional traditional names and some Classic Maori artefacts recovered from them or their vicinity.

The circular raised-rim pit is much less common in the Wairarapa as a whole. Three distinct examples were recorded near horticultural terraces at the mouth of the Makotukutuku River and one of these was excavated. Stratigraphically it was clearly later than the dated garden terrace, and the pit date of >1740 AD (NZ1636) confirmed this. It is possible that these were potato pits constructed in the early 1840s (qv. B.F. Leach, 1976: 228-232).

The site survey revealed several clusters of rimless, often narrow rectangular pits in the Turanganui and Moikau valleys. In the latter, one set was directly associated with several houses belonging to an Archaic village, one of which was excavated and dated to 1179 ± 54 AD (NZ1645) and 1181 ± 54 AD (NZ1644) (qv. N. Prickett, 1974:217). On the coastal platform of Palliser Bay, there was no indication of the existence of this pit type until the earliest layers were reached in the Washpool Midden site. Two grave-like, rectangular pits, and one oval pit with an annexe and two floor levels were

discovered. One of the narrow pits was directly dated to 1191 \pm 41 AD (NZ1505) while the oval pit was dated to 1313 \pm 40 AD (NZ1507). The rectangular pits had been filled with midden but their vertical sides in such unstable materials as sand and gravel indicated that they had been filled immediately after digging, or, more plausibly, had been lined. The lining of a rubbish pit seems unlikely; however, presumed kumara storage pits elsewhere in New Zealand were often lined with timber (Fox, 1974: 146, 149). Although the evidence is slender, these generally narrow, rimless pits appear to be the earliest form in Palliser Bay. It is probably significant that they occur within Archaic coastal habitation sites, unlike the raised-rim variety which so often occupies a naturally or artificially defended or 'hide-away' position (qv. B.F. Leach, 1976: 141-3, 313-4).

The distribution of pits of both rectangular types provides additional support for the interpretation of the stone walled enclosures as gardens, that is if they were used for winter storage of garden produce. It is now clear that prehistoric horticultural activities in Palliser Bay involved at least three types of garden and two storage devices. The flatland or slope strip garden featured stone rows or ditches as boundary markers and persisted from the earliest period to the end of the 16th century, although with a possible change in design. Terrace gardens were in use by the 14th century if not before, and mound gardening was practised at some period after the 13th century. It is likely that the three garden types were contemporary for several centuries. Pits, on the other hand, may have been rimless for the first 400 years until the introduction of the rim fashion, possibly from the Hawkes Bay region. The implications of these temporal relationships will be examined in a later chapter.

CHAPTER FIVE

STONE WALLS AND OTHER HORTICULTURAL FEATURES IN NEW ZEALAND

It should be clear that many conclusions relating to horticultural activities in Palliser Bay depend on the integration of evidence from a variety of site types, not just from the gardens themselves. Similarly an appreciation of horticultural and related evidence from other parts of New Zealand may contribute to the reconstruction of gardening patterns by strengthening particular conclusions or suggesting a more likely interpretation of a certain feature. In this chapter, therefore, the range of prehistoric and early protohistoric horticultural practices and techniques will be surveyed for New Zealand as a whole (see Figure 41).

In Chapter One it was shown that disused stone walls were recognised relatively early in the 19th century and interpreted as the edges of garden plots. By 1894 gravel quarry pits had been identified near Nelson (Rutland, 1894) and horticultural swamp drains were described in Northland by D. Wilson in 1921. There were no records of prehistoric garden terraces which even today are very difficult to distinguish from house terraces. Until the 1960s storage pits were often interpreted as dwelling sites (for example, Rutland, 1897; Duff, 1961). Problems of defining and isolating horticultural sites from archaeological surface surveys can be by-passed to some extent by drawing on 18th and early 19th century records of the actual gardening activities. These activities, however, were subject to misinterpretation and inadequate reporting, and the extent to which they were rapidly modified by European introductions of metal tools and new plants is relatively unstudied. Nevertheless they are a valuable guide to the ephemeral aspects of Classic Maori period gardening, such as particular planting techniques, seasonality and even garden tools.

From the first landfall on the eastern coast of the North Island, Cook and his party saw many garden clearings situated on slopes, a type of garden which is seldom recognisable by the archaeologist. Of course these complexes were particularly visible from offshore. Cook described such gardens on Mahia Peninsula as "square plantations". It was not until they anchored at Anaura Bay on 21 October,

1769 that a clearer picture emerged. Banks estimated that the plantations were "from 1 or 2 to 8 or 10 acres each" and that "in the bay might be 150 or 200 acres in cultivation" (Banks, I, 1963:417). Cook's comment that the gardens were dispersed "up and down the Country" (Cook, 1968:186) was well illustrated by Spöring's contemporary drawing of Anaura Bay (qv. Begg and Begg, 1969:23-4, Pl.22, Pl.23). Six garden complexes are shown of which 4 occupy the lower slopes of the hills directly behind the narrow coastal strip, while the remaining smaller complexes appear to be a hundred metres or more above the beach. Each complex is shown with longitudinal and transverse subdivisions forming neat rectangular plots. This regularity contrasts with the outer edges of the complex which are particularly irregular along the higher edge. In one complex the different longitudinal sections terminate at several different altitudes, giving a roughly crenelated appearance. While the lower edges of the beach-side gardens were not visible from the ship, it appears that as in Palliser Bay each plot was worked in a strip from a coastal baseline, as far inland as was required by the individual social group responsible for the clearing and cultivation.

All the observers commented on the existence of fences. Cook referred to "low pailing which can only serve as ornament" (Cook, 1968:186), while Banks made the important comment that "each distinct patch was fenc'd in, generally with reeds, placed close one by another, so that scarce a mouse could creep thro' " (Banks, I, 1963:417). Monkhouse elaborated on this observation, and it is possible that the density of the fence would protect the emergent shoots from damage from Rattus exulans, the likely predator:

"these Cultivated spots are enclosed with a perfectly close pailing of reeds about twenty inches high. The Natives are now at work compleating these fences. We saw a snare or two set upon the ground for some small animal, probably of the Mus tribe."

(Cook, 1968:583-4)

It is hard to conceive that these low fences could have been visible from the sea even with telescopes; however, the planting pattern may have varied on either side and this contrast would stand out from a great distance. Banks had noted that even in early October, some plots were

"fresh turnd up and laying in furrows like ploughd land, others with plants growing upon them some younger and some older ..."

(Banks, I, 1963:409)

The variation in stage of growth, coupled with the different planting layout, consisting of mounds set in straight lines or in quincunx for kumara and yams, and hollows for taro and gourds (Monkhouse in Cook, 1968:583) would have given each plot a distinctive appearance, and reinforced the geometric characteristics of the gardens.

In addition to the slope gardens at Anaura Bay, one of the European visitors noted flat land plots where taro was planted (Banks, I, 1963:417) and Monkhouse described "houses ornamented with gourd plants in flower" (Cook, 1968:584). On the same day Banks (I, 1963:417) had observed plants "of the cucumber kind" of which the "seed leaves [had] just appeard above ground"; so it would appear that some gourd plants were over-wintered in the settlements to flower in October while the bulk of the seed was planted in spring in the main garden plots.

Garden tools that were described can be identified as the ko or digging stick, about 2 m long and 75 mm wide, and a pinaki, a pointed tool 75 mm broad and 0.75 m long (Monkhouse in Cook, 1968:584). Banks (II, 1963:26) also noted the digging stick foot rest, "a peice of stick" fixed across the ko which Du Clesmeur indicated was about a metre above the point (McNab, 1914:475). In Doubtless Bay, L'Horne saw only two tools, and neither fit the description of ko or pinaki:

"One is an implement shaped like a trowel, the other is also wooden and shaped like a grubber, and about 2 ft. or 3 ft. in length."

(McNab, 1914:335)

Best (1925:31) believed these correspond to the ketu and tima. An important observation by Banks (II, 1963:26), that the planting mounds were "rangd in a regular Quincunx by lines which with the pegs still remaind in the feild", may indicate that the garden plots themselves were laid out with cords and marker pegs, a suggestion already made for Palliser Bay stone wall boundaries.

The 18th century observations cover the northeastern area between Hawkes Bay and Doubtless Bay and slope gardens appear to have been used at least as far north as the Bay of Island (qv. McNab, 1914:475). In his survey of East Cape soils, Gibbs (1954:45) quoted the

journal of E. Lucett, a merchant who visited Hicks Bay in 1840 and who noted that the Maoris "appear very partial to cultivating the face of the hills..." and that "every hill was under cultivation in greater or less degree...". Some of these hillsides may have been in cultivation seventy years previously, when Cook commented on "a great deal of Cultivated land laid out in rectangular inclosures" as he rounded East Cape (Cook, 1968:188). Gibbs (1954:45) described the use of steep slope gardens as "a consequence of the shortage of fertile cropping soils on flattish slopes". It should not be assumed that flat land soils provide optimum conditions for this type of horticulture. The observer Monkhouse (Cook, 1968:584) had distinguished Anaura Bay soils as "light and sandy in some parts" and "on the sides of the hills ...a black good mold". The very lightness of some of the lower soils would retard growth in summer through over-rapid drainage. At Hicks Bay, a typical east coast bay backed by steep hills, Waiapu stony sands occur immediately above the beach and these grade inland into Oweka sandy loam on the flats and fans of streams draining the steep land (Gibbs, 1954:Fig.1). Waiapu stony sands are formed from coarse alluvium and the plants growing on them obtain nutrients from particles of silt or clay added during small floods or dust storms. They are described as having very rapid drainage. Oweka sandy loam is also free-draining and is formed from alluvium derived from sandstone, volcanic ash and other local rocks. It is brown and friable and of varying thickness, overlying sand which in turn overlies gravel and stones. When summer rainfall is inadequate the capacity of soils to hold moisture from spring rains is vital for the horticulturalist and thus the soils of the lower hill slopes which are deep, rich in humus, and contain moisture-holding particles of clay derived from the hills above, might actually be the preferred soil type.

North of the Bay of Islands rainfall becomes heavier and more regular than on the east coast. In 1772 Roux described a plain near Tom Bowling Bay as being

"of a fertile appearance, and...divided by several small streams. It appeared to me to have been cultivated. Every ten paces or so there were little canals through which the water flowed..." [an alternative translation is "little ditches for the water to run along" - it is possible that the ditches were empty]

(McNab, 1914:361)

In view of the rainfall pattern the channels probably served to take excess water away rather than to supply extra water to a crop, although the possibility of swamp taro irrigation should not be totally discounted. This observation was made in late April when the main crop of kumara might be expected to have been harvested. If the crop had been taro, however, which requires a longer growing season and does not store well (see Chapter Seven) one might expect it to have been still in the ground.

There is only one reference in the 18th century accounts to the methods of garden preparation. On Cook's second voyage, Bayly noted that vegetation on the site of a future garden was set on fire and then cut off "about knee high" before the ground was worked with some form of digging stick (McNab, 1914:213). This 'burn and slash' variant of the almost universal horticultural technique was probably employed in all parts of New Zealand where slope gardening was practised, but does not preclude the existence of more specialised gardens such as drained swamps or river-side plots where nutrient levels can be maintained for long periods. Even gardens at the base of slopes receive the benefit of soil washed down during heavy rainfall, although the amount of vegetation cover on the hillside is critical - if the ground has been bared by fire, unwelcome quantities of the less fertile sub-soil will be transported. Although Monkhouse referred to kumara hillocks in one plot "surrounded with dried grass" (Cook, 1968:583), there is no indication from the early records that quantities of vegetation were brought in to be burnt on the gardens to provide extra nutrients. This influential suggestion was made by Rigg and Bruce (1923) in their study of modified soils of the Waimea Plains in Nelson. It may have stemmed originally from Yate (1835:156):

"This people have also found by experience, that burning their superabundant vegetable matter, and spreading it over the land, improves their crops, not only in quality, but in quantity."

Two other practices, gravel addition and stone wall boundary construction, are not mentioned in the 18th century records. The former was first discussed by Yate in 1835 (*ibid.*). Stone walls are most abundant in those areas of the northern North Island where extremely fertile but stony volcanic soils occur in Auckland and inland from

the Bay of Islands, regions which were not visited by Europeans before the 19th century. Nicholas watched the mounding of stones during garden preparations in inland Northland (Nicholas, 1817), while Marshall (1836:69) described a pathway bordered by low scoria walls which ran through a maize field in the same area. Near Kaipara, Polack (1839:181) described a garden of mixed Maori and European-introduced vegetables:

"the herbaceous land was cleared of weeds, piled above the walls of stone that had been collected from the grounds, which I calculated occupied about twenty acres in extent."

The use of the walls as repositories for weeds is reminiscent of the Palliser Bay situation where rubbish was often incorporated within the walls. Campbell's observations of walled plots on Brown's Island, which had not reverted to bracken may also be taken to indicate that the plots had been in use not too many years before.

In summary, early European records describe a varied horticulture involving kumara as a major crop, with yams, taro, and gourds occupying a lesser position. Kumara and yam gardens appear to have been located on favourable hillslopes, while taro was planted on the flat. High standards of neatness were followed and the gardens were laid out and planted with geometric precision. Internal subdivisions such as fences were noticed and garden complexes seem to have consisted of several individual plots. Since not all were at the same stage of development, it seems likely that the separate plots were worked by different groups who made their own decision as to the time of planting and what should be grown. Low-land gardens drained by ditches, and plots outlined by stone walls were in use in some localities. The prevailing soil types of the gardens, which are described as generally light, are consistent with the wooden gardening tools. Of these, the long digging stick was observed in all districts but there may have been some regional variation in the smaller tools. In the eastern coast area, at least, spring was the main planting season for all four plants, and Monkhouse estimated that in 1769 this work took place at the beginning of October.

The archaeological evidence for horticulture is naturally less detailed but covers far more of the horticulturally suitable

land of the North and South Island than was ever seen by 18th or early 19th century European visitors. In addition, the evidence may represent up to a thousand years of horticulture in contrast to the 60 - 70 years of protohistoric records.

In the field, prehistoric horticultural activities are inferred from a variety of features: stone walls and alignments marking off relatively large enclosures; soils modified by additions of gravel, charcoal, or worn shell fragments; 'borrow' pits; storage pits; swamp drains; slope lines; and, in certain cases, terraces. Recognition of these features is unfortunately not even, since storage pits often dominate an archaeological landscape and modified soils and slope lines may only be detected by the experienced observer.

Although prehistoric stone wall complexes were recognised in the 19th century, none was mapped or described in detail until Adkin (1955) published his paper on eastern Palliser Bay. Stone structures in general had been discussed by earlier writers and included upright stones (Anon., 1915) and stone-faced terraces (Best, 1927; Anon., 1933; Maxwell, 1933). W.H. Skinner (1893) described a stone-faced defensive ditch and bank at Koru pa in Taranaki, and Best listed other examples in Taranaki, Auckland, Hawkes Bay, Coromandel and Northland (Best, 1927: 155-9, 248). It is not surprising that areas stony enough to encourage the use of stones in pa construction also featured structures which were interpreted as stone garden walls, especially near Ohaeawai, and on the Auckland Isthmus. Describing the former area, Best (1924:373-4) indicated some of the details of the stone wall complexes which he visited:

"The far-spread miles of level and undulating land of the Taiamai district still show what large areas were formerly cultivated. The evidence consists of innumerable piles and walls of volcanic stones... There are also seen many double rows of stones set in straight lines in the soil. The narrow spaces between these rows were the paths that divided different divisions (raukawa) of a field, each of which would be the garden plot of a family."

In his paper on Puketutu (Weekes Is.) in Manukau Harbour, Auckland, where several hundred acres of stone walls were visible, Fairfield (1938) did not follow Best's horticultural interpretation of their function but viewed them as subsidiary defences "intended to quarter a large population in times of war (in Golson, 1957a:97). In

rejecting this view, Golson (ibid.) pointed out that

"an identical feature is to be seen at Wiri Mt., near Auckland, where the rubble walls in question spread down the hillside from the terraced defences of the pa well on to the surrounding plain... It seems certain that they must be interpreted as the signs of agriculture and not defence."

The walls of Wiri Mt. and nearby McLaughlins Mt. have now been investigated in detail by A. Sullivan, and her work constitutes the only other major research programme to concentrate on New Zealand stone wall complexes. It commenced with a study of the former extent of these complexes in central Auckland (Sullivan, 1972), in which it proved possible to identify from early photographs and records at least 15 wall systems, covering a minimum of 500 ha. The largest is the Wiri-McLaughlins complex consisting of about 280 ha. There are good grounds for postulating the former existence of another 15 wall systems on the Tamaki Isthmus, and the total number of hectares from which stone was removed might be as high as 2000. A major conclusion of the survey was that the complexes occurred only on those areas of volcanic soil where before clearing, the surface would have been strewn with basaltic rocks (ibid.:150). As in the Wairarapa, it was found that "stones were shifted no further than was necessary" (ibid.). Sullivan also argued that all volcanic soils of the region might have been used for prehistoric gardening, and that if this assessment is correct, "the intensity of stone structures in a locality is seen as dependent on initial concentrations of uncleared surface debris, and not primarily as a function of agricultural intensity" (ibid.:154). A similar conclusion was reached in the Wairarapa.

The common unit of land division in these Auckland complexes appeared to be "a rectangular plot, roughly twice as long as it is broad" (ibid.:155). These plots were later described as being 25 - 60 m wide, and 80 - 300 m long, often with internal subdivisions (Sullivan, 1974:135). Smaller enclosures, 10 - 20 m long, were also consistently seen, usually clustered together in spaces between the larger, walled enclosures. The walls themselves exhibit greater variety than in the Wairarapa with double faced walls as well as the single faced and unfaced rows and single stone lines noted in Palliser Bay. Piles, semi-platforms, terraces and L and C-shaped structures were also recorded (Sullivan, 1972:155). It was found that in cases where the systems on

the lower slopes of the volcanic cones are intact "stone walls radiate out initially from the cone, and then form a more irregular network" (ibid.:156). This may suggest that the earliest clearance of stones was to allow slope gardening. In general most of the stone structures were regarded as having a horticultural function, although Sullivan was careful to point out that some archaeological features on the fortified cones duplicated elements found in the walled complex below.

Intensive fieldwork at Wiri revealed, in addition to hundreds of walls, the remains of some very thick-walled, small enclosures, about 2 x 2 m inside, often associated with shell midden. These were interpreted as garden shelters (Sullivan, 1974:128, 135). Although similar structures were an important element of Hawaiian garden complexes (see Chapter Six), the association of dwellings and gardens has seldom been documented in New Zealand. Only Savage (1807:3, 12) noted that in the Bay of Islands on each plot of cultivated soil was "a well-thatched hut, and a shed at a little distance", the latter possibly a store house or even a roofed pit.

Even more numerous at Wiri than the walls were stone mounds which were usually partly earthed up. Five were excavated and were found to have been formed during a period when an 'A' horizon of different character to the modern topsoil was accumulating (Sullivan, 1974:133). Two were structured mounds, built by depositing small scoria pieces within a ring of larger blocks two courses high (ibid.:130-2). In contrast, some scoria mounds were found to be the remains of previous enclosure walls. The curb and core mounds are interpreted as "either casual clearance mounds, built for convenient stowage of limited amounts of scoria turned up in cultivation" or "they may have been intended as supports for the cultivation of such crops as gourds" (ibid.:140). Sullivan believes that the clusters of structured mounds may represent "a zone of intensive gourd cultivation" (ibid.), an interpretation similar to that advanced for the Cross Site (M4) mounds in Palliser Bay. Most garden plots at Wiri, however, were probably used for the cultivation of kumara, and the subsidiary harvesting of bracken fern root from gardens in fallow (ibid.:140-1).

Radio-carbon dates are available for an excavated site on the lower slopes of the former terraced pa on Wiri Mt. N42/24-5. The excavation examined the relationship between a terrace and a scoria

wall "bordering a garden plot" (Sullivan, 1975:206), and was therefore particularly relevant to the broader question of chronological links between pa building and horticulture. Sullivan obtained clear separation between slope gardening activities at this site dated to the 13th century and the terrace occupation c.1600 AD.

Although the natural occurrence and distribution of stone as well as the type of stone used in the walls varies between Palliser Bay and Wiri, it is apparent that similar principles of garden layout were followed. The rectangular system, the various levels of subdivision, the range of plot sizes, the constructional details, and the orientation of the walls in relationship to topography, all exhibit convincing parallels. In precision of layout, however, the major Palliser complexes are very much neater. Pathways have not been found at Wiri but this may reflect the difficulties of recognising them, rather than their absence. Similarly the lack of field shelters in Palliser Bay may not necessarily imply a different habitation pattern, especially since the shell midden which is often associated with these shelters at Wiri does occur within some field systems at Palliser Bay. The question of field shelters is clearly complex and must surely relate to the distance between the main habitation area and the gardens. It has been argued that in Palliser Bay the earlier wall complexes were built close to coastal villages and thus field shelters may not have been needed. What are regarded as later gardens which are not associated with large beach middens and industrial sites may have possessed shelters constructed in less durable materials than scoria. Although Sullivan has not commented on the distribution of these small enclosures at Wiri, they may in fact be more common in garden areas some distance from the cone, and if her suggestion that slope gardens preceeded the expansion beyond the cone is correct, the field shelter may be considered a later development.

Closer to Palliser Bay, a wall system at Te Awaiti (II) 29 km north of Cape Palliser on the eastern Wairarapa coast has recently been mapped and excavated in part by B.McFadgen. A plan supplied to the author showed an arrangement of long, rectangular plots, 12 - 35 m wide and 20 - 100 m long. In plot size and layout this complex is very similar to that described at North Waiwhero. The most striking parallel is the use of beach ridges and scarps to close off areas demarcated by longitudinal walls. As at Waiwhero, transverse walls are rare.

In addition the complex appears to consist of several sections with internal subdivisions into equal units. Two sections of single boulder alignment are shown, one of which may mark the inside of a path running along the edge of a beach ridge cusp. There is a published date for Te Awaiti of 410 years BP (Moore and Tiller, 1975:102, 105) from a shell sample, but its exact provenance has not yet been described. If it does date the mapped complex it is encouragingly similar to the Waiwhero charcoal date of 477 years BP.

At Waikokino, 32 km north of Te Awaiti, a wall was sectioned in January 1969 under the direction of O. Wilkes during Mitcalfe's survey of the eastern Wairarape coast. A section drawing obtained by the author shows the characteristic deepening of the former 'A' horizon north of the stone row with complex mixing of grit and silt layers. The wall formation was contemporary with this modified soil. Another section of a wall and adjacent 'garden' at Tora was described by Mitcalfe (n.d. a: 13) as displaying

"an artificial Maori garden soil in both the wall and the intervening garden areas. Charcoal and organically darkened material of a fine sandy mixture permeated the wall of rounded stones, each from 4 inches to 12 inches in diameter. This suggests that the walls might possibly have been used for propagating the plants."

At this time Mitcalfe believed that most walls arose from the need to clear stones from the land, but fulfilled the secondary role of supplying shelter and marking boundaries (ibid.).

In 1970 Mitcalfe argued strongly that the Wairarapa stone rows, including the wall at Waikokino, were in fact deliberately enriched for horticultural purposes. He also noted that the ridges contained midden and artefacts (Mitcalfe, 1970:175). In his view, clearing the adjacent ground of stones and cultural rubbish would not account for the fine black soil in the walls; however, he ignores the possibility that normal soil-building processes could act on coarse organic rubbish such as burnt brushwood and household refuse to produce such a fine matrix.

Although no other excavations of horticultural walls have been reported, there are many scattered references to walls encountered during field surveys. The most southerly are those described by A. Jones (1962), Thacker (1961) and Harrowfield (1969) on Banks Peninsula. Thacker

(1961:9) referred to "numerous parallel ridges, thirty to forty feet apart" running up a sunny slope at Pa Bay. At Menzies Bay (S84/18) "rows of stone heaps, probably part of a former kumara garden" were recorded by Jones (1962:113). Harrowfield summarized the available information, adding records of three stone rows at Long Lookout Point (S85-95/3), one row at Stony Bay (S85-95/12), one at Goughs Bay (S85-95/15), and several at Ducksfoot Bay (Harrowfield, 1969:98-9). Most of these were associated with middens and promontory pa.

Walls have been reported just over 30 km to the north and south of Kaikoura, at the mouths of the Clarence and Conway rivers. The southern occurrence was reported to Duff (1961:274) as being "towards the southern end of the Conway Flat" (S55-6/ ? 747628) while the walls at the Clarence River (S42-3/11) have been referred to by Sullivan (1972:148), and personally visited by the author. They form long, low, grassed ridges running across the coastal platform which here, as in the Wairarapa, consists of a series of raised beaches. Raised-rim pits have been reported on the ridges overlooking the coastal strip. The complex is reminiscent of the simple and probably later type described in the Wairarapa.

Walls and pits recently recorded by N. and K. Prickett on D'Urville Island display strong similarities to some Wairarapa complexes. The Opotiki site (S10/23) occupies a consolidated fan now cut by a gully. A "simple almost geometric design of stone walls" is flanked by 11 raised-rim rectangular pits which are positioned along the edges of terraces and banks; the area is over-looked by spurs on which more pits have been dug (Prickett and Prickett, 1975:123). Some midden was noticed incorporated in the walls. This description could apply almost without modification to the simple wall and pit systems found on fans in the Kawakawa Valley, especially in the location of the pits along the extreme edges of the garden area.

The Manawakupakupa walls (S10/149), also on the southwestern coast of D'Urville Is., occupy 2 - 3 ha and "form massive straggling lines set close together" (*ibid.*). Large piles of stones are present and the impression is given that "the stones and boulders appear to have been piled up as a result of clearing operations rather than simply to bound garden plots" (*ibid.*). Again, many pits were located on slopes and spurs overlooking the garden area.

The status of stone walls on the southeastern edge of Wellington Harbour is of some relevance to the Wairarapa study since they occupy a similar topographical position on a raised beach coastal platform. Palmer (1963:131-2) maintains that two periods of wall building may explain the grassed-over walls which lie at right angles to the beach and the long transverse wall commented on by early visitors (see p. 3). The latter wall was double-faced, comparatively high and carefully constructed. It may be of some significance that the grass-covered rows occur at only one end of the high wall and are close to ovens, middens, working floors and burials at the mouth of the Okakaho Stream, an association reminiscent of many wall complexes in eastern Palliser Bay. It seems likely that the free-standing wall belongs to the European era while the longitudinal rows may be of comparable antiquity to those of the Wairarapa.

The situation nearby at the mouth of the Orongorongo River is also complicated by 19th century settlement and agriculture (McFadgen: pers. comm.). Middens, rimmed and unrimmed pits, and transverse and longitudinal walls occur on raised beach ridges and river terraces on both sides of the river. Although a pit close to the northern river bank was found to have been dug in the post-contact period (c.f. the late, circular, raised-rim pit on the north bank of the Makotukutuku River), portions of the stone wall systems are similar to those seen in Palliser Bay, and much of the Orongorongo evidence may also be Archaic. This section of coast between Cape Turakirae and Pencarrow Head may tentatively be regarded as the most western locus of the southern and eastern Wairarapa wall building tradition.

Islands of the Hauraki Gulf and further north are well known for their stone structural remains. Recently S. Edson (1974:59) reported "spectacular stone-walled field systems and former cultivations" in association with large pit complexes, undefended settlements and pa on Great Mercury Island.

Other references to stone walls can be cited, but it is uncertain whether they are part of horticultural complexes. At Kaupokonui, for example, Buist (1962:236) described two enclosures, cleared of stones "which had been heaped to form ridges enclosing areas some thirty to fifty feet square". Within one, several pits were

noted (see below p.133). At Paraparaumu, Beckett (1957) recorded two rubble walls running parallel on a strip of land below terraces and pits, but because of the rocky nature of the ground they enclosed he interpreted them as palisade reinforcing. Mitcalfe, however, included them in a list of horticultural walls (Mitcalfe, 1970:175-6).

If the isolated and ambiguous examples of horticultural stone walls are set aside, two regional concentrations are apparent. In the north, large scoria and basalt wall systems occur on rich volcanic soils in association with terraced volcanic cones. They appear to have crept out from the cone like the lava flows on which they are built, eventually covering several hundred hectares. In the south, much smaller coastal complexes are encountered along the Wairarapa and eastern Wellington coasts with extensions to D'Urville Island, Kaikoura and Banks Peninsula. These satellite complexes are comparable in style to what may be the later rimmed pit-associated systems in the Wairarapa. As far as can be determined, in both major regions wall building began by the 12th century AD and persisted for many centuries.

Records of modified, also called 'made' or 'Maori' soils, indicate regional concentrations, particularly in Nelson and the Waikato, but their antiquity is less certain. As soon as borrow pits were recognised on the Waimea Plains near Nelson, they were linked with prehistoric kumara horticulture (Rutland, 1894:221) and this interpretation has not been challenged subsequently (Rigg and Bruce, 1923:85; Chittenden, Hodgson and Dodson, 1966:16). Pits and gravel-strewn surfaces near Kaiapoi were discussed in remarkably similar terms by Stack in 1893 (Stack, 1906:184-5) and it is possible that his opinion formed the basis of Rutland's assessment. An even earlier reference by Shortland to sand borrow pits for kumara horticulture in the Waikato was cited by Best (1925:60). All subsequent papers have accepted the association of 'made' soils, borrow pits and kumara growing (for example Taylor, 1958; Law, 1968; Pick, 1968; Cassels, 1972), but there is no general agreement on the purpose of adding sand, gravel and charcoal. A sample of opinions include making hard ground easier to work, better aerated and more absorbent of light rains and dews, making wet ground drier and quicker draining, making cool ground warmer, making dry ground conserve water, making warm ground retain heat, and making poor ground more fertile (Yate, 1835; Shortland, 1854; Colenso, 1880; Stack, 1893;

Walsh, 1902; Rigg and Bruce, 1923; Taylor, 1958; Law, 1968; Pick, 1968; Macnab, 1969; Cassels, 1972).

As indicated earlier, no reference was made to the practice of modifying soils before Yate's (1835) comment and there are indications that at least some of the major areas of these soils were created in the 19th century. Gorbey is quoted by Law (1968:74) as suggesting that some of the Waikato 'made' soils date from the pre-1860 historical period. In his detailed paper on the Waikato, Cassels (1972:226) commented that

"it is possible that many of the sites were of very recent date, say between 1800 and 1860, although the extent of the cultivation argues for some antiquity. Kumara was certainly grown on these soils in historic times, possibly also in conjunction with the white potato and maize."

An early Taranaki settler recalled Maori expeditions up the Mimi River in North Taranaki in the 19th century to quarry coarse river sand for cultivations (Buist, 1964:25). In the Nelson area there is also some evidence to argue for a 19th century formation of the 'made' soils. When European settlement began, only low vegetation was noted (Allan, 1965: 197-8), even though the land was fertile and well-watered, ideal conditions for rapid regeneration. This suggests some cultural interference with the vegetation not long before. Some of the soils at Motueka were almost certainly used by the Maori in the 1840s, for potato cultivations were recorded in the lower reaches of the valley near the Motueka pa (Peart, 1937:62). Furthermore, the recent soil survey team noticed a marked decrease in the fertility of the 'made' soils in the thirty years since Rigg and Bruce's analyses (Chittenden, Hodgson and Dodson, 1966: 16-7). It is hard to understand how fertility levels which are claimed to have been built up several centuries ago could persist through the 19th century European farming era only to decline in three decades in the 20th century when the practice of fertilisation has been most widespread. In this case, the 1923 results may be in error, or the fertility was actually built up in the early decades of the 19th century.

The prehistoric status of the Kaiapoi gravel soils is also in doubt. Stack did not become acquainted with the Kaiapoi area or inhabitants until the 1860s and it is unlikely that his informants were referring to a period much earlier than the 1820s. It may be significant that kumara is frequently discussed in the same breath as maize by Maori informants of 19th century Canterbury (for example,

Shortland, 1851:159-60, 244) and there was some unsuccessful experimentation with taro growing at the same time (Beattie, 1939). Even the existence of gravel borrow pits at Temuka (qv. Teviotdale, 1931; Lockerbie, 1950a:81-2; Griffiths, 1955:233, 236; Yen, 1961:343; Yen, 1961/2:3; Law, 1969:226) may be explained by this theory of a horticultural boom in the 19th century, for the inhabitants were seen to be busy at their cultivations by visitors in the 1840s (Shortland, 1851:228). Since Shortland was satisfied that kumara had never been grown south of Lake Ellesmere (ibid.:244), these cultivations must have been for the white potato, and may have utilized a gravel mulch. In addition to garden tools, missionaries were known to have given instruction in horticultural techniques, and it is worth remembering that the addition of sand was advocated in English gardens in the late 18th century:

"By means of sand or sandy Earth, strong loam or clay is fertilized, the Earth being rendered porous, and interstices or space maintained, by which the juices are prepared, and thrown off into the roots of the plants, and the fibres find room to extend themselves."
(from Mawes' Encyclopedia of Gardening in Bryan and Castle, 1975:8)

Although a case can be made that the laying of gravel to a depth of 15 cm over large areas is a 19th century phenomenon, soil modification by deliberate additions of beach sands, fine gravels and fragmented shell has now been shown to be an ancient practice in New Zealand. Beyond the Wairarapa, where beach pebbles and coarse sand were detected in garden soils on the northern fan at Black Rocks (dated to 1390 ± 71 AD), modified soils are known from Kauri Point, Moturua Island in the Bay of Islands, and Waiheke Island, in securely pre-historic deposits. Peters (1975:175) described a slope garden soil on Moturua (N12/8)

"formed from the then topsoil with the addition of beach pebbles, sand, fragmented shell, and charcoal. The fragmented shell consisted mainly of pipi, cockle, and the occasional oyster shell. The sand, pebbles and shell were no doubt collected on the beach below, while the charcoal could have been derived from the burn-off which took place when clearing the slope."

At a later period a similar garden soil was formed and at both periods flat ground at the foot of the slope was probably also cultivated (ibid.:

179). Dates for the earlier layer of 1230 ± 100 AD and for the later of 1440 ± 85 AD and 1420 ± 90 AD are regarded as acceptable (*ibid.*), while Groube's earlier date of 800 ± 90 AD is rejected. At Kauri Point (N63-4/5) Ambrose (n.d.:11) describes a garden soil "created with the addition of finely broken shell, sand and charcoal". From an analysis of available carbon dates for other features of the site, Law considers that this soil was formed before about 1500 AD (Law, n.d.; Law, 1975a:181). The Waiheke Island example (N43/72) contained gravel and coarse sand brought up from the beach. Law believes that cultivation commenced soon after AD 1390 - AD 1610 (Law, 1975b:189).

The Moturua Garden excavation was the first to explore the function of 'drains', a field feature consisting of shallow depressions running down many slopes behind Northland bays and beaches. In 1965 Nicholls mapped 'drains' at Tupou Bay (N7/56) just north of the Whangaroa Heads, and found that they lay

"not only on the flat area behind the beach dunes, but also in places extend on to the stabilised and grass-covered sand, as well as extending up the slopes of the hills at the back of the beach."

(Nicholls, 1965:148)

The features formed an irregular grid system on the flat while on the hillside they ran down the slope. The plots between them were sometimes broken by low transverse scarps. Earth mounds and banks, middens, pits, terraces and pa were also recorded in the vicinity. In a personal communication to Nicholls, D.Yen pointed out that these depressions "need not necessarily have been for actual drainage purposes, but could have served a variety of functions, including drainage, irrigation, or boundary markers...." (*ibid.*:149).

Since Nicholls' survey, slope lines have been recorded in such places as Mimiwhangata (Calder, 1973:11), Waiheke Island (Atwell, 1975:39) and South Kaipara (Nugent, pers.comm. - N37/355, 361, 372). In several cases observers have noticed that the 'drains' "did not serve to drain the gardens in any obvious way" (Peters, 1975:178). Cross drains above garden slopes are often absent and longitudinal trenches would in any case be inefficient drains. Peters follows Yen and Sullivan in regarding many of these features as primarily boundary markers, and notes that the main feature may have been a ridge composed

of material dug from the trench, which has since been flattened by erosion. Evidence from Palliser Bay does not support this view of the missing 'ridge' boundary marker, for the trenches there appeared to lie directly beneath stone walls, rather than to one side. Whatever the correct interpretation the plots outlined by these depressions are remarkably similar in dimensions to many stone wall enclosures. Like the majority of Palliser Bay plots, transverse boundaries are less frequently marked, or utilized impermanent markers such as logs or a line of brushwood. The rectangular system appears to have been followed with various levels of internal subdivisions. There are indications from the Wairarapa and Moturua Island excavations that the construction of trench boundaries formed part of the horticultural repertoire of early New Zealand, and also persisted in use for several centuries, probably over a wide area. It should not be forgotten that construction of another type of trench boundary, the ditch of the pa, occupied many prehistoric groups in massive earth-moving operations for much of the later prehistoric period; so conceptually a trench boundary must have been regarded as a 'normal' device.

Genuine swamp drains were utilized in northern New Zealand and should be treated separately. D. Wilson (1922:130-2) recorded systems of drains in the Kaitaia swamp and argued that they belonged to kumara cultivations:

"With reference to this swamp being too wet for kumara growing, at the present time the farmers grow great crops on the drained portions. Kaitaia is noted for its kumaras, being the best place in New Zealand for the culture, and these are nearly all grown on this swamp land."

(ibid.: 131)

In the Kaipara area, Harding (1928:367) noted many examples of similarly drained swamps and hollows, with ditches up to 20 feet deep. Near Houhora a grid pattern of drains was found in the Motutangi Swamp and these were believed to be for wet taro cultivation in the prehistoric period (Mitcalfe, n.d. b). There is a pressing need for a thorough study of such a system along the lines of the Wahgi Valley project (Golson, n.d.), for of all the aspects of prehistoric horticulture in New Zealand, swamp gardening is least understood.

The practice of terrace gardening is also relatively unstudied,

but not for lack of field observation of terraces, perhaps the most common site category in New Zealand. In the Wairarapa it was found that distinguishing house from garden terraces required excavation of most of the terrace, well into the subsoil. Macnab (1969), however, identified garden terraces on the southern side of Porirua Harbour by examination of a soil profile which contained small pebbles, some fine gravels and finely divided charcoal. He was impressed by Wakefield's observations in 1840 that the gardens at Paekakariki

"extended about thirty yards up the face of the hill, in terraces formed by logs of wood laid horizontally, and supported by large pegs. The terraces were covered with sand from off the beach, which the natives assured me was the best soil for the growth of the kumera."

(Wakefield, 1845:225)

From the Wairarapa and Wellington evidence it may be suggested that the terrace garden, like the slope garden further north, was utilized for most of the prehistoric period.

The subject of storage pits has occupied considerable space in New Zealand archaeological literature, and now that the functional issue is no longer debated, much interest is currently shown in the antiquity of the form (for example Davidson, 1974c; Fox, 1975). Less attention has been paid to the horticultural implications, and few archaeologists engaged in a site survey or excavation would consciously ask on discovery of a pit or pit complex - "where where the associated gardens?". In the Wairarapa the evidence indicates that produce was stored directly beside gardens, within coastal villages close to gardens, on ridges overlooking gardens, or up to 1.6 km from the nearest garden. Considering the means of transport, it would be unlikely under Wairarapa conditions that quantities of food were carried further than 2 km from a garden unless a canoe was available.

Pits fall into a wide range of shapes and sizes, some of which have a distinctive regional distribution. The subterranean rua, for example, is typical of western areas of the North Island, although found in early sites on the Coromandel Peninsula, while the rectangular raised-rim pit is distributed on the east coast between Marau Point (north of Anaura Bay) and Banks Peninsula, with a western extension to D'Urville Island, Wellington, and the Marlborough Sounds (Law, 1969).

Excavations at a number of Archaic sites have indicated a considerable variation in pit design within a single level. Pits at the Washpool Midden site (N168-9/22 -B.F.Leach, 1976), Skipper's Ridge (N40/7 - Davidson, 1975), Kumara-Kaiamo (N109/9 - Buist, 1964) and Kaupokonui (N128/3 - Robinson, 1963) suggest that regional styles of pit building crystallised after this period utilizing designs which were developed in what might be described as an 'Experimental' era.

In the light of these examples, carbon dates from roof supports of typical raised-rim pits at Tiromoana Pa, Te Awanga, Hawkes Bay (N135/1 - Fox, 1975) are unexpectedly early. Fox rejected a date of 1960 BC from a door slab in one pit as being "from driftwood" while accepting an estimation of 1200 ± 80 AD for a central timber post in the same pit. An earlier date of 930 ± 120 AD was obtained from a post in another pit (*ibid.*:202-2). Fox argues against the use of twig charcoal for resolving "the major structural problems of a site" (*ibid.*:202), but in the Wairarapa twig charcoal invariably gave the most consistent results. However this anomaly is resolved, securely dated pits of 12th century age at Skipper's Ridge and the Washpool Midden site accord with age estimations for other types of horticultural evidence such as stone walls. The proliferation of shapes and designs of pits suggests that at that time pit storage techniques were in early stages of active development.

If the overall distribution of storage pits is used to indicate the extent of horticulture in New Zealand, it is apparent that many coastal and lowland locations of the North Island had been or were currently utilized by the end of the 18th century. This pattern of land use is reinforced by the evidence of stone walls, slope lines, swamp drains, modified soils, garden terraces and borrow pits. It indicates that only the most favourable coastal sites in the South Island were used (Law, 1969).

In summary, the horticultural repertoire of both early and late New Zealand communities was varied and sophisticated and it is significant that most of the garden types and practices which survived to be recorded in the 18th and 19th centuries can now be identified in 12th - 14th century sites, suggesting perhaps, that with the possible exception of pit storage, the principles and techniques of horticulture were introduced as a unified and well-established technology from the tropics.

CHAPTER SIX

STONE WALLS AS HORTICULTURAL FEATURES IN TROPICAL POLYNESIA

When the Samoan archaeological research programme commenced in 1964, "methods for collecting archaeological evidence of former agricultural practices in Polynesia were just beginning to be developed" (Green & Davidson, 1974:281). In contrast to New Zealand where the issue of early horticulture was entangled with disputes on the accuracy of oral traditions and the function of subterranean pits, it was believed that in tropical Polynesia "the subsistence system of a group in the past was very much like the traditional one recorded for the modern period" (*ibid.*). The surveys of prehistoric gardens marked by stone walls in Hawaii which began in 1968 soon revealed that dry land horticulture had formerly utilized large areas of Hawaii Island and that over a long period, subsistence economy had evolved according to climate and topography into a complex and variable system exhibiting some marked differences from the modern pattern (qv. Newman, 1970:103-11). The potential of such studies was quickly recognised and stone structures belonging to garden systems were recorded in detail on other Hawaiian islands, in the Marquesas (Bellwood, 1972), and in the western Pacific (Yen, 1973:78). At the same time, the difficulties of identifying horticultural activity which did not involve stone structures or terraces were recognised (Yen *et al.*, 1972:91; Green & Davidson, 1974:281). At present, therefore, the archaeological association of stone structures and horticulture has only been investigated in detail in the Hawaiian islands, while assessments of Polynesian horticulture in general are still dependent on field observations and ethnographic and historical records of varying quality. Although this type of research is in its infancy, there is now sufficient evidence for a fruitful comparison of the New Zealand and tropical Polynesian data which will be attempted in this chapter.

It is now clear that the islands of Samoa witnessed the development of many cultural traits and practices that are regarded as distinctively Polynesian. Even though no stone walled field systems were recorded comparable to those of some Eastern Polynesian island groups, prehistoric stone walls were constructed in Samoa to serve as boundary markers (Davidson, 1974a:157). As in New Zealand, most formed

open-ended 'enclosures'. Similarly, single boulder alignments demarcated many types of domestic and ceremonial structure throughout the prehistoric period. Davidson (1974b:238) commented that, in general,

"Stone walls are a common feature of the archaeological landscape. Wright...considered them possible evidence of former agricultural activity; the larger examples are sometimes interpreted as defensive. Stone walls seem to have performed many functions, however. Some are boundaries of agricultural plots, house site land, the land of a nu'u (parish), or the land of a district. Some have served as paths, sometimes as single walls, and sometimes as parallel walls on either side of a level or sunken track."

Systems of large ditches at Sasoa'a and Folasa were regarded as more promising agricultural evidence. Although of unknown age, "the conclusion reached at Folasa was that the ditches there outline agricultural plots" (*ibid.*). If this interpretation is correct, three of the basic elements of Eastern Polynesian horticultural systems have been identified archaeologically in Samoa: the ditch boundary marker, the stone line boundary marker, and the stone-edged path. The ditch boundary survived into the 20th century and Mead (1930:72) noted that

"A man need only go into the bush, ring a few trees, burn off the underbrush, set up a row of boundary stones, or dig a ditch. He has staked out his claim."

Mercer and Scott (1958:351) described the continuing importance of marked paths to garden location in modern times:

"It is symptomatic that land situated some distance inland but adjacent to a path was selected for clearance in preference to land close to the village but requiring a track to be built. These paths are paved with selected flattish stones and flanked by stone walls up to 3 feet high...they range from 6 to 8 feet in width..."

Although stone walls are noticeably rare on Tongatapu, through lack of stone, much care was given to marking land boundaries and access routes through plantations in the 18th century. Cook (1969:252) described a smooth road about 5 m wide with reed fences on each side, interrupted by "doors which opened into the adjoining Plantations". On the northern Tongan islands of Niuatoputapu and Tafahi, stone walls are well represented (Davidson, 1974b:240).

In central East Polynesia, the high islands of the Society

and Marquesas groups are regarded as the immediate homelands of the inhabitants of marginal Polynesia. In the light of similarities between Hawaiian and New Zealand field systems (see below) it is possible that prototype horticultural complexes might be discovered in this central area. Alternatively the Hawaiian and New Zealand practices might be found to have undergone convergent evolution due to climatic stresses. At present, available evidence favours the latter explanation. In fact both the Society and Marquesas islands appear to have evolved quite different horticultural specialities.

In the European contact period only the lowlands of Tahiti were in regular cultivation, although there were signs that large areas of the lower hills had been cultivated formerly and were lying fallow under a cover of grass and fern (Lewthwaite, 1964:14-5). On Huahine scorched slopes were taken as an indication of garden preparation (ibid.:18). The Spanish visitor, Andia, described the removal of stones from lowland plots to form the walls of raised seed beds; he wrote

"They dig drains along the borders of these, which... also do duty as boundaries, between the holdings of different persons."

(Corney, 1915:273)

This description is reminiscent of the ditch boundaries of Samoa. Irrigation channels and irrigated terraces are mentioned, but Lewthwaite concluded that in the 18th century the bulk of the staple root crop of taro was grown in natural swamps (Lewthwaite, 1964:18). Yams, although not common, were grown in lightly terraced slope gardens and utilized a leaf mulch (ibid.:19), while kumara was planted in 1 m high and 3 m diameter mounds. Like the yam, the sweet potato was of limited significance (ibid.:21), beside taro, breadfruit, banana and plantain.

Early archaeological surveys in the Society Islands indicated that unirrigated garden terraces and stone-walled enclosures occur on several islands (Emory, 1933:70, 86, 114-5, 119, 137), but only Green et al. (1967:136) described "extensive systems of terracing, presumably for wet taro cultivation" in inland Mo'orea. In non-agricultural contexts, single boulder alignments or curbs marking houses were frequently recorded as well as low walls demarcating boundaries (Emory, 1933:14); thus the Samoan utilization of stones to divide off parcels

of land was clearly repeated in the Society Islands, although seldom within the context of horticulture.

In the Marquesas, Handy claimed to have seen irrigated, stone-faced terraces at eight locations, but only supplied details on one (Handy, 1923:185-6, Fig.20). In addition to the stone retaining walls, boundary walls were clearly present. No irrigated terraces were seen in the Hanatekua Valley on Hiva Oa, where Bellwood conducted a detailed survey; however he plotted many dry terraces in the upper reaches of the valley (Bellwood, 1972:35-6, 38). The valley bottom was divided into enclosures and terraces, with walls up to 1 m high. Bellwood found that these features fell into two groups: walled enclosures, enclosed on all sides, and terraced enclosures with one or more open sides and with boundary walls running downslope along the sides of the terraces (*ibid.*:36). All but one of the enclosures were rectilinear. Analysis of size ranges in conjunction with historical observations suggested that the larger complete enclosures offered protection to the staple Marquesan crop, the breadfruit (*ibid.*). The breadfruit fermentation pits were located close by, reinforcing this interpretation. The semi-enclosed terrace features predominated in the upper valley and were regarded as root crop plots (*ibid.*: 43). Bellwood drew attention to the similarity of these terraces with those in the Makaha Valley on Oahu in the Hawaiian Islands and commented that

"Many other areas of Polynesia have similar terraces, which on the whole, have received little intensive study."

(*ibid.*:38)

Irrigated taro terraces in valleys, sunken coastal taro gardens and a strong dependence on tree crops characterized the Rarotongan horticulture of the contact period (Bellwood, 1969:518-9), while terracing for root crops was noted on Aitutaki (Bellwood, 1971: 155-6). Again, throughout the southern Cook Islands curbstones were extensively used in demarcating domestic and religious structures, major pathways, and wells (Parker, 1974:67, c.f. Bellwood, 1972 for Marquesan stone-edged springs).

From Tubuai in the Austral Islands, Aitken (1930:118) briefly described a wide range of stone structures including curbed

wells, curbed and paved bathing places, paved roadways, stepping stones and "stone walls marking land boundaries". Whether the latter enclosed gardens was not specified, but it is clear that most horticulture was carried out on irrigated taro terraces and lowland taro plots (*ibid.*:16). Some dryland taro was grown at the time of the survey, with the help of a leaf mulch.

From the island of Rapa, also in the Austral group, the techniques of stone-faced taro terracing were believed to have been taken to Mangareva in recent times (Emory, 1939:17). Sunken taro gardens were also a recent innovation, from the atolls of the Tuamotu Archipelago. However, dry land terraces and some rough stone-walled enclosures may have been utilized for arrowroot, kumara or turmeric cultivation (*ibid.*: 17, 24). In historic times the kumara was not esteemed, but when planted it was placed in small mounds as in New Zealand (Buck, 1938:213, 225).

On Easter Island, construction of stone-walled enclosures may also have been a relatively recent phenomenon to protect crops from goats and sheep, for the 18th century explorers, La Pérouse and Cook, noted neither fences nor hedges, except around paper mulberry plots (Métraux, 1940:151-2). They commented on the neatness of the gardens, their symmetry, and the use of a grass mulch. Some years later Beechey described fields along the north coast:

"Such places as were not immediately exposed to the scorching rays of the sun were laid out in oblong strips taking the direction of the ravines; and furrows were ploughed at right angles to them, for the purposes of intersecting the streams of water in their descent."

(Beechey, 1831 cited in Métraux, 1940:152)

Although ambiguously worded, this observation appears to refer to rectangular plots on sloping ground with the long axis at right angles to the course of the gullies, and trenches running across the strips along the contours. Comparative data suggest an alternative interpretation of their function: that the trenches were boundaries rather than water catchments. Although both taro and yam were grown, the kumara was the most successful cultigen on Easter Island. As in many parts of Polynesia it was grown on small earth mounds. Despite intensive site surveys no clearly prehistoric stone wall field systems have been located; however Easter Islanders retained the basic

Polynesian practice of outlining ceremonial and house features with curbs or stone walls.

In the Hawaiian Islands, archaeological projects in which prehistoric horticulture has been studied in detail have been conducted at Kealakekua Bay, and in the North Kohala (Lapakahi) area on Hawaii Island, at Makaha Valley on Oahu, in the Halawa Valley on Molokai, and on the remote Nihoa Island (Yen, 1971:11). Usually they have involved extensive surface and aerial surveys followed by small excavations at particular localities within the garden complex, a similar approach to that followed in the New Zealand studies.

At Kealakekua Bay (Newman, 1968:Map 13), contemporary descriptions of the gardens, made by Menzies (1792-4) and two members of Cook's party, Ledyard and King (1779) permitted the identification of post-18th century modifications to the stone wall field system. These involved some additions to existing walls as well as the construction of new walls superimposed over the prehistoric system (Newman, 1968:137), which consisted of

"a network of elongated rectangular fields...oriented lengthwise on a northeast to southwest axis and also... along a sea to mountain axis. The major field boundaries (the long sides) lie perpendicular to the topographic contours and parallel to the terrain slope, while random short cross boundaries run parallel to the contours. Although the survey area encompassed two different native land tenure units (ahupua'a), there is no discernible change in field symmetry between the two areas. Individual fields vary in size from about 50 feet (15 meters) long and 30 feet (9 meters) wide to some that are over 1,000 feet (300 meters) long and up to 150 feet (50 meters) wide. There is no apparent correlation between field length and width..."

(ibid.: 135)

The downslope orientation of these plots is similar to the Palliser Bay gardens, and it is interesting to note that transverse walls are also apparently less important than the longitudinal walls. Wall height is comparable (0.5 to 1 m) and construction varies from carefully stacked stones to loose piles (ibid.:136). Some plot boundaries are marked by earthen mound 'walls' up to 3 m wide.

In this dryland system kumara was grown in small mounds, and taro in holes in the centres of water-collecting basins. Grass mulching was extensively practised (Menzies in Newman, 1968:126).

These three techniques are precisely those commented on by Monkhouse in New Zealand (see p.116). Perhaps the most significant comment made by Menzies concerned the relationship of land divisions and land utilization:

"The land there is divided into plantations, called ili, which take their rise at the sea side and proceed up the country, preserving a certain breadth without any limitations, or as far as the owner chooses to cultivate them..."

(ibid.:126-7)

It may be recalled that these conclusions, that breadth of plot is the only socially important variable, and that the 'base line' of the system is on the seaward edge, were independently reached in the Palliser Bay analysis. The similarity, established between regions at the extreme northern and southern limits of Polynesian settlement, is not simply a case of marginal survival since the New Zealand example is some five or six hundred years earlier than the Hawaiian. These may in fact be principles of land division and use basic to Polynesian culture, which particular circumstances of history, topography and surface stoniness have rendered visible and well-preserved.

Ledyard's observations in 1779 provided some details of the cropping system operated in this area:

"Some of these fields were planted, and others by their appearance were left fallow. In some we saw the natives collecting the coarse grass that had grown upon it during the time it had lain unimproved, and burning it in detached heaps. Their sweet potatoes are mostly raised here, and indeed are the principle object of their agriculture."

(ibid.:131)

Newman found that the dominant feature of the field evidence at Lapakahi was again the elongated rectangular strip (ibid.:139). In contrast to Kealakekua Bay, the long sides of each strip are parallel to the coastline. A close examination of his map (ibid.:Map 4) shows that another set of longer walls, from which the many transverse walls emerge, run between sea and mountains, roughly parallel to the major land boundaries of the ahupua'a, and commonly 100 - 200 m apart. So many of the transverse walls terminate at these longitudinal walls that

they must be interpreted as long-standing structures on which the framework of contour walls is suspended. It should be noted that a similar hierarchy of walls was detected in the New Zealand walled garden complexes, and that the width of the component sections of Palliser Bay complexes was of the same order of magnitude. Many of the individual plots at Lapakahi which abut a longitudinal wall terminate at different distances out from the wall, in the same manner as the strips in Palliser Bay vary in their length. This suggests that at Lapakahi the long walls have been used as the base line. A contributing factor to this change of orientation might be the distance of the gardens from the shore, for at Lapakahi the horticultural zone begins some 3 km inland. By contrast, the Kealakekua Bay base line appears to have been the upper edge of coastal cliffs, a natural and unmistakeable boundary. Newman's explanation for the change is that at Lapakahi crops required protection from the strong trade wind which sweeps down the slopes, and that walls set 10 - 20 m apart in the path of this wind would supply the necessary shelter (ibid.:143-4).

Some of the Lapakahi fields contained numerous rock cairns, 1 - 2 m in diameter and up to 50 cm high. Newman (1968:139) believes that

"...these rock piles served a special agricultural purpose, perhaps to prevent gourds from rotting owing to soil contact or for growing sweet potatoes. Their symmetry and distribution argue against being the result of clearing rocks from within the field."

A similar function was ascribed to structured mounds at Wiri, described as commonly 2 - 3 m in diameter and 30 - 60 cm high (Sullivan, 1974:128, 140), and to the Cross Site mounds in the Wairarapa most of which were 1 - 3 m in diameter and 50 cm high (B.F. Leach, 1976:249).

Trenches cut across several Lapakahi plots exposed small quantities of bone and shell, and charcoal lenses, lying within a disturbed layer. The interface between this layer and the compacted subsoil was generally at a constant depth but with many small-scale irregularities attributed to the use of the digging stick (Newman, 1968:141). Charcoal from this interface was dated to 1545 ± 95 AD, while a sample from a nearby oven gave a result of 1645 ± 110 AD.

'C' and 'L'-shaped shelters occur in association with stone

field boundaries throughout the upper dry land garden zone at Lapakahi. In one of these the unusual and important find of three carbonised and almost entire tubers was made, of which one was unquestionably kumara. The firepit in which it was found was dated to 1655 ± 90 AD, expressed as a range of 1425 - 1725 AD. This conforms with estimates from 4 upland and 5 coastal Lapakahi samples of 1365 - 1750 AD (Rosendahl and Yen, 1971:381). Excavations in shelters such as this demonstrated repeated reoccupation rather than continuous use, and this was seen as evidence of shifting cultivation techniques within the dryland portion of the ahupua'a.

Evidence for swiddening on Oahu Island was obtained during excavation of irrigated stone-faced terraces in the upper reaches of the Makaha Valley. Charcoal occurred throughout the mixed soil layers of the terraces:

"It is assumed that this carbonized plant material cannot be the accumulation from agricultural practices associated with pond-field culture. In no case of such agriculture studied in the Pacific, Asia, and South America, has the use of fire been recorded other than on small piles of weeds allowed to dry out, as part of the process of renewal of fields. This could hardly have produced the type of deposits that were found in the alluvium terrace trenches. A more likely source was through the irrigation water which carried with it the products of erosion. Among these products was the deposited charcoal, which in turn was the product of man's activity at the time - the most likely being shifting cultivation, with clearing by the aid of fire, in the uphill areas of the environment."

(Yen, Kirch, Rosendahl & Riley,
1972:91)

In the Halawa Valley, as at Makaha, irrigated and non-irrigated terraces predominated within the valley. There was also evidence of erosion brought on by slash and burn horticulture in a taluvial fan closer to the mouth of the valley. The onset of erosion between 1110 and 1290 AD was associated with loss of natural forest cover and the land snail fauna changed dramatically (Kirch, 1971:48, 54). Kirch maintained that swiddening was the basic agronomic technique in the first few centuries after occupation c.600 AD, with pond-field cultivation and some non-irrigated gardening in use later in the prehistoric era (ibid.:55). In contrast, Yen (1973:81) suggested that irrigation agriculture was practised early, and expanded along with dryland terracing and permanent

field boundaries in the 14th - 16th centuries. He stressed that the Hawaiian settlers had arrived with a "nearly full agricultural set" (ibid.).

Although horticultural stone walls have not received as much attention in the Hawaiian projects as terraces, or religious structures, there is ample evidence that they are widespread in the Hawaiian islands and fulfilled similar functions to those in New Zealand. A particular parallel is the use of low walls and single boulder alignments to mark pathways, referred to in Hawaii as 'trails' (Peterson, 1968). In the Lapakahi area these are generally 1 m wide, with either a single stone edging on both sides or low rough walls (Kaschko, 1973:127-8). As with walls in Palliser Bay, "the quantity of stone-lining present is apparently directly related to the amount of surface rock available in the immediate area" (ibid.:128). Kaschko argued that besides serving as routes of movement, some paths acted as land boundaries. In these cases,

"The agricultural system on each side of the trail was constructed without regard for the organization of the system on the opposite side. This results in the mismatch of field boundaries at some trails. These trails can be inferred to be 'boundary' trails."

(Kaschko, 1973:129)

The implication that the trail structure was formed to act at the same time as both a path and a boundary should be avoided, for the existence of a boundary might have influenced the positioning of the pathway to avoid interrupting garden plots. An alternative is Kaschko's argument for the prior existence of trails before horticulture commenced (ibid.: 137). These claims, indeed the whole chronology of paths, deserve further archaeological examination.

This brief survey of Polynesian horticultural techniques involving stone wall construction supports Yen's views that

"The agriculture of Eastern Polynesia is consistent with a pattern of total transfer and segregation of its elements on the broad environmental assortment"

(Yen, 1973:82)

and

"...agricultural development in Eastern Polynesia was minimal"

(ibid.: 83)

Elements of prehistoric New Zealand horticulture such as stone wall and stone alignment field boundaries, unirrigated garden terraces, trench boundaries, stone-edged pathways, garden mounds, garden shelters and small enclosures, grass mulching, small earth mounds for yams and kumara, taro basins, and swiddening, as well as basic principles of land division and use have been shown to occur in various combinations throughout island Polynesia. As archaeology intensifies in each island group, these elements will probably be found to be as old as the resident cultures. Their ultimate origin may lie several millennia ago in the western Pacific.

CHAPTER SEVEN

THE DETERMINATION OF THE PALLISER BAY CULTIGENS

Direct evidence of some of the plants grown in prehistoric gardens has now been obtained from Hawaii, the Marquesas Islands, Easter Island and New Zealand. From 8 14th - 18th century sites at Lapakahi, Yen identified carbonized remains of "coconut, bitter yam, candlenut, at least three cucurbits, and sweet potato" (Griffin, Riley, Rosendahl & Tuggle, 1971:111; also Rosendahl and Yen, 1971). A 12th century AD rock shelter (MUH4) in the Marquesas contained a large quantity of plant material including pieces of what are believed to be sugar cane, coconut, pandanus, candlenut, gourd and breadfruit (Kirch, 1973:35). The remains of sweet potato were obtained from a 16th century AD house site on Easter Island, together with sugar cane and a nut-like fruit, possibly from Thespesia populnea (Skjølsvold, 1961:297). Although gourd fragments have been recovered from several New Zealand swamp, lake and cave sites (for example Waverley qv. Downes, 1932, and Whakamoenga Cave, Taupo qv. Leahy, 1975:48-50) only one sweet potato discovery has been reported, from Waioneke, South Kaipara. The antiquity of this find is uncertain, and Rosendahl and Yen (1971:380) describe it as follows:

"Groube states that one nearly complete tuber and several pieces were found in the carbonised remains of a basket within the fill of a storage pit. The cultural context is described as 'undoubtedly Classic Maori', and while Groube opines that the site 'is no more than 100 - 300 years old', he leaves open the question of the age of the pit itself..."

Yen (1974:27) later refers to the context as Archaic, although McKinlay (1971:91) favours a temporal span of only 200 years for the site, on the basis of three carbon samples, the oldest of which is 290 ± 95 BP.

In addition to carbonized tuber or stem pieces, seeds and pollen may survive for many centuries in particular deposits. A general belief that many Polynesian cultigens having been reproduced vegetatively for several millennia have now lost the ability to flower and set seed, may have inhibited the search for such microfossils. Purseglove (1968:79) described the kumara, for example, as a 'short day plant'. A photoperiod of 11 hours or less promotes flowering, at 12 hours less flowering occurs, and at $13\frac{1}{2}$ hours flowering is inhibited. Thus in

temperate countries such as New Zealand, flowering should not occur. Copley (1956:170) maintained that flowering is rare, especially away from the tropics, that some varieties are sterile, and that in general, seed is rarely set. Certainly both sterility and self-incompatibility have been detected in kumara varieties (Martin, 1965, 1967), largely due to the genetic make-up of the plant, which is hexaploid with 90 chromosomes (Martin, 1967:12). Extensive tests conducted at Otara, New Zealand by Yen (1974:178-81), however, have shown that flowering is not totally inhibited and that seed formation can occur. Yen (ibid.:181) concludes that

"The fact that the phenomenon can occur in the New Zealand environment of the present time, however, suggests that in the past there was some possibility that sexual reproduction could have played some role in the production of local variation in the species."

Although none of Yen's Polynesian or Maori varieties flowered, Best (1925:55-6) listed four Maori varieties "said to flower". Colenso (1880:14) believed that flowers and seed may have been obtained "in ancient times", although in the 19th century flowering was not noticed. Walsh (1902:13) wrote that

"although occasionally flowering, the plant has never been known to set seed in this country."

It may be concluded, therefore, that kumara pollen and seeds might be present in a few New Zealand contexts but that they are most unlikely to be found in quantity.

In taro (Colocasia esculenta) prolonged asexual propagation is also believed to have led to only rare seed production; however Kikuta, Whitney and Parris (1937:186-8) and Handy (1940:9) listed several cases of seedling development in Hawaii. Beyond Hawaii, fruiting was considered rare until Barrau (1959) described flowers and fertile seeds in New Guinea. Examples are now known from New Zealand sources, but the particular specimens discussed by Cooper (1969:406) failed to ripen seed. A similar situation prevailed for the greater yam (Dioscorea alata). Martin (in Royes, 1967:153) described it as a typical high chromosome polyploid cultivar which seldom flowers and is difficult to cross. In contrast to these root crops, the gourd (Lagenaria siceraria) produces large pollen grains and 12 mm long viable seeds. It has a low

chromosome number ($2n=22$) and was normally propagated by seed, thus promoting fertility (Purseglove, 1968:124).

A further possibility of obtaining direct evidence of cultigens is the identification of specific mineral structures, formed in plant tissues. In grasses, silica plant opals have proved to be quite distinctive (Raeside, 1970). Both cystoliths (which are protruberances of cell walls, variously covered with silica, calcium carbonate, or lignin) and crystals of calcium oxalate have been used in systematic studies of plant anatomy (for example Solereder, 1908; Metcalfe and Chalk, 1950). The calcium oxalate crystals occur in eight forms of which raphides (bundles of needle-shaped crystals), columnar crystals, and crystal sand are considered to have the greatest systematic value. Examination of tuber sections showed that raphides are present in the taro (see also Greenwell, 1947:276). The kumara, however, forms a druse or clustered crystal which is comparatively common in many species (Esau, 1960: 39). Further investigation is needed before the value of plant opals and crystals to archaeology can be assessed; however it has been established that chemically these remains are capable of survival in soils. The most likely use would be the separation of pieces of various cultivated species found together in a hearth or cave deposit.

No direct evidence for plants grown in the Palliser Bay gardens was recovered. In view of the macrofossil finds at Waioneke, Hawaii and the Marquesas, a watch was kept for carbonized tubers, fruits and seeds. Some seeds were found in the M4 excavation, which had obviously been brought to the house for consumption. These were predominantly hinau, karaka, and pokako (B.F. Leach, 1976:255), all native species. The possibility that macro-fossils of cultigens have been included in the many bags of charcoal yet to be identified is fully recognised. The specialist assistance that was available for the identification of charcoal was unfortunately limited to only a few pieces, usually associated with radio-carbon samples from dwellings.

Nevertheless it is possible to circumscribe the field of possible cultigens by comparing the physical requirements of garden plants believed to have been introduced by the earliest settlers, with the physical conditions prevalent in Palliser Bay. It will be shown in following sections that the climatically marginal position of this region permits elimination of all but two of the Polynesian garden

plants through lack of hardiness. For the purposes of this argument, climatic conditions will be assumed to be broadly similar to those of today. The details and significance to Palliser Bay horticulture of the postulated New Zealand climatic change will be reviewed in the following chapter.

From a number of sources (for example Barrau, 1965; Yen, 1973; Green, 1975; Pawley and K.Green, 1971) it is possible to draw up a list of the likely cultivated species that accompanied Polynesian migrants in their voyages within Eastern Polynesia: the root crops were taro (Colocasia esculenta), kape (Alocasia macrorhiza), arrowroot or pia (Tacca leontopetaloides or T.pinnatifida), up to three species of yam (Dioscorea alata - the greater yam, D.pentaphylla, and D.bulbifera - the wild or bitter yam), turmeric (Curcuma longa), and kumara (Ipomoea batatas). Shrub and tree crops supplying edible rootstocks, stems or fruits were the ti (Cordyline terminalis or C.fruticosa), the breadfruit (Artocarpus altilis), the sugar cane (Saccharum officinarum), the coconut (Cocos nucifera), the kava (Piper methysticum), the fehi banana or plantain (Musa troglodytarum), the meika or Pacific banana (Musa sapientum), and possibly some pandanus species, the Tahitian chestnut (Inocarpus edulis), the Malay apple (Eugenia malaccensis), the Tahitian apple (Spondias dulcis), and the miro (Thespesia populnea). The gourd (Lagenaria siceraria or L.vulgaris) and the paper mulberry (Broussonetia papyrifera) were also included. High islands of central East Polynesia, especially the Marquesas and Society groups, possessed virtually the full range of these plants (Lewthwaite, 1964; Rollin, 1929), but there is a marked decline in diversity in the marginal islands of Hawaii, Easter Is. and the Austral Is. (for example see Yen, 1973:69-70). It is unlikely that the original settlers of New Zealand arrived with this full complement of cultigens. It is equally unlikely that the fewer species which accompanied them all survived in New Zealand conditions. There is a possibility too that some introduced plants (such as kape, the smaller yams, sugar cane and turmeric) survived for a few centuries in the far north before succumbing to the unsuitable climate. Thus the six cultigens that survived to the 18th century should be regarded as a minimum number of those introduced. They were the kumara, taro, yam (?D.alata on grounds of distribution), gourd, ti, and paper mulberry.

The most basic climatic difference between tropical Polynesia

and New Zealand is marked temperature variation in the temperate land mass within the seasonal cycle. This propensity for extremes is a major obstacle to the establishment of any perennial species of tropical origin, for while New Zealand summer temperatures may be comparable to or in cases even higher than in the tropics, winter temperatures in most of the country regularly fall below 5°C (41°F). In Palliser Bay where seasonal temperature changes are marked, the perennial Polynesian tree crops such as breadfruit, coconut, Tahitian chestnut and bananas, can be eliminated from the list of possible cultigens without further discussion. The ti, although recorded in the far north, must also be excluded since it normally takes 18 months to reach maturity from a cutting under Hawaiian conditions (Ezumah, 1970:168). Arrowroot and kape also exceed 12 months in their growing period (Plucknett, 1970:129). The survival of the perennial paper mulberry and ti in Northland until the 19th century indicates, however, that these plants and others like arrowroot and kape might be anticipated in any macro-fossil assemblages that are discovered in this sub-tropical region.

Of necessity, the Palliser Bay cultigens must have been those that reached maturity in less than 12 months, and had the propensity to undergo a dormant or storage phase in or out of the ground for the remainder of the year. From the original list, kumara, taro, greater yam, and gourd remain. Ethnographic evidence from Polynesia indicates that all were commonly grown in field systems. Thus, further assessment of the likelihood that they formed part of the Wairarapa produce, must be made on the grounds of their physical requirements. These will be reviewed for the 4 remaining species under the categories of growth period, temperature tolerance, moisture needs, preferred soil type, nutrient needs, capacity for storage, and yield.

Growth in the kumara involves two overlapping phases. After sprouting takes place, usually at temperatures above 20°C (Coleman, 1972:13; Deonier and Kushman, 1960; c.f. 18°C in Kennelly, 1952:159), leaf development predominates for some six weeks (Coleman, 1972:22) before tubers are initiated and bulking begins. Maturity is reached under New Zealand conditions in 5 - 6 months (Walsh, 1902: 17,20; Coleman, 1972:19) although digging may commence after 3½ or

4 months (Kennelly, 1952:161; Pullar, 1962:63; Purseglove, 1968:88). In tropical conditions the growth period is comparable: $5\frac{1}{2}$ - 6 months in Uganda (MacDonald, 1967:III-124), and 5 - 6 months in Trinidad (Haynes, 1970:11). At altitudes of 1670 - 2723 m AMSL in New Guinea, harvesting begins after $5\frac{1}{2}$ months and continues up to 13 months (Waddell, 1972:117). Optimum temperatures during this time vary according to the stage of development. Sekioka (1970:39) found that

"In the early growth stage, the plant should be cultivated in a rather high temperature, $25 - 30^{\circ}\text{C}$, so that the stems and leaves grow thick and the production of photosynthates is increased. In the later growth period, the temperature should be kept at $20 - 25^{\circ}$ to increase the translocation of carbohydrates and improve their accumulation in the tuberous root."

Soil temperature in Sekioka's study was found not to be as important as air temperature. Hernandez et al. (1967:III-35) noted that the fibrous feeding roots of the young plant form in the presence of moisture when soil temperature exceeds 21°C , and this value is cited by Coleman (1972:7) as the optimum soil temperature. An air temperature above 24°C is recommended by Purseglove (1968:88). Mean growing season temperature (November to March) in commercial kumara production areas in Gisborne is 17.2°C (based on Gisborne Airport figures), a value well below these recommendations. Law (1970:116) suggested an even lower value of 12.5°C based on Yen's kumara growing experiments at Lincoln, Canterbury. It should be noted, however, that the season in which adequate yields were obtained at Lincoln was described by Yen (1961:341) as displaying "better-than-usual growing conditions". Thus it appears that yields in modern varieties may be satisfactory if mean temperature in the growing season exceeds about 17°C . This may be compared with values of growing season minimum mean temperatures used in Britain: 5.5°C for indigenous crops and 15.5°C for hot-house plants (Hogg, 1965:143-5).

Kumara plants are unquestionably frost-tender. Even a light frost will cause leaf degeneration (Yen, 1974:216-7), but this does not always result in loss of the tubers. Coleman (1972:24) claims that tubers from frost-affected plants will store normally but will lose "their ability to produce good plants, making them unsuitable for seed". In this case it is recommended that digging should take place at once before any rot spreads from the vine into the roots (Walsh, 1902:20). Some variation in cold tolerance was noted in the Pacific collection of

kumara cultivars:

"While no varieties withstood sustained low temperatures at or near frost level 32 degrees F, many, even those derived from lowland tropic regions, exhibited surprising tolerance"

(Yen, 1967:I-49)

"Two of three varieties cited as examples of those adapted to high level growing [in New Guinea] proved to be among the most cold-tolerant in the collection in the New Zealand test"

(ibid.: 51-2)

Vines of the three New Zealand Maori varieties were no more tolerant of cold than many lowland tropical examples (Yen, 1974:217-8).

Tuber tolerance to chilling which is critical to the survival of the plant into the next growing season, appears to be less than that of the vine. Although an early frost may damage foliage, the tuber remains protected by a blanket of warm soil. Once soil temperature drops, however, and the insulation effect is lost, tuber decay sets in rapidly:

"Sweet potatoes are injured when the temperature falls to 40°F [4.5°C]...and the keeping quality is so seriously affected that long storage is usually impossible. For best results the tubers should not be subjected to temperatures below 50°F [10°C].."

(Kennelly, 1952:161)

The chilling effects of heavy rain are also recognized as damaging to the mature plant (Walsh, 1902:20; Pullar, 1962:64) and water-logging cannot be tolerated (Purseglove, 1968:88). Moisture requirements, however, can be high when tuberization is taking place. Hernandez et al. (1967:III-35) found that in Louisiana silt loam soils in the early growing season, 2.5 mm of rainfall (or irrigation water equivalent) might be used by the sweet potato crop each day, and this amount rose to 6.35 mm at the peak of growth in mid-summer. Expressed as monthly totals these quantities are 76.2 mm each month for the leaf production period, followed by 190.5 mm each month for the last two or three months. In New Zealand the kumara is considered to be fairly drought tolerant, especially if growth is well advanced. Best yields, however, are obtained from soils which carry over moisture from winter and early spring rainfall (Coleman, 1972:7). Purseglove (1968:88) gives

optimum annual rainfall figures of 762 - 1270 mm, well distributed throughout the year. These are low by comparison with those considered ideal in Louisiana, which would amount to an average annual rainfall of about 1600 mm.

The sweet potato's sensitivity to low temperatures and extremes in moisture levels effectively restricts it to a few soil types. Authorities agree that an ideal soil is a light, porous sandy or gravelly loam, worked to a fine tilth, with a clay or heavy silt loam subsoil for retaining moisture over the summer (Colenso, 1880:8; Walsh, 1902:13-4, 16; Kennelly, 1952:160; Pullar, 1962:63; Purseglove, 1968:88; Coleman, 1972:22-3). The primary effect of sand or gravel naturally in the soil, or added to it by man, is the promotion of good drainage, and this affects soil temperature:

"the temperature of some soils in the spring can be increased by improving their drainage, but it is not quite clear how far this is due to an increase in their air content - thus decreasing their heat conductivity - or to a decrease in their water content - thus decreasing their specific heat - and how far to increasing their maximum daily surface temperature through a smaller proportion of the incoming radiation being used for evaporating water, so leaving a larger proportion for warming the soil."

(Russell cited by Taylor and Pohlen, 1970:42)

Walsh (1902:13-14) noted that in New Zealand conditions the greatest yields are obtained "on the sand and shingle terraces above high-water mark on the sea-coast". Coastal cropping is facilitated by the tolerance of the sweet potato to saline levels "from 600 up to 1000 p.p.m." (Hernandez et al. 1967:III-38).

The sweet potato is not especially demanding of soil nutrients. Potassium salts are considered the most effective in increasing yields (Fujise and Tsuno, 1967:II-20; Pullar, 1962:63) but yields may become depressed if too much is applied (Coleman, 1972:18). Too narrow nitrogen-potassium ratios (for example 2:2 or 1:2) have been found to reduce yields in soils with high available nitrogen (Samuels, 1967:II-91; see also Kennelly, 1952:160 who recommends .5:4 for New Zealand conditions). Slight to moderate soil acidity (pH 5-7) is preferred (ibid.; Coleman, 1972:18).

As early as 1820 Banks outlined the difficulties of storing the kumara or sweet potato:

"the slightest scratch predisposes them to rot. They must be kept free from frost and damp..."

(Banks in Cooley, 1951:386)

The same warnings were repeated by Colenso (1880:12) and Walsh (1902:21). An elaborate technology of kumara storage has been developed in America and New Zealand to facilitate successful commercial kumara production in temperate or sub-tropical conditions. This involves curing the tubers over a period of 1 - 3 weeks followed by storage up to 7 - 9 months. Curing is designed to heal wounds caused by breaking the tubers off the crown, which might otherwise permit the entry of fungus or bacterial diseases (Coleman, 1972:29). It should be noted that mechanical harvesting produces additional cuts and scratches (*ibid.*:25). The optimum temperature for the healing of skin wounds is considered to be 29.4°C at 85% humidity (Haynes, 1970:11). Curing regimes normally involve temperatures of 21 - 33°C, and humidity percentages of 85 - 100% over periods of 4-20 days (*ibid.*; see also Kennelly, 1952:161-2; Coleman, 1972:29-30; Purseglove, 1968:88; Cooley, Kushman and Smart, 1954:22). Temperatures have to be reduced as soon as the skins have healed, otherwise sprouting and weight and moisture loss occur. One recommended storage regime in New Zealand is 13 - 16°C and 75 - 80% humidity (Coleman, 1972:30), another is 10 - 12°C at 80-85% humidity (Kennelly, 1952:162). American experiments conducted by Cooley, Kushman and Smart (1954:22) investigated 3, 5, and 7 month storage of 6 varieties at 3 different temperatures: 10°C, 12.7°C and 15.5°C. After 7 months only 20.3% of those kept at 10°C were sound, 74.6% kept at 12.7°C were in good condition and 80.2% of those stored at 15.5°C. Such regimes might be necessary for commercial production; however, if harvesting is by hand and tuber damage minimal, wrapping the tubers in paper and keeping them at room temperature is sufficient for successful storage for several months (Yen, 1963:32-3). When this simple method was applied to the Maori cultivars, fair to excellent results (25 to over 75%) were obtained (*ibid.*:33, 35, 37). Thus for Maori varieties at least, elaborate curing techniques are not necessary if care is taken in lifting and transporting the crop. There is no evidence, however, that they can tolerate storage temperatures below 10°C, nor excessive dampness, so the location and design of the

store would still require great care.

Yields of sweet potatoes grown by peasant farmers vary from 7.5t/ha in Uganda (MacDonald, 1967:III-113) to 15t/ha in Ghana (Doku, 1967:III-39) and 23.6t/ha in New Guinea (Waddell, 1972:117). These figures encompass the range of commercial and experimental production: New Zealand 15.75t/ha (Coleman, 1972:6) and 5-40t/ha, with many of 25-30t/ha (Pullar, 1962:65); Hawaii 10t/ha (Emory, 1928:12); United States 5.2-10.2t/ha from 1940 to 1969 (Jones, 1970:5); and Japan 13t/ha until 1940, now 20t/ha (Fujise, 1970:19). Leslie (1967:V-10) lists average yields from 8 tropical countries. The poorest, Sierra Leone, has yields from 1.25t/ha to 5t/ha. Best yields were in the Congo, 25t/ha to 50t/ha. The overall average is 17.9t/ha ($SD=12.3$, $SE_{\bar{x}}=4.4$).

Taro varieties are commonly divided into two groups: wet taro, grown in irrigated pond fields, and dry taro, which utilizes natural rainfall and may be mulched for water retention (Handy, 1940:10). Some varieties have been developed suitable only for one or the other method of planting. Of 82 named Hawaiian varieties, however, Handy lists 13 which can be planted 'wet' or 'dry' (*ibid.*:Table 2). The growth period of dry taro is often considered to be longer than that of wet, "because it grows somewhat more slowly even where there is plenty of rain, and the corms and the whole plant grow much larger and hence take longer to complete their cycle" (*ibid.*:53-4). This view may be incorrect, for modern tests by de la Pena and Plucknett (1967:II-75) showed upland dry taro maturing consistently earlier (at about 12 months) than irrigated taro (at about 15 months). No information was supplied about the varieties tested. A later dryland planting experiment by Ching (1970) involved 4 Hawaiian varieties, one of which 'Piko Kea' is usually grown under paddy conditions. As a 'wet' taro it takes 15 - 18 months to mature, and this period was reduced to 8 - 9 months in dryland culture (*ibid.*:145). Another cultivar adapted to both wet and dry cultivation matured at 9 - 10 months, while the remaining two were mature at 11 months. Since no trace of irrigation has been found in prehistoric New Zealand gardens, nor the practice convincingly documented in early records, it is most appropriate to use dryland culture statistics in the following review.

In Egypt taro is grown as an annual (along with cucumber and beans) during months when water is available for bi-weekly furrow

irrigation. Maturity is reached in 7 - 9 months (Plucknett, 1970:131; Warid, 1970:141). Fijian planting normally takes place from September to November for growth during the period September - May when rainfall is adequate. Maturity is reached in most varieties of a collection of 30 in 10 months (Sivan, 1970:152). One cultivar was singled out as maturing in 7 - 9 months. Watters (1958:342) described planting early in the rainy season in Samoa and noted a growing time of 6 - 7 months. On Lifuka Island in the Ha'apai group, Tonga, taro matured in 12 months (Beaglehole and Beaglehole, 1941:43). No marked rainy season occurs there, and this factor of seasonality may be found to be an important determinant of maturity times.

Taro is not usually grown as an annual in modern New Zealand, but is over-wintered in semi-wild patches in northern districts. The capacity of the plant to survive on the west coast of the South Island is evident from Brunner's observation that "some taro plantations of former days" existed at Hokitika (in N.M.Taylor, 1959:286). Heaphy also commented on old taro gardens north of Heaphy Mouth (*ibid.*:210). Both explorers ate taro at Maori villages on this coast. The Anaura Bay descriptions of October, 1769, together with Colenso's observations at East Cape (Te Araroa) in November, 1841 (*ibid.*:6-7) leave no doubt that on this east coast taro was planted out in spring en masse and was presumably treated as an annual. No information is available concerning its growing period; however the limits may be determined from the figures cited above: not less than 6 - 7 months and not more than 12.

An optimum temperature range for taro production in Hawaii was given by Greenwell (1947:287) as "not far above or below 70 degrees Fahrenheit" [21.11°C]. During the 9 month Fijian taro-growing period, mean monthly temperatures vary from 23.3°C to 26.1°C. Spier (1951:71) found that areas where taro grows have normal mean winter temperatures in excess of 10°C. Winter mean monthly temperatures in Hokitika, however, are about 8°C (McLintock, 1960:Map 8). It is not known at what minimum temperature leaf or corm damage occurs in the taro. Although it is believed to be frost-tender, exposure by the author of a 'Maori' variety from Northland to air temperatures of 2 - 5°C on winter nights in Dunedin produced only minor curling of the leaves and temporary cessation of growth. These specimens have been in cultivation in Dunedin for 6 years. For most of this period they have been grown indoors

at air temperatures from 10 - 22°C. Each year they showed reduction in leaf number and growth from May to November. One plant has produced several viable cormels, but corm enlargement has been slow. Simmons (1975:pers.comm.) found that taro grown outdoors in a frost-free Dunedin location made good leaf growth but only stunted corms resulted. It appears that this variety is quite tolerant to temperatures of 0-10°C, but requires temperatures closer to 20°C for corm development.

Like the sweet potato, taro has two growth stages after planting. Where annual production occurs, as in Egypt, whole cormels or corm pieces are planted at a rate of 2t/ha (Warid, 1970:141; see also Colenso, 1880) whereas in wet tropical countries continuous production enables the planting of short lengths of petioles and the crowns cut from the corms as they are harvested. Whatever the planting material, leaf development follows rapidly in warm and moist conditions. Top growth is abundant for the first six months in tested Hawaiian varieties, and then declines. Corm bulking commences at 3 - 5 months and continues to maturity at 8 - 10 months (Ching, 1970:143). This suggests a possible reason for taro corm failure in Dunedin: that corm bulking begins at the end of the 5 month growing season and is prematurely terminated by falling temperatures. It would appear that successful taro production in a temperate climate requires a growing season of at least 7 months.

Moisture requirements are greater in the taro than in the kumara. Trujillo (1967:IV-13) found that in Hawaii

"Upland taro culture is practised in areas with annual rainfall above 70 inches [1778 mm] and soils that drain easily."

The same figure was cited by Greenwell (1947:287). At the Kauai Branch Experimental Station where upland taro experiments were conducted by de la Pena and Plucknett (1967), annual rainfall is 2400 mm. Monthly rainfall means are available from Fiji. During the months September to May, mean rainfall in a period of over twenty years at the Koronivia Research Station varies from 206 mm to 385 mm, and the annual mean is 3114 mm (Sivan, 1970:151). Low yields and crop damage occur in Fiji when monthly means are as low as 50 - 100 mm (expressed as an annual rainfall of 600 - 1200 mm).

The preferred soil type for taro cultivation in New Zealand was described by Colenso (1880:8) as

"light and deep yet loamy, or alluvial, often on the banks of streams or lagoons, and sometimes at the foot of high cliffs near the sea".

Clay loams are preferred in Egypt, or sandy soils well supplied with organic matter (Warid, 1970:141). In Fiji, well-drained porous soils with abundant humus are favoured (Sivan, 1970:151).

Nutrient requirements of taro were studied by de la Pena and Plucknett (1967) who found that in pot experiments only nitrogen gave significant increases in corm and leaf weights. In field trials upland taro showed yield increases with moderate quantities of nitrogen, phosphorus and potassium fertiliser (approximately 1 : 1 : 2). In general, humus enrichment is seen as important.

Storage of mature corms in the ground is considered relatively successful if water is withheld (Warid, 1970:142; Spier, 1951:70), but sprouting occurs once the moisture level rises. Doku (1967:III-42) described cases of taro plant survival under secondary forest for 34 years and subsequent vigorous growth when the bush was cleared. The most definitive statement of storage conditions is that by Plucknett (1970:134):

"It is possible to store corms and cormels of Colocasia ...for several months in dry, ventilated, and cool (10° C) conditions."

Taro yields under peasant farming conditions in Fiji are as low as 4.5t/ha (Sivan, 1970:152), and in Melanesia as a whole 7.5t/ha (Barrau, 1958). In Barbados yields of 5t/ha are obtained (Gooding, 1967:V-117). Under commercial and experimental farming, dryland taro often exceeds 20t/ha (for example Sivan, 1970:152; Plucknett, 1970:134).

Dioscorea or yam species originated in areas with sharply defined wet and dry seasons (Coursey and Martin, 1970:87). With the onset of the wet season, vine growth in D. alata, the greater yam, is extremely rapid and lasts for 8 or more months, depending on the cultivar (Haynes et al., 1967:III-2). Rapid tuber development begins after the fourth month (ibid.). In Barbados tests bulking was found to begin at 5 months and maturity was reached at 8½ months (Gooding and Hoad, 1967:III-138). Maturity of some Indian varieties is marked by drying up of the leaves at 5 - 8 months (Kundu, 1967:I-127).

No information is available about temperature tolerance in

the greater yam; however it is described as being less tolerant than the taro. Burkill (in Spier, 1951:71) placed the northern and southern limits of cultivation of taro as 10° of latitude beyond those of the yam. This observation is not strictly true for New Zealand since the southernmost record of yam cultivation (at Tolaga Bay $38^{\circ} 25'S$) is only $4^{\circ} 17'$ north of the southernmost record of taro cultivation (at Hokitika $42^{\circ} 42'S$).

Rainfall requirements of the yam fall between those of the kumara and taro. In West Africa the critical period is the first 5 months, and an ideal amount for that region is given as 1000 - 1500 mm distributed over 6 - 7 months (Enyi, 1970:90). Under Barbados conditions rainfall below 1000 mm during the 8 month growing season limits crop yields (Gooding, 1970:98).

Fertile and free-draining soils are important to yam production (Enyi, 1970:90) and as the crop is considered 'exhaustive' in Indian conditions, soils there are manured liberally with farmyard dung (Kundu, 1967:I-127). Potassium and nitrogen fertilisation has been found beneficial in the West Indies (Ferguson and Haynes, 1970:93).

Like the kumara, yam tubers continue respiration during storage (Coursey, 1967:VI-30). In Africa they may be stored 6 months in dry, airy conditions but sometimes with losses up to 40% (Enyi, 1970:92). Sprouting effectively ends the 3 - 4 month storage period in Barbados (Gooding, 1970:97). Although chilling inhibits sprouting, irreversible changes in the tubers occur at $5^{\circ}C$ (Coursey, 1967:VI-30), a similar limit to that found in the kumara.

Peasant production of the greater yam gives yields of 9t/ha in West Africa (Enyi, 1970:91), 5-6t/ha in Barbados (Gooding, 1970:97), and 7.5t/ha in Trinidad (Royer, 1967:I-149). General figures for peasant yam growing are 2.5 - 7.5t/ha (Coursey, 1967:VI-28) and 5 - 10t/ha (Coursey and Martin, 1970:88). Commercial production may give yields of 25-58t/ha (*ibid.*). Planting material normally consists of small tubers, or pieces of tuber, and 2 tonnes of these sets are needed to plant one hectare (Degras, 1970:163; Enyi, 1970:91), a similar quantity to that used in taro planting from cormels or corm pieces. With some peasant farming yields restricted to 6t/ha, only 2/3 of the crop would be available for consumption. This figure of 2t/ha may be appropriate to New Zealand prehistoric kumara planting, which traditionally utilized small tubers

for planting material, or if these were not sufficient

"they were supplemented by the heads-the end containing the eyes-of the larger ones broken off for the purpose."

(Walsh, 1902:18)

The gourd is propagated by seed and thus the crucial factor in its survival is the adequacy of growing season conditions to fill out and ripen the fruit. Generally in tropical locations vines begin fruiting 3 months after planting (Purseglove, 1968). Cultivation in temperate countries is terminated by frost which immediately kills the vine and can damage unripened fruit (Organ, 1963). Thus early, heat-assisted germination of the seed is advocated. At 24°C the seeds sprout vigorously within 7 days of planting and are then hardened off to grow at 18°C. Rich, well-drained soil is required, with regular rain-fall (Colenso, 1880:8).

'Maori' gourd seeds obtained from the Waikato were grown in a warm, sheltered location in Dunedin, to give an indication of the needs of this plant. Heat-assisted germination took place in early October with 95% success. Some losses from damping off occurred before the plants were transplanted outside in early November. Flowering commenced 3 months later and the few fertilised female flowers swelled rapidly to a diameter of about 7 cm in 5 weeks. By mid-March, however, cold, wet weather terminated growth and the immature fruit rotted on the vine. Under Dunedin conditions the 4 months of growth which preceded fruiting did not leave sufficient time for the fruit to enlarge and ripen. In the same season other cucurbits ripened and stored satisfactorily, indicating that the bottle gourd is among the more tender members of the family. It is judged that a minimum 6 - 7 month growing season is needed for gourd production.

Storage of the mature fruit is not difficult. Dry airy conditions and regular turning of the gourds are recommended. Within 3 months the gourds are a straw colour and the ripe seeds may be extracted. Under English conditions, 2 - 6 fruits per plant are ripened (Organ, 1963) and in India each plant will set 10 - 15 fruits of .45 - 1.36 kg each (Purseglove, 1968).

An estimate of the basic growing season needs of these four species, based on the data synthesized above, can now be presented:

	Length of Season	Optimum Temp.	Tuber Damage Threshold	Optimum Monthly Rainfall	Minimum Monthly Rainfall
KUMARA	5 - 6 mo.	17°C	4.5°C	76- 100 mm	60 mm
DRY TARO	7 - 9 mo.	20°C	20°C	147 mm	100 mm
GREATER YAM	8 mo.	? 20°C	5°C	125 mm	100 mm
GOURD	6 - 7 mo.	17°C	n.a.	?	?

Monthly rainfall means are available for Palliser Bay from 1930 - 1969. They were supplied by the New Zealand Meteorological Service and are derived from observations made on the coastal platform at Cape Palliser Lighthouse:

Monthly Rainfall Means 1930 - 1969

Jan.*	Feb.*	March*	April*	May	June	July	Aug.	Sept.	Oct.*	Nov.*	Dec.*	Annual	

Mean	71.63	82.04	72.39	79.76	109.22	100.08	122.68	100.58	74.42	76.45	58.17	75.69	1023.11

SD	52.58	72.14	49.28	52.58	64.01	60.45	56.13	58.67	39.37	46.99	38.10	45.21	174.24

(*marks months of possible growing season for Polynesian cultigens - all measurements in millimetres)

Until 1973 this station officially recorded only rainfall data, but unpublished temperature readings taken at 6 am, 9 am, 12 midday, and 3 pm (or 6 pm) were made available by the Meteorological Service for this study. These have been collated for the period December, 1941 to December, 1948. The calculation of the mean monthly temperature is based on the sums of the lowest and highest monthly readings at each observation time. They should be corrected by 1°C for comparison with conventional calculations, since 9 pm, midnight and 3 am readings are not included.

Approximate Mean Monthly Temperatures 1942 - 1948

Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	

Mean	19.0	17.8	17.0	15.0	11.7	9.9	9.6	10.0	11.6	13.1	15.7	17.2	14.0

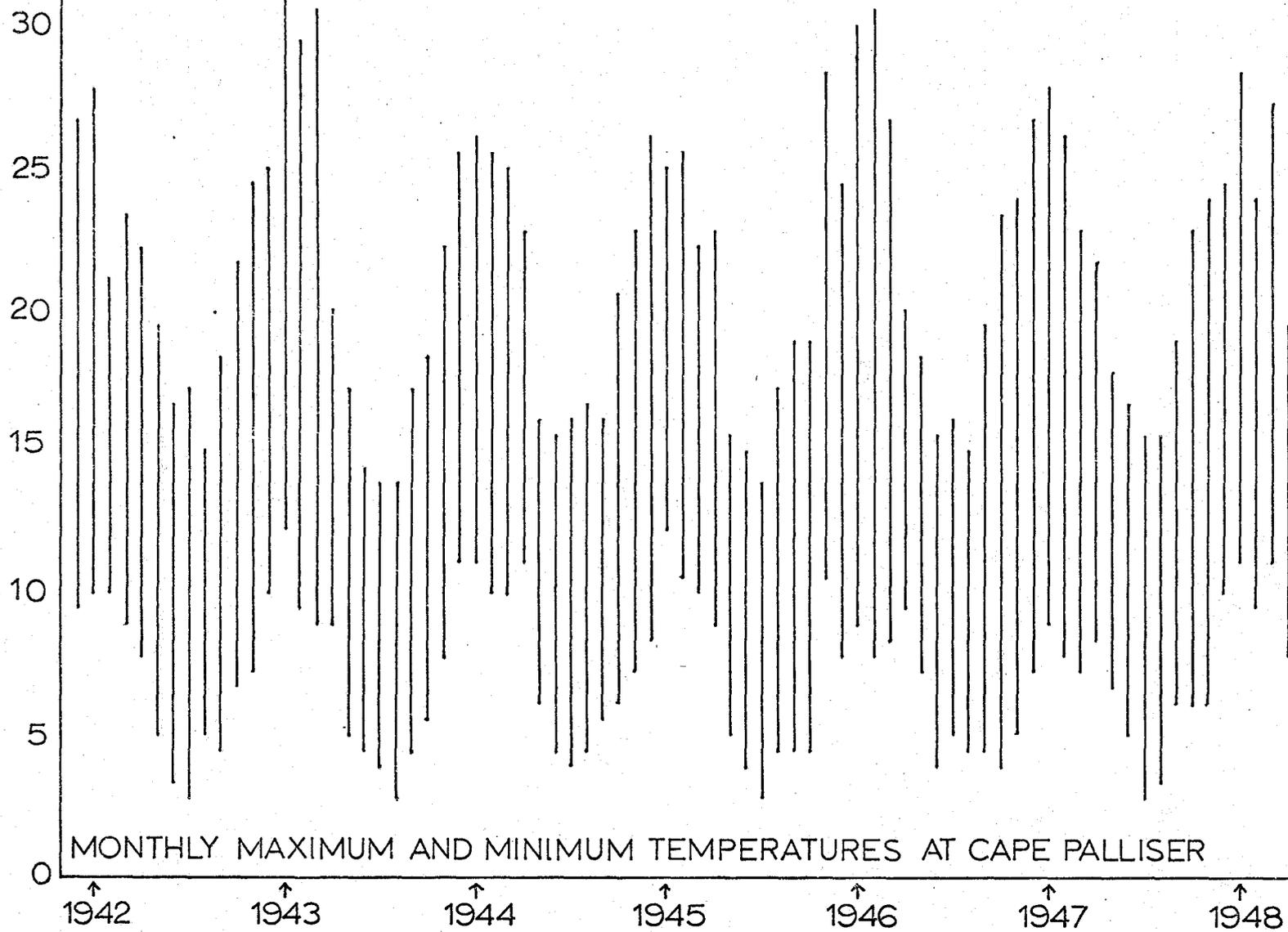
Corrected Mean	18.0	16.8	16.0	14.0	10.7	8.9	8.6	9.0	10.6	12.1	14.7	16.2	13.0

SD	0.82	1.46	0.98	1.19	1.01	0.61	0.85	0.97	1.02	0.99	1.48	1.48	3.37

A plot of highest and lowest readings at the above hours over this period of seven years (Figure 42) shows the sharp deterioration in temperature between March and April or April and May, which marks the end of the growing season. This is accompanied by increased rainfall which persists through the winter months until the beginning of September. Temperatures rise gradually from October, and vigorous growth in half-hardy or frost-tender plants would occur in the months from mid-October to mid-April inclusive. In some years this six month growth period might be shortened to five months.

Under modern conditions Palliser Bay is marginal for kumara growth: it has adequate rainfall, suitable soils, a sufficiently long growing season, but temperatures about 1°C lower (16.3°C) than those judged suitable for commercial production. There is insufficient rainfall for taro and the greater yam, and the growing season is too short for both of these. Growing season length might be adequate for gourd cultivation. By extrapolation, therefore, the probability that kumara and gourds were grown in prehistoric Palliser Bay is regarded as high, whereas taro and yam cultivation can be eliminated on major climatic grounds.

°C FIGURE 42



CHAPTER EIGHT

CLIMATIC CHANGE AND PALLISER BAY HORTICULTURE

The relevance of possible changes in climate to the course of horticulture in prehistoric New Zealand was first discussed by Lockerbie (1950a & b). In searching for a reason why Polynesians should leave the North Island to settle in the South, he discovered in Raeside's (1948) publication on Canterbury vegetation and soils a suggestion that "the climate of Murihiku from the 4th to the 13th century was several degrees warmer than at present" (Lockerbie, 1950a:81). In fact Raeside's postulated 2°C temperature fall after the 13th century applied to the downlands of Canterbury and the uplands of eastern Otago (Raeside, 1948:167), a more restricted area than Murihiku. The temperature estimation was derived from Raeside's observation that

"Forest remains above the present timber line can be best explained by the hypothesis that at some time in the past the temperature was high enough to raise the timber line at least 500 ft. higher than it is now. Such a rise would require a temperature increase of between 1½° and 2°C."

(ibid.:157)

The dating of the shift was by age estimates of these forest remains as well as by analogy with the northern hemisphere where it was believed that the period 900 to 1200 AD had been warmer and drier than the subsequent seven centuries. In contrast, Raeside saw unquestionable evidence in Canterbury pedalfers (leached soils) and river gravel sections that a wetter climate had prevailed. He associated warmer temperatures with more common anticyclonic weather which produces a moist north-easterly or easterly sea breeze in this eastern zone. High ground in its path intercepts the moisture (ibid.:167).

Lockerbie's interest lay not with the inter-relationships of soil, vegetation and climate, but with a simple temperature shift which might permit "the growing of kumara where conditions are now too cold for the plant to grow" (Lockerbie, 1950a:81). In the light of this evidence the presumed borrow pits at Temuka (see p. 129) took on "all the characteristics of gravel pits associated with the cultivation of kumara" (ibid.:82).

Without a prior knowledge of Raeside's work, Holloway

(1954:374) postulated that existing forest instability in the south-western South Island had its roots in climatic instability

"The change of conditions which brought about cessation of effective podocarp regeneration must have taken place during the life span of trees now living and the mean age of these forest veterans is estimated at from 500 to 800 years" (*ibid.*:372)

Holloway favoured the younger date for this change of climate. The actual details were left vague, although he noted signs that the onset of the period had been associated with "markedly severe (drought) weather" (*ibid.*:374). Later he commented that the change "was generally in the direction of increasing cold" (Holloway, 1964:8). Fleming (1963), Pullar (1966), and Gorbey (1967) have reviewed the controversy that followed mis-quotation of Holloway's remarks at the 1957 New Zealand Archaeological Association conference. In brief, this appears to have stemmed from a simplistic view of climate which modified Raeside and Holloway's regionally specific and tentative suggestions into statements of temperature and rainfall changes applicable to widely separated parts of New Zealand (for example, Cumberland, 1962; Lockerbie, 1959; Golson, 1957b). Misled by these statements, Green (1963) was later criticised (for example by Simmons, 1965) for his use of climatic change in an account of economic development in the northern North Island (qv. Green, 1970:50).

Despite the criticism, the evidence of Holloway and Raeside had not been refuted. Indeed it was consistently augmented by several botanists working in both the North and South Island (McKelvey, 1953; Nichols, 1956; P.Wardle & Mark, 1956; Elder, 1956, 1962, 1963; Burrows, 1960; Grant, 1963, 1965; P.Wardle, 1963, 1965). In general, they detected serious failure of regeneration at periods after 1600 AD, and some evidence of windthrow, erosion and flooding. There were also indications of these phenomena one to three centuries earlier (P.Wardle, 1963; Grant, 1963). More recently Pullar and Penhale (1970) confirmed Grant's (1963) observations from sediment analysis.

Following Lockerbie's correlation of possible horticultural evidence at Temuka with an earlier warmer phase, Yen (1961) argued that this may have been an important factor in the successful adjustment of kumara horticulture to New Zealand conditions as a whole. Applying Raeside's temperature shift of 2^oC, he wrote

"A 5^oF or 2^oC higher temperature in 1200 A.D. than present may have given New Zealand a considerably longer warm growing season or even a number of frost-free areas in which for a time, the 'artificial' storage phase in kumara growing may have been unimportant.

The subsequent deterioration in climate would have provided the stimulus and time for the Maori to invent the technical methods to preserve his plants."

(Yen, 1961:342)

Although the details of this hypothesis were questioned by Law (1970:120-1), the accumulated evidence for climatic change in a horticulturally marginal zone cannot be dismissed as unimportant or irrelevant, for as Yen realised, a temperature shift of 1^o or 2^oC might have a profound effect on the length of the growing season. Indeed, in Britain, an overall change of only 1^oC in the period from 1680 AD was found to mask winter temperature drops of more than 2^oC in individual decades. Slight cooling has occurred in Britain in this century:

"These differences may seem trivial. They are, however, enough to have shortened the average growing season since 1950 by about two weeks in comparison with the warmest decades and to have doubled the frequency of snow on the ground in most inland districts of England since the years between the two world wars..."

(Lamb, 1969:1211)

As has been shown, growing season length is critical to successful kumara production in New Zealand.

Since 1970, reports by Bray (1971), P.Wardle (1973) and Wilson, Hendy and Reynolds (Wilson, 1973: pers.comm.) have so enlarged the corpus of evidence that climatic change can no longer be doubted. Some of their results are compared in Figure 43. Particularly important has been the use of research methods such as lichenometry (P.Wardle, 1973) and speleothem O¹⁸/O¹⁶ analysis (Hendy and Wilson, 1968) to provide evidence independent of vegetation and soil and sediment studies. Bray's contribution was to place New Zealand evidence in a global framework based on many factors, such as indices of winter mildness and severity and crop success from historical records, C-14 and O18 ratios, solar activity, tree growth, and glacial advances. His study showed

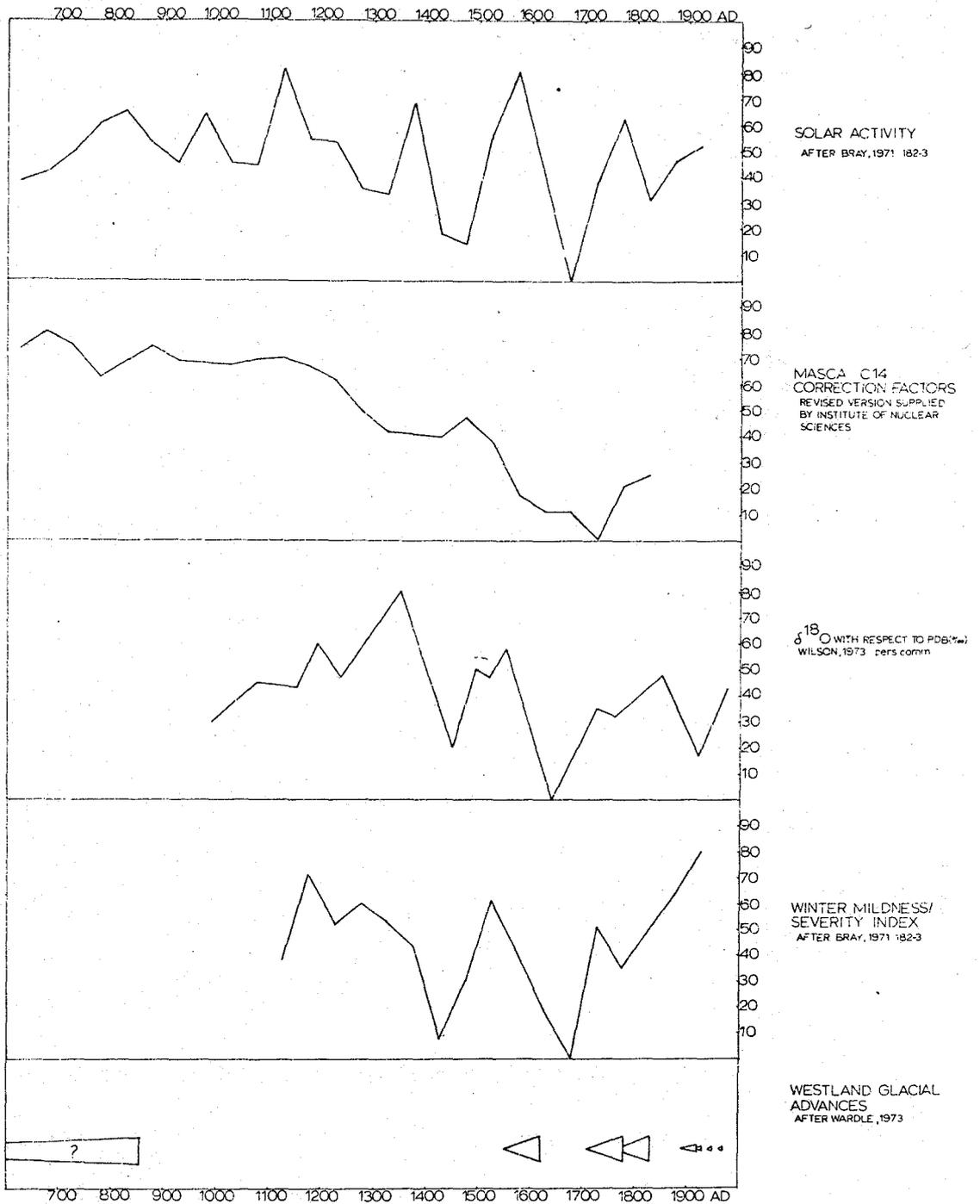


FIGURE 43 GRAPHS OF CLIMATIC CHANGE AND RELATED PHENOMENA
(ORIGINAL DATA CONVERTED TO SCALE 0 - 100 FOR COMPARABILITY)

"coincidences in the timing of LIA [Little Ice Age] advances and of recent retreats for greatly diverse parts of the world; similar coincidences have occurred in analysing the vegetational distribution and growth data."

(Bray, 1971:216-7)

A detailed synthesis of European climatic data by Ladurie (1971) found a parallel in P.Wardle's (1973) analysis of post-glacial variations in 18 New Zealand glaciers. He demonstrated conclusively that

"The advances and retreats of the last four centuries constitute a distinct glacial episode culminating between 1600 and 1850AD, and thereby equivalent to the 'Little Ice Age' of the Northern Hemisphere. The main maxima appear to have occurred before about 1620, 1780, and 1830, and though retreat has prevailed subsequently, it has been interrupted by minor advances between 1890 and 1920, and in the 1930s, early 1950s, and mid 1960s."

(P.Wardle, 1973:349)

The causes of glacial advance and retreat are unquestionably complex, and at a local level may involve lower temperatures, reduced insolation (especially in summer), and increased precipitation (especially in winter) (*ibid.*:384). A higher level cause is increasing strength of the principal zonal currents of the global wind circulation (Lamb, 1969), and this is brought about by an increasing temperature differential between equatorial and polar regions (Wilson & Hendy, 1971:344). Ultimately, reduced levels of solar activity may be responsible (Bray, 1971:180; Lamb, 1969). New Zealand climatic records available for the 1890 glacial advance indicate that the immediate cause was increased precipitation on the western side of the Southern Alps, associated with more frequent and stronger southwesterly winds (P.Wardle, 1973). During the same period drought and strong north-westerly winds were experienced east of the main divide.

A disadvantage of glacier study can be the obliteration of traces of former advances by a later major advance. This may be the reason why Wardle did not detect any increase in glacier volume corresponding to the brief 'medieval thrust' experienced in the northern hemisphere during the period 1200 - 1500 AD (Bray, 1971: 180-2; c.f. Ladurie, 1971). Oxygen isotope measurements made on the calcite layers which build up stalagmites have no such handicap. Using samples from the Paturau (Nelson) and Waitomo areas (especially

the Twin Forks stalagmite from Paturau) Hendy and Wilson detected a sharp decline in O^{18} (interpreted as a fall of about $1.3^{\circ}C$ in mean temperature) followed by a partial recovery prior to the major decline of the post-1600 AD period (see Figure 43). The prolonged period when mean temperature was below $12.25^{\circ}C$ correlates well with Wardle's period of greatest glacial activity after about 1600 AD. The earlier decline may be a New Zealand equivalent of the medieval cooling in Europe. A mean temperature peak of nearly $13^{\circ}C$ appears just prior to 1400 AD. This may not have been the highest mean of the warm period for the particular curve used in the study stops at about 1200 AD.

Although speleothem analysis was initially applied to major Pleistocene and post-Pleistocene temperature trends, the correspondence between the Twin Forks curve and the botanical and soil evidence collected by Wardle and earlier workers, indicates considerable potential in this method when applied to short periods of a thousand years or less. It should be stressed, however, that the dating technique involves carbon- 14 determination with its attendant difficulties (Hendy & Wilson, 1968:49).

The research reviewed above is relevant to the New Zealand archaeologist in two major respects. Firstly it confirms that in the last millenium, New Zealand, like countries in the northern hemisphere, underwent significant climatic modification from a climate a little warmer than present, through a series of declines and partial recoveries to the present day. These changes may be expected to have had important cultural repercussions. Secondly it suggests that the actual weather phenomena encountered during this period would have displayed important regional differences. Thus statements of climate becoming 'cooler and wetter' or 'cooler and drier' should not be applied to the New Zealand land mass as a whole.

Historical records have proved particularly valuable in constructing a picture of weather systems and their movements in Europe especially during the Little Ice Age. Of course no such data are available for New Zealand prior to European settlement. It should not be forgotten, however, that Cook visited at a time when glacial maxima were reached on the west coast and from his 1769 - 1770 observations of wind strength, wind direction and rainfall, a meteorological picture of a New Zealand summer may be inferred (Cook, 1968:167-294). It may or may not be typical for that era. Certainly what appears to have been

a similar summer experienced in 1975-1976 has been considered particularly 'unseasonable'.

On reaching Hawkes Bay in October, 1769 Cook experienced fine anticyclonic weather for nearly two weeks with only one day of misty rain. About the 18th a low pressure area crossing to the north was followed by the formation of a depression to the south and a disturbed southwesterly flow brought five days of rain over the next nine days. A ridge of high pressure with fine weather crossed the country at the end of October, but was quickly replaced by a low pressure centre crossing the North Island in early November. This brought rain on 6 consecutive days. The weather remained unsettled as Cook sailed across the Bay of Plenty and the few fine days were interrupted by the passage of cold fronts. After a short-lived ridge of high pressure moved off the country at the end of November, Cook experienced four more days of rain. An anticyclone persisted over the country from December 4 to 12 and this was followed by the passage of an active cold front, presumably associated with a depression in the south. Fine weather was experienced in mid-December as Cook neared North Cape, then a disturbed westerly flow followed by light southwesterly winds again indicated the passage of a low pressure area to the south. On December 25 a cloud sheet on the leading edge of a tropical cyclone began to thicken and gale and hurricane force winds were experienced for 4 days, with the wind swinging from east to south and southwest as the centre passed close to New Zealand. A disturbed southwesterly flow with showers persisted until January 6. Another ridge crossed the country to be replaced by a slow-moving trough which brought heavy rain and thunderstorms as Cook passed Mt. Egmont. From January 15-21 anticyclonic conditions prevailed. These were followed by a disturbed westerly air flow with periodic rain until February 1 when a severe storm from the northwest brought local flooding in the Marlborough Sounds. Conditions improved as high pressure systems crossed the country separated by shallow troughs which brought cooler southerlies but no rain. An active cold front was encountered off South Canterbury on February 21 and this was followed by fronts presumably associated with a deep depression whose centre appears to have crossed Southland on February 26. Other disturbances were encountered on March 1-2 and 5-6. A short-lived ridge of high pressure brought fine weather for the

next few days until an active cold front associated with another deep depression brought hail and cold showers. Fresh snow fell in Dusky Sound. As Cook sailed up the west coast of the South Island before leaving New Zealand waters he experienced rain on 9 out of 15 days, associated with disturbed westerly conditions.

The significant features of the weather in the summer of 1769-1770 were the short-lived anticyclones, the number of low pressure systems crossing the North Island, the possible passage of deep depressions close to the south of the South Island at a time of the year when they are normally far to the south of New Zealand, the prevailing disturbed west to southwesterly air stream, the apparent survival of active fronts as far north as Northland, and the occurrence of a tropical cyclone in late December when the normal cyclone season is late summer-early autumn (Maunder, 1971:221).

Cook's general impression of Marlborough Sounds' weather was such that on April 25, 1773 he wrote

"For the Eight days past we have not had a single shower of rain, a circumstance that I believe is very uncommon here especially at this time of the year."

(Cook, 1969:127)

There is certainly no trace in his records of the "large, slow moving, deep warm-type anticyclones stagnating over New Zealand and the adjacent seas" (Hill, 1971:1, 6) which bring about long dry spells and characterise a hot, settled summer.

Historical records of the 18th to 20th century cover years of both settled and unsettled weather, and from them some suggestions may be made of weather patterns which might have prevailed in Palliser Bay during the local equivalent of the Little Climatic Optimum c.1150 AD or the coldest years of the Little Ice Age c.1650 AD. These are based on the assumption that extremes of weather experienced within recent decades cover nearly the full range experienced in previous centuries, at least within the post-glacial era:

"Many climatologists think that in fact all climatic oscillations are of the same type, whether they are, individually, annual, decennary, secular, millenary, or have to be measured in geological time."

(Ladurie, 1971:247)

Thus the Little Climatic Optimum would have been characterized by dominance of weather phenomena normally described as 'settled', and the Little Ice Age by patterns more often viewed as 'unsettled' or 'stormy'. A typical summer during the earlier phase would have been dominated by anticyclones with generally light winds veering from southwest to northwest or north as the high pressure area moves across the country from west to east. With the centre to the west of the country, eastern districts experience locally strong sea breezes, and sometimes widespread drizzle. Then as the weather clears in eastern areas, mild and relatively humid conditions are found in areas exposed to the west and northwest (Maunder, 1971:217-8). Fog is common on high ground. Between high pressure centres shallow troughs occur, often associated with cold fronts of which the southern portion is part of one of the deep depressions travelling from west to east in antarctic seas. As the trough approaches, northwesterly winds increase, especially in Fiordland and Cook Strait. The deeper the trough the more rain falls in western districts from Taranaki south. At the same time a very warm föhn wind may prevail in eastern areas, especially Canterbury. Cold fronts associated with shallow troughs bring a shift from northwest to south or southwest winds, and in summer the front often weakens before it reaches Cook Strait and little or no rain falls in eastern districts. Thus many summers in 12th century Palliser Bay would have been marked by a cycle of north-easterly breezes with drizzle night and morning and fine days, followed by fresh northwesterly winds with warm day temperatures, and then brief, cooler southerly winds with only light rain. There is little likelihood that more rain fell than at present, but humidity may have been higher. Minor droughts could have been experienced. Wind strengths were probably lower and less desiccating. It is possible that anticyclonic conditions persisted well into autumn, thereby lengthening the growing period by several weeks. Winter conditions would have brought more frequent cold fronts with heavier rain and also periods of fine, cool weather with sharp inland frosts.

Weather in a typical growing season in the 17th century was probably far more unpredictable. With low pressure systems dominating the weather in both winter and summer, wave depressions forming on cold fronts at various stages in their progress from west to east can result in quite different local effects (Maunder, 1971:219-20). If the wave

develops to the east of New Zealand, exposed eastern districts such as Palliser Bay experience strong east or southeast winds and continuous heavy rain for 2-3 days. A disturbed westerly airflow would be experienced in Palliser Bay in the form of strong dry northwesterly winds blowing continuously for several days (*ibid.*:221). It might be predicted that summer temperatures would fluctuate between extremes, up to 30°C when northwesterly winds prevailed, and down to 4° or 5°C during the passage of active cold fronts. Shelter would probably become a critical factor for successful gardening. Increased wind strength during this period was undoubtedly reflected in more turbulent sea conditions.

Conditions in western districts during the Little Ice Age may have differed considerably. South of Taranaki, more cloud and rain may have been experienced, while to the north slightly increased rain might have been accompanied by milder temperatures. In all coastal districts, the incidence of frosts may have declined significantly.

Much research into the shifting dominance of weather patterns and the accompanying local effects remains to be done. However, with the assistance of climatological records and analyses of synoptic patterns (for example Kerr, 1962; Kidson, 1932) it is possible to improve the archaeologist's understanding of weather patterns of earlier centuries, beyond the simplistic level of 'cooler and wetter' or 'warmer and drier'.

The hypothesized changes in weather patterns in Palliser Bay receive some support from the archaeological evidence, although in many cases cultural factors are clearly involved as well. Because of the complex cause and effect relationship of human economy and the natural environment, prospects of unravelling the precise effects of climatic change remain poor.

It should not be thought that significant secular climatic changes occurred only in the last ten centuries. Bird remains from the Martinborough Caves in the north of the Aorangi (Haurangi) Mountains appear to indicate habitat modification before Polynesian settlement. The caves were the subject of a number of reports from 1920 to 1958 (Anon., 1920; Stidolph, 1921; Yaldwyn, 1956, 1958; Dell, 1956). Cave 1, a near vertical sink-hole with a single narrow entrance from a ridge, proved an ideal trap for flightless birds travelling along the ridge crest:

"In Cave 1, the numerically predominant birds were the Kakapo, Extinct Duck, Notornis, Aptornis and Kiwi, all flightless. None of these birds was found in Cave 5..."

(Yaldwyn, 1956:5)

Cave 5 was a shelter among limestone boulders, which contained moa egg shell and a juvenile Anomalopteryx, the remains of a large weka which may have used it for shelter, and incomplete remains of flying forest species thought to have fallen into the crevice from a falcon's nest (Yaldwyn, 1956:7). A full list of species appears in Appendix 7. The caves are not directly dated but the absence of sealing layers of solifluxion deposits caused by periglacial conditions which prevailed in the area until about 6000 BC, provides a terminus post quem. Yaldwyn concluded that

"for some time during the last 8,000 years, probably until only a few hundred years ago, the mixed podocarp-broadleaf forest of the Haurangi Mountains, Eastern Wairarapa, at about 2,500 ft [762 m] above sea-level, contained at least the following flying birds: New Zealand falcon, blue-wattled crow, robin, pigeon, kaka, parrakeet, saddleback, and tui. At the same time there was a large ground bird fauna, containing a number of extinct forms. There were several moas, representing three genera (Anomalopteryx, Pachyornis, and Dinornis), a kiwi, the extinct flightless duck (very common), a large rail (Aptornis), a large takahe, several wekas, and the kakapo (very common)."

(Yaldwyn, 1958:132-3)

To this list one may add from Scarlett's identifications (1971:pers. comm.) a further two rails, the bellbird, huia, extinct New Zealand owlet-nightjar, and the North Island tit.

With no significant pre-Polynesian changes in habitat, considerable quantities of flightless birds which would be the easiest to catch, might be expected to be represented in the earliest layers of the middens, in particular the flightless duck, large rail and kakapo. Smaller quantities of moa, kiwi, weka and takahe might also be expected. In fact in comparison with the flying species, the total numbers of flightless birds (excluding penguins) from the middens are extremely low:

Washpool Midden Site (N168-9/22 - B.F. Leach, 1976:Appendix 29)

Gallirallus australis greyi (weka) 3
Capellirallus/Rallus ?sp. (small rail) 3
Euryapteryx geranoides 2
E. gravis 2
?Pachyornis mappini/E. geranoides 2
Pachyornis mappini 1

Pararaki Midden Wall (N168-9/41 - p.90)

Euryapteryx geranoides/Pachyornis mappini 1

Black Rocks Black Midden (N168-9/77 - Anderson, 1973:Appendix G)

Gallirallus australis greyi 1
Euryapteryx ?gravis 1

Black Rocks Crescent Midden (N168-9/77 - ibid.)

Euryapteryx gravis 1
Dinornis ?spp. 3

It has been argued at length (p.91) on the basis of skeletal representation and the presence of a South Island species, that the moas were not hunted locally. Thus with the exception of four wekas and three small rails, the flightless birds of the Martinborough Caves are not found in cultural deposits. In view of the abundance of such species in South Island middens, cultural reasons for their absence are unconvincing, and a thesis of extinction before settlement must be advanced.

Flightless birds would be particularly prone to loss of food and breeding partners as a result of destruction of patches of forest by wind-thrower fire. The isolation of the surviving birds in 'islands' of undamaged forest might reduce breeding stocks below the critical level for recovery of the species and re-stocking of new secondary forest. Northwesterly gales in the historic era (Thomson, 1936) have brought about a patchwork pattern of destruction by wind-throw in the Tararua Mountains, which has also been described for the Aorangi Mountains (J. Wardle, 1967; Franklin, 1967; Druce, 1971). The pattern is directly correlated with topography and can be distinguished from the results of accidental or deliberate forest clearance by man (qv. McKelvey, 1958:30).

It has been argued that increased wind strength was associated with periods of glacial advance, thus the incidence of wind-throw might be expected to increase during the Little Ice Age and earlier episodes of cooling. P.Wardle (1973:349) identified glacial advances before 2780 BC, between 620 and 210 BC, and between 440 and 855 AD. Wind-throw and north-westerly desiccation associated with any or all of these periods might have been responsible for the virtual extinction of the flightless birds of the Martinborough Caves, before human settlement.

Another group of birds became locally extinct during the prehistoric and early historic period. These were the New Zealand quail, the small rails, the saddleback, huia, blue-wattled crow and thrush. Prehistoric human predation does not seem to have been an important factor in their extinction since they constitute not more than 2% of any avifaunal archaeological assemblage. Indeed the most frequently hunted species, the tui and parakeet, have survived in comparatively large numbers. It is possible that the extinct birds were casualties of vegetation damage suffered during the Little Ice Age. Unlike the mobile, nectar and berry-eating flocking birds, such as tui and parakeet, the saddleback, huia, blue-wattled crow and thrush were known to be sedentary birds feeding in isolated pairs close to the forest floor. Their diet was largely insects. Not only would they have been vulnerable to isolation in small pockets of forest after wind-throw, but the insects on which they fed may have been periodically depleted by the extremes of temperature experienced in unsettled summers (Hamel, 1974: pers.comm.).

There is good evidence of accelerated local erosion after settlement from several sites in Palliser Bay. At Whatarangi, the stream underwent major flooding on at least three occasions after the beginning of the 15th century and before European occupation. As well, fans became active on the hillside behind the site. Charcoal in the earliest silt layer indicates that the erosion followed burning of nearby vegetation; however, only prolonged heavy rainfall could produce the volume of silt and gravel-laden water that buried the sandy loam garden soil.

At one Te Humenga excavation it was found that increased fan activity also followed the gardening phase, but not before the upper portion of the stone row had collapsed outward. Topsoil development above the fan outwash would place the erosion well within the prehistoric period. In another site of this complex, even thicker erosion layers had

built up at some period after a late 12th century occupation.

Excavations at North Pararaki showed that although a large fan had existed before settlement, serious river flooding occurred long enough after the occupation for a topsoil to develop. Human activity in this locality seems to have been concentrated in the 12-13th centuries.

At North Waiwhero it was found that several fans became active after the gardening phase. In one case a short period of abandonment intervened. A wall of this complex was dated to the late 15th century, and if this date applies to the stone rows almost completely buried by fan outwash, the erosion phase must have occurred in the 16th century or later.

There is clear evidence in shellfish remains from Palliser Bay middens that protected sandy beaches and clear water habitats suitable for filter feeders such as pipi, tuatua and mussels were present locally in the first few centuries of settlement, but absent by about the 16th century (B.F. Leach, 1976:179-80, 272-3). The last appearance of filter feeders was dated to the late 15th century (ibid.:181), and there is a little evidence that the decline had set in by the mid-fourteenth century. The change to the unstable gravel beaches and cloudy water conditions may be correlated with the evidence of flooding and major erosion which increased the sediment load of creeks, streams and rivers and affected the inshore marine environment of the whole bay.

While erosion may have been accelerated by increased storminess and heavy rains during the Little Ice Age, the effects of erosion can be detected up to two centuries before. It is in this period that human influence and the effects of the proposed earlier climatic deterioration of about 1400-1450 AD cannot be disentangled.

To the prehistoric gardeners who might individually have experience of 30-40 growing seasons, the major trends would of course be imperceptible. Even in the warmest era soon after settlement poor yields might be obtained in particular years, and even in the 17th century the chances of a long, warm summer would not be nil. Within a single lifetime the outstanding effects of climatic deterioration would not have been a noticeable drop in yield, but a few totally unexpected summer storms with flooding and damage to houses and gardens, or a few years when spring was long delayed and food supplies ran out.

Natural disasters occur regardless of the prevailing mean annual temperature; however the spacing between severe storms or poor summers might be critical to the economic recovery of communities growing crops of tropical origin. Furthermore when periodic hunting or fishing failure is added to horticultural difficulties, the cumulative effect might trigger archaeologically detectable 'abandonment' or 'emigration'.

In summary, the hypothesis of significant climatic change in the last millenium in New Zealand has now received support from independent fields of research throughout the country. In the Wairarapa it has been argued that climatic deterioration was a prime cause of virtual abandonment of the Palliser Bay settlements (B.F. Leach, 1976). Even though conditions were a little warmer and more settled for the first few centuries of occupation, there is no indication that the growing season or the rainfall would have been sufficiently increased to extend the range of cultigens beyond kumara and gourd. Thus the conclusions reached in the previous chapter remain unaltered. At the same time yields of these two crops were probably substantially higher than might be obtained in the area today, thereby making continued stone clearance and garden preparation a worthwhile investment.

CHAPTER NINE

PREHISTORIC HORTICULTURE IN PALLISER BAY

It is now appropriate to review the significance of Palliser Bay stone walls. The structures span the period from the early 12th century to the early 17th century, although eleven of fourteen carbon-14 estimations fall before the 15th century. They occur on warm, friable, sandy loam soils with abundant stones, usually on the coastal platform and occasionally on river terraces up to 3 km inland. They were built with a variable amount of care, sometimes with single boulders meticulously positioned, sometimes merely by heaping up stones of all sizes into long, low mounds. It has been argued that they served as boundary markers and if conditions were excessively stony, as dumps for stones cleared from adjacent land. The ground between them was utilized for gardening, and the chief crop is believed to have been the kumara (Ipomoea batatas) both on the grounds of elimination of other prehistoric Oceanic cultigens, and of the positive suitability of Palliser Bay for kumara production. It is also argued that the more settled climate which prevailed for the first two to three centuries after settlement would have favoured the kumara even more without offering additional advantages to yam (Dioscorea sp.) or taro (Colocasia esculenta). The gourd (Lagenaria siceraria) may have been grown as a minor crop on stone and earth mounds to provide containers and a little food. The identity of the wall-builders, while not always obvious from the contents of the walls and gardens, can be determined from a few diagnostic artefacts such as an unfinished stone minnow lure, and a large quadrangular adze butt, as being of New Zealand's early East Polynesian culture, also known as Archaic or Moa-hunter. In terms of the species represented, the biological remains included in walls were consistently similar to those from adjacent Archaic middens.

With reference to the development of horticulture, a model is presented, but with the clear understanding that the data are at times insufficient for firmer conclusions.

The hydrological environment of Palliser Bay at the time of settlement was relatively stable, judging from particular marine

shellfish species found in the early middens. This state could not have existed without corresponding stability in water catchment areas. The land snail fauna at the Washpool Midden site provided convincing evidence that mature lowland forest extended coastwards at least as far as the Makotukutuku Valley mouth, if not on to the coastal platform (ibid.:200). Similarly the bird component of early midden layers at the Washpool, Pararaki mouth and Black Rocks is predominantly forest or forest-fringe dwellers (ibid.:194-5, 272, 275). The vegetation picture constructed on the basis of this evidence may be filled out by reference to modern studies (for example J.Wardle, 1967; Franklin, 1967; Druce, 1971; H.Leach and Hamel, n.d.) and some palaeobotanical analyses (B.F.Leach and Anderson, 1974; Yaldwyn, 1958). Drier slopes and spurs of the valleys carried black beech (Northofagus solandri) and possible small patches of mature kanuka (Leptospermum ericoides). Damper slopes and gullies were occupied by hardwood-podocarp forest, in particular mahoe (Melicytus ramiflorus), pigeonwood (Hedycarya arborea), titoki (Alectryon excelsus), and rewarewa (Knightia excelsa), and less commonly miro (Podocarpus ferrugineus) and rimu (Dacrydium cupressinum) (H.Leach and Hamel, n.d.).

On the coast, dune areas would have provided suitable habitats for sand-binders such as Carex pumila and pingao (Desmoschoenus spiralis). Where the sand was firmer, the sedge Scirpus nodosus may have been present with Cyperus ustulatus in damper hollows, and cushions of Hymenantha crassifolia covered with Muehlenbeckia complexa on small knolls and rocky ground. A few tussocks (e.g. Poa laevis) may have grown in this zone. Further back from the shore a mosaic of shrubland, kanuka, karaka (Corynocarpus laevigatus) and ngaio (Myoporum laetum) groves has been reconstructed, depending on the soil depth and degree of exposure. The shrubs would have included the Muehlenbeckia-Hymenantha cushions, and Coprosma crassifolium shrubs sheltering several herb species - Calystegia tuguriorum, Acaena anserinifolia, Diochondra repens and the fern Asplenium flabellifolium. A low forest of some of the hardier forest species could have grown in the most sheltered locations, including kowhai (Sophora spp.), cabbage tree (Cordyline australis), kawakawa (Macropiper excelsa), Coprosma rhamnoides, flaxes (Phormium tenax and P.cookianum), and tree nettle (Urtica ferox).

It would not have been difficult to clear large areas of the coastal platform for gardening. In dry summer weather the lack of a deep, moist litter layer such as that found in mature lowland hardwood-podocarp forest would assist burning off. In addition there were probably no tall podocarps to be chopped down or ring-barked in a previous season. Ease of clearance, however, would have been offset by unintentional destruction of the hillside vegetation with the result that gardens established at the foot of the slope would have faced the new problem of rock slides.

Important soil characteristics such as fertility, friability, and degree of stoniness would have varied from place to place on the coastal platform according to the position of the dry, stony beach ridges, the age of each ridge and hollow or alluvial fan, and the amount of shelter available. Naturally the higher and older zones receiving protection and silt wash from the hills would have promoted the densest vegetation, and this in turn would have further enriched the soil. Nevertheless soils formed on largely greywacke sands and gravels are normally only of medium or low fertility (Ward et al., 1964: 14, 19). They respond well to phosphate fertilisation and on the basis of the quantity available in wood ash from the burning of manuka scrubland (N.H.Taylor, 1958:76), two to three years cropping of kumara should have been possible following initial clearance.

It is difficult to estimate the fallow period needed to restore fertility in this area. Hamel's study of seral successions in the Makotukutuku Valley (H.Leach and Hamel, n.d.) established the importance of tauhinu (Cassinia leptophylla) in covering bare alluvium within two years of deposition. Within a decade manuka and kanuka (Leptospermum spp.) begin to grow up through the tauhinu forming a vigorous stand by about 25 years and killing the tauhinu. At the same stage ngaio and karaka seedlings enter the area depending on the degree of exposure and light. Near the exposed Cape Palliser, however, "the tauhinu scrub seems to hold a more permanent position on the coastal platform and kanuka is strongly invasive only on minor sheltered sites against the hill slope" (ibid.:13).

The amount of shelter of a particular garden area, provided by topography or the existence of patches of scrub or bush, may have played a crucial role in determining the length of the necessary

fallow period. Once trees were cleared from the widest areas of the coastal platform, it may have proved impossible to re-establish the full succession, and thus restore fertility. It is not known what nutrients could have been supplied by burning 2 - 3 m high tauhinu stands, but it is not likely that they are as well-endowed as taller manuka or kanuka stands. Thus yields from many areas would not have equalled those obtained in the first two to three cropping seasons. The estimates of fallow period used below allow the maximum re-growth time recorded ethnographically, 14 years (Best, 1925:74; K.Shawcross, 1967:344). It is suggested that even this may not have been sufficient in some coastal areas and a figure of 25 years is considered more realistic (Hamel, 1976: pers.comm.).

The mean temperature during this introductory period is believed to have been up to 1° or 1.5°C warmer than today. The weather was more settled, and although rainfall may have been close to the modern range, lack of wind coupled with night-time fog and mist during anti-cyclones could have resulted in greater humidity. Under modern summer conditions evapo-transpiration rates are high during the frequent northwesterly periods and this is the major obstacle to modern gardening, requiring elaborate fencing or shelter structures, and regular watering. The highest beach ridges in exposed areas like the Pararaki Mouth dry up by the end of December and support no vegetation for the next three months. Prehistoric garden plots extended on to these ridges and if these were at all productive, some change in the moisture regime must be inferred. Of the possibilities, decreased evapo-transpiration and/or higher humidity are preferred over increased rainfall, especially since Park (1970) has evidence of a lower watertable in the Tararua Range in the early 13th century. Higher humidity would prevail during spells of fine weather and evaporation would be kept to a low level in sheltered clearings in the middle of scrub or low forest.

Archaeological evidence from early habitation sites indicates that the settlers migrated to the Wairarapa from a northern or northeastern area where they had already forged exchange links with occupants of Northland, the Coromandel, and the Bay of Plenty (B.F.Leach, 1976:174-5, 325-6). Presumably they learnt the necessary techniques of raising and storing kumara as an annual crop in this warmer area. Even with a slightly warmer climate, overwintering a crop

in Palliser Bay would result in great losses because of the concentration of rainfall in the winter months and exposure to strong southerly winds. Occasional overwintering of kumara is recorded from Northland (Law, 1970: 115), Cape Runaway (Colenso, 1881:39) and Great Mercury Island (Edson, 1974:59), areas at least 500 km to the north, and far less affected by active cold fronts. It is possible that the migrants brought other food crops to the Wairarapa, such as taro and yam, only to find the growing season too short and possibly too dry to procure adequate yields. It has been argued earlier that pits in use at the Washpool Midden site share certain features with those at Kaupokonui, South Taranaki, and belong to a phase of experimentation with pit design when many shapes and sizes were utilized. The diversity of pits at Skipper's Ridge, Coromandel may indicate that the experimentation centre was somewhere on the northeastern coast. In the light of the information presented on the storage of yams, archaeologists working in coastal areas north of Hawkes Bay should not assume that all early pits were for kumara storage.

The relationship between garden area, crop yields, and population size has been explored in a number of ethnographic and prehistoric contexts in the Pacific (for example, Groube, 1970:159, 162; Waddell, 1972:43, 116-7; Green, 1973; Bellwood, 1972:40-44; Emory, 1928:12). These suggest various ways of estimating population size from the total and annual amounts of land involved in a horticultural system. In a continuous kumara cropping system operated by the Raiapu Enga in Highland New Guinea, 0.14 - 0.17 ha per head of population was used for gardening each year, with soil fertility maintained by composting (Waddell, 1972:42-3). In this area gardening provided all the vegetable part of the diet and supplied extra kumara for pig raising. Using a range of cultivation cycles from 2/5 to 2/8 crop/fallow ratios Green assessed likely per capita figures of root crop land in Tonga as from .129 ha to .16 ha annually, and on an average $.729 \pm .081$ ha for indefinite cultivation. If applied to low fertility soils in Palliser Bay this figure could be viewed as an extreme minimum. Thus from the total area encompassed by Palliser Bay walls from Whatarangi to Cape Palliser (93.4 ha), it may be estimated that the population could not have exceeded 128 persons without supplementary foods.

Botanical studies suggest that the bracken fern (Pteridium

esculentum) is rare if not absent in most parts in the Aorangi Range. The cabbage tree (Cordyline australis), however, is common on the coast and in the lower reaches of the valleys, and may have been an important vegetable supplement. It is also possible that prehistoric New Zealand groups derived more of their calorific intake from meat and fish than the inhabitants of tropical Polynesia. In these circumstances the use of tropical standards to judge New Zealand group sizes is potentially most misleading.

Another approach is to estimate carrying capacity of a particular garden area from the following variables: cropping period, length of fallow, yield, proportion retained for seed, storage losses, and proportion of diet. This is closer to Bellwood's method (1972) and is probably more accurate for restricted areas than an overall land use statistic. Of course the only variable on which there is archaeological evidence is the area under cultivation and even this cannot be measured accurately unless clear natural barriers delimit the garden area. Although the value for each variable is necessarily a guess, the range of values can be satisfactorily assessed from many sources including human nutrition, ethnography, and agronomy (c.f.W.Shawcross, 1970:282). Typical kumara yields and storage losses have been outlined earlier (p.154) as well as fallow and cropping periods (p.179). On the basis of the lower range of 'peasant' kumara yields, a figure of 10t/ha was selected as a best estimate rather than the average of 17.9t/ha. Even commercial production in New Zealand has a lower average (15.5t/ha). A range from 5 to 15t/ha should cover New Zealand prehistoric yields. Storage losses may have varied from 10% to over 50%. In view of Yen's low losses with Maori varieties and the method of harvesting employing hands or wooden tools rather than metal prongs and tines, tuber damage and ultimately losses are believed to have been comparatively low - about 10%. No range of weights for re-planting material is known. It will be assumed that the modern recommended figure of 2t/ha is relevant. The low to moderate fertility of soils in Palliser Bay suggests that the ethnographically recorded maximum fallow period of 14 years should be used, although the range might have been 7 - 25 years. A cropping period of 3 years may have been successful after initial land clearance. After fallow it is doubtful if two years' cropping would have been possible without significant reduction in yield. Overall a figure of 2 years is selected as a best estimate. Proportion of diet is probably the most difficult to estimate. If minimum daily calorie

requirements of an active adult are set at about 2000 (Bellwood, 1972: 41-2), the individual would need to consume 1 kg of sweet potato to supply half his needs (1000 calories). Taking into account a period of three or four months when kumara was immature, his average kumara consumption might not exceed 700 gm per day. This figure is chosen as a best estimate - the range might be from 200 to 1000 gm. Even with the higher value a significant amount of energy would still have to be supplied from other foods.

From these estimates the population carrying capacity of each major garden complex has been calculated (for details see Appendix 4). These figures are consistent with adjacent settlement size (B.F. Leach, 1976:314) and probably with midden content, although no calculations of meat weights were attempted. If it is assumed that all complexes were in use from the earliest period, the maximum number of people supported by gardening, fishing and hunting in this area would have been 319. If, however, only the major complexes of Makotukutuku, Te Humenga-Pararaki, Kawakawa and Black Rocks were utilized during the first two centuries, as the carbon-14 estimations tend to suggest, the population estimate would be reduced to 225. At a later period newly cleared garden areas may have supported 94 persons, together with an unknown number utilizing portions of the earlier complexes such as the northern fan at Black Rocks, or the Washpool river mouth gardens.

The possibility that a portion of the kumara crop was exported as part of an exchange network has been discussed by B.F. Leach (1976:310). This would further reduce the population estimate for Palliser Bay. In support of this claim is the evidence of argillite adzes transported in roughout form from the Nelson-Marlborough area, with no sign of North Island resources, except obsidian, in the contemporary South Island sites. Furthermore, the dentition of possible trading partners at Wairau Bar indicates a soft and non-abrasive diet, in sharp contrast with the marked tooth wear of individuals from Palliser Bay (*ibid.*:297, 305). A possible interpretation of this evidence is that the South Island communities with both the necessary skills and raw materials to make large adzes, obtained sufficient kumara from their trading partners to last for most of the year, while the northern groups suffered a much longer period of vegetable shortage and a harsher diet of wild roots

and rhizomes.*

From the limited information on garden age and settlement pattern there are signs of decreasing population after the first two or three centuries of occupation. Likely and inter-related factors in this decline are the effects of vegetation loss on the regenerative powers of coastal soils, climatic deterioration, failure of certain marine resources following erosion, and operation of an unsuitable horticultural system which did not allow sufficient fallow. It seems likely that the dangers of burning off vegetation in a naturally unstable greywacke area were not appreciated and this may imply that the swidden techniques employed by these communities prior to settlement of Palliser Bay had been applied in an area of higher rainfall or humidity and more stable landform. The eastern Bay of Plenty or the Coromandel Peninsula and its offshore islands could have been such areas.

Horticulture in Palliser Bay appears to have much in common with dry land gardening in many islands of Polynesia. Garden preparation was similar, with the removal of existing vegetation by fire and the setting out of a system of narrow rectangular plots marked by trenches, stone alignments or rows, and logs or natural features, often with marked pathways. In view of the ubiquity of the small kumara mound in East Polynesia and 18th century New Zealand, which is commonly referred to as puke, it is likely that in Palliser Bay gardens also, small hillocks were raised up using the basic digging stick (ko) and the tuber pieces were planted in them. One important change from tropical techniques of kumara horticulture was the use of setts instead of slips for planting (qv. Yen, 1961:338-9). This was not a complete innovation, however, as the yam is normally reproduced from setts throughout the tropics, and it is possible that for several centuries after the introduction of the kumara into East Polynesia from the Americas, it was treated as a form of yam. Stem cuttings may have become more usual in a later period. It should be remembered that yams were grown in puke in 18th century Anaura Bay (p.116) as well as on Easter Island (Métraux, 1940:155).

*Footnote

It has been suggested that kumara was a prestige food of little dietary significance in some parts of New Zealand. This suggestion and that of export of a large proportion of the crop may be rejected in the Wairarapa where storage pits indicate local consumption of much of the crop.

The puke probably served initially to prevent the kumara or yam from rotting in wet ground. In low rainfall areas into which Polynesian horticulture was introduced, the practice continued, in particular in eastern New Zealand, Easter Island and parts of the Hawaiian chain. The soil moisture deficit to which mounds would have become prone in these drier areas appears to have been minimized by mulching. In New Zealand, Easter Island and Hawaii dry grass mulching was recorded, while the use of a layer of stones around taro, kumara and yam in Easter Island has been described by Yen (1974: 145-6) and Métraux (1940:154).

The functioning of gravel and stone mulches in modern agriculture has been studied by Corey and Kemper (1968). In one experiment they found that a 5 cm thick gravel mulch

"resulted in an additional accumulation of 14 inches [355 mm] of water during one year, as compared to that which accumulated under the bare soil"

(ibid.: i)

Unlike plant residue mulches which absorb water and conduct it upwards from the soil, gravel mulches if correctly applied act as a one-way valve, permitting water to pass in a downward direction only. The basic criterion in determining the type of layer is that the

"mulch should not contain a substantial fraction of particles smaller in grain-size than the larger grains of the underlying soil i.e. nearly all the pores of the mulch should be larger than the largest pores of the soil below"

(ibid.:14)

From archaeological evidence alone it will prove difficult to decide whether sand or gravel additions in New Zealand prehistoric gardens were initially water-conservation devices mixed into the topsoil during later cultivation or worm action, or had been introduced as soil-conditioners to warm the ground and improve drainage. Nevertheless the moisture-retention practices of tropical Eastern Polynesia suggest the former function may have been most familiar to early New Zealand gardeners.

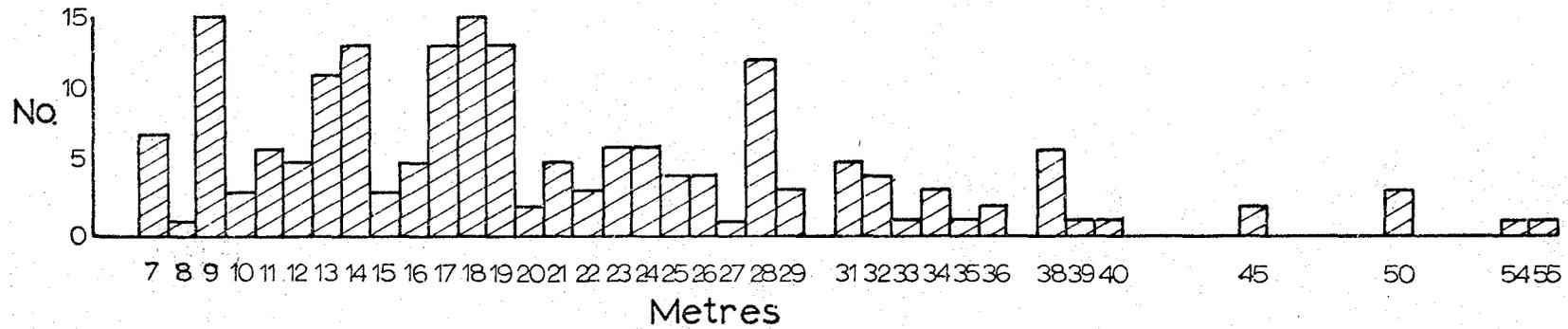
In an earlier chapter (p.106) some rules of land division and use were inferred from garden layout in Palliser Bay and these were later shown to be similar to those of 18th century Hawaii (p.140).

The means whereby the division took place is obscure, and in general, little detailed information is available on Polynesian mensuration, with the exception of tapa measuring techniques involving hand and finger-based units (Tamahori, 1963:92-4). Although the measurement of plot width was complicated by lack of parallelism, or horizontal spread of the boundary walls, an attempt was made to determine if a consistent unit of width and its multiples had been used in the Palliser Bay gardens. In ethnographic literature on the Maori two measurement units which may be relevant were the maro and takoto. The maro like the West Polynesian ngafa (Koch, 1961:136) was the distance from fingertip to fingertip with both arms extended, approximately 1.8 m. The takoto was the length of the prone body plus that of an arm outstretched beyond the head (about 2.2 m). Superficial examination of the range of plot widths showed that none were less than 7 m and only a few exceeded 40 m. Within this range there were major peaks at 9, 14, 18, and 28 m, which might give the impression that two systems were operating, based on multiples of units roughly equivalent to 7 and 9 m (see Figure 44). In no major wall complex did one system operate to the exclusion of the other. A more systematic analysis of the same data (see Appendix 5) led to the identification of two smaller units of which the plot widths were multiples (Figure 45). One lay between 1.7 and 1.9 m, apparently centred about 1.80 m, and the other between 2.1 and 2.4 m, with a centre at 2.25, a rather striking similarity with the ethnographic units maro and takoto (about 1.8 and 2.2 m respectively).

Unfortunately because of errors in original wall layout coupled with errors of measurement from field plans, it is not possible to decide if a particular plot was laid out in maro or takoto units. If more precise field measurements can be obtained, however, it may be discovered that some of the sections of major complexes are exclusively of one system of measurement, thereby raising the possibility of a change through time or the preference of particular groups of people for different systems of measurement.

There is a possibility that in the process of laying out a garden area individual plot size was not determined by multiplying the basic units, but by taking whole number fractions of a larger distance (for example $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$). While this may be foreign to European concepts of surveying, it can be achieved simply and accurately, with

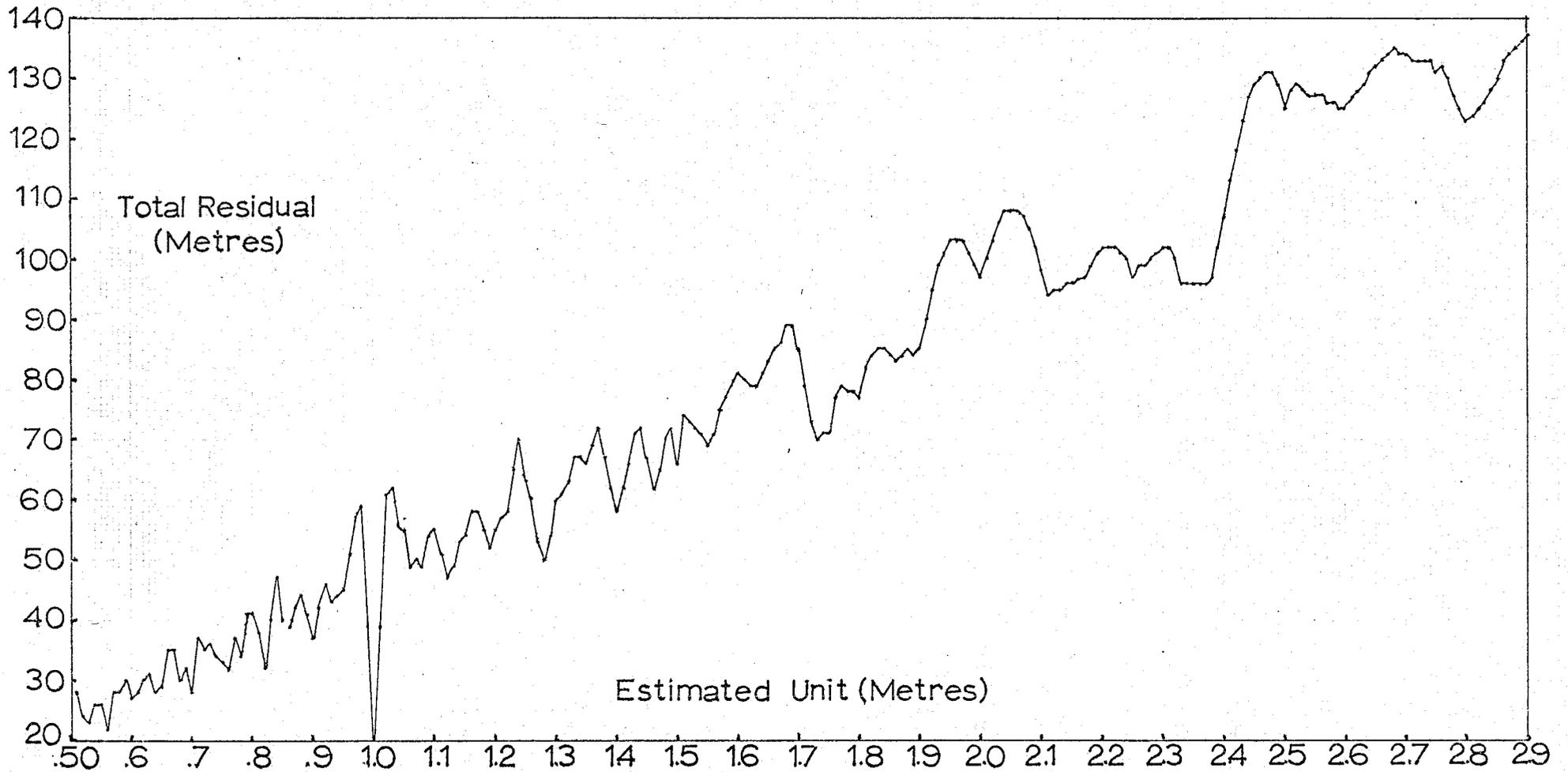
FIGURE 44



DISTRIBUTION OF PLOT WIDTHS IN MAJOR WALL COMPLEXES

FIGURE 45

ESTIMATING PREHISTORIC MEASUREMENT UNITS BY RESIDUALS



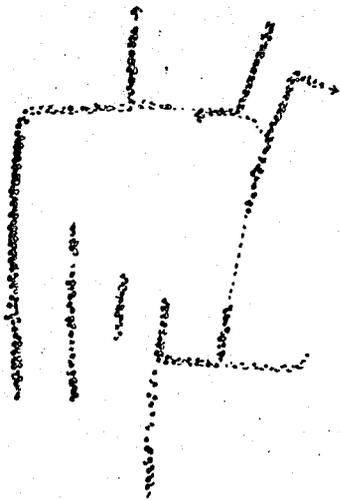
the aid of a cord the same length as the piece of land to be divided. In fact the actual measurements of the cord need not be known. To divide a block into halves, the cord is laid out over the full length and then one end is brought back to the other. When it is approximately in position the two sections of cord can be tightened and the bend in the cord then represents the mid-point. The same procedure can be followed, with the addition of an extra bend to achieve division into thirds. Quarter shares may be obtained by halving the half shares, and thus the method can cope with any desired fraction. In this type of system the measurements 9, 14, 18 and 28 m would represent division of 28 m blocks into two of 14 m and division of 18 m blocks into two of 9 m. Inspection of field plans reveals many examples of subdivision of areas into two and occasionally into three or four equal segments. Some of these are illustrated in Figure 46. This explanation of plot sizes accords with what is known of land rights and inheritance throughout Polynesia. For example, in Tikopia

"The general principle followed is to divide either the ground in each orchard or to allot the separate orchards between the sons in a family after the death of their father."

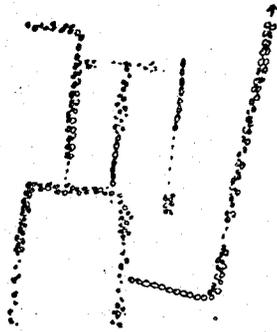
(Firth, 1957:390)

If it were possible to identify all the subdivisions of particular plots instead of just those marked by stones, some idea of the number of children inheriting rights to land in each family might be obtained. This need not imply that blocks were used for periods of time spanning more than one generation. On the contrary, the minor subdivisions may have been created in the same season as the major blocks were cleared. In such a case they might mark individual responsibility for weeding and plant care within a framework of a larger family holding.

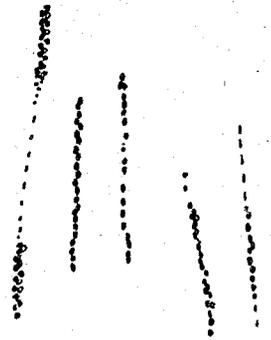
The course of prehistoric horticulture in Palliser Bay seems to follow trends established from midden analysis at Black Rocks (Anderson, 1973) and the Washpool (B.F. Leach, 1976). Progressive impoverishment is evident in marine and forest fauna and analysis of land-snails at the Washpool has documented the replacement of coastal and adjacent lowland forest by low open vegetation (*ibid.*:200-1). Several of the major wall complexes at river mouths appear to have been abandoned some time before serious river flooding commenced and fan



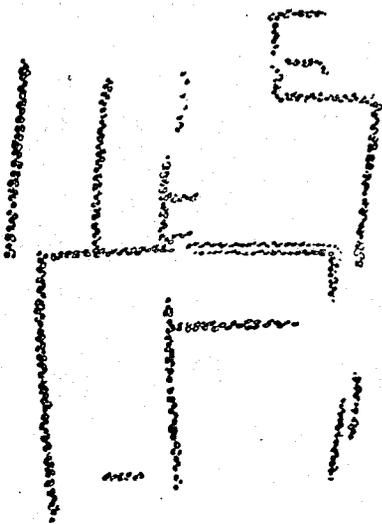
WAIHERO



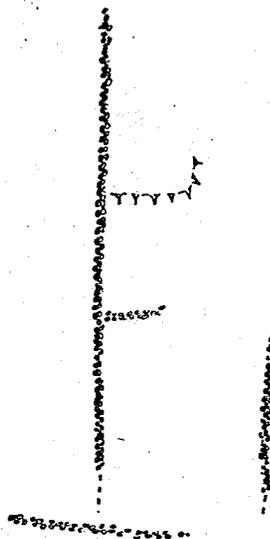
WAIHERO



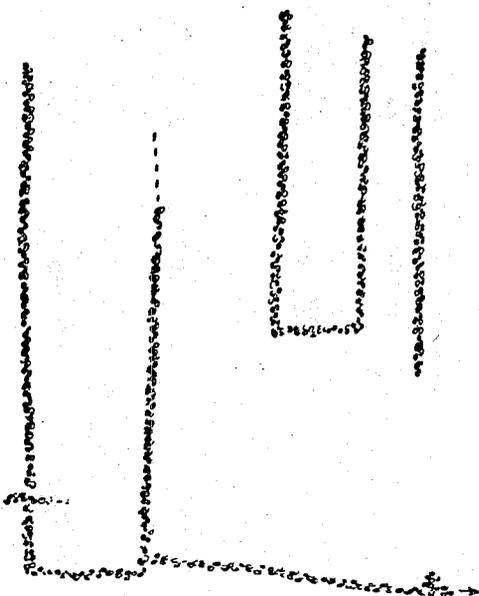
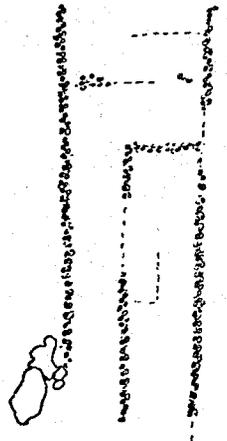
TE HUMENGA



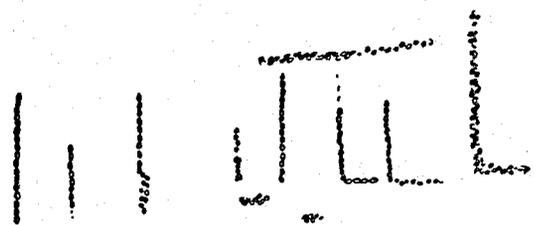
SOUTH PARARAKI



TE HUMENGA



BLACK ROCKS



WASHPOOL

FIGURE 46



activity accelerated (for example, Te Humenga and North Pararaki). This may be an indication that the fallow period had not proved adequate. New ground was cleared including shallow less favourable soils on consolidated fans (for example Black Rocks) and any beach ridge areas not close to the major rivers (for example Whatarangi and North Waiwhero). Neither these nor the complexes with 12 - 14th century age estimates are associated with rectangular raised rim pits. The implication is that this fashion of kumara storage was adopted or introduced at a later time, a view which accords with direct dating and dating by association of such pits in the Makotukutuku Valley. Eleven wall complexes encompass rectangular raised-rim pits and all are in the area of the Kawakawa Valley, South Kawakawa coastal strip and South Waiwhero-Ngawi Bay. They are consistently small, usually less than one hectare, and as described earlier, appear to have been less carefully laid out. The coastal examples all occupy portions of consolidated fans. Without a further series of carbon-14 determinations their position in the Palliser Bay sequence must remain tentative. Nevertheless the unprotected position of the pits on the edge of gardens suggests that enemy raids were not anticipated.

The role of garden and pit sites in the overall settlement pattern still requires clarification, particularly in later phases of prehistory. Despite many uncertainties, a sequence is presented below. Although some details of chronology and location may be modified by future research, it is believed that the general trend away from elaborate garden systems and away from horticulture itself has been correctly identified. It should be stressed that this reconstruction applies only to coastal Palliser Bay.

Century AD	Garden Location	Pits	Garden Types
12th-13th	Large gardens on raised beach deposits of coastal platform, at mouths of major rivers - occasionally on river terraces	Narrow, rectangular pits and possibly other varieties within coastal settlements adjacent to gardens	Narrow, rectangular plots on flat or slopes, large mounds, terraces, rows, trenches and alignment boundaries
13th-15th	First use of consolidated fans, and raised beach deposits away from river mouths; progressive abandonment of earlier complexes	? Several types still within coastal settlements	" "
15th-16th	Proliferation of small, isolated gardens on semi-consolidated coastal fans and river terraces	Rectangular raised-rim pits adjacent to coastal and valley gardens or to inland house terraces	" "
16th-17th	Small gardens close to defensive positions	Rectangular raised-rim pits in hidden or defensive locations	Simple rectangular plots with no wall subdivisions - stone rows but no alignments
18th	VIRTUAL ABANDONMENT		
19th (c.1840- 1850)	Re-use of river mouth areas for European crops	Circular raised-rim pits near gardens and river mouth settlements	Some free standing stone walls elsewhere (e.g. Fitzroy Bay)

CHAPTER TEN

CONCLUSIONS AND IMPLICATIONS

The principal objective of this dissertation, which was to establish the function of the stone walls of Palliser Bay within a full cultural context, has been accomplished within the traditional constraints of archaeological enquiry. During the analysis, however, several issues were touched on which are relevant to studies of prehistoric gardens elsewhere in New Zealand, and even to aspects of East Polynesian prehistory. They are not strictly conclusions of the Palliser Bay research, rather more implications, and as such their validity must await testing in future programmes. They cover aspects of the methodology of horticultural archaeology, the potential of this new field of study, D.Yen's models of horticultural development in New Zealand, and the introduction of kumara to Eastern Polynesia.

Although the archaeology of horticultural features received scant attention from Pacific prehistorians until the Hawaiian and New Zealand field-system programmes began in the late 1960s, it has in a short time proved capable of illuminating aspects of social and economic behaviour which are not represented in other types of site. Perhaps the most unexpected of these were concepts of land ownership and use exemplified in boundary markers, different levels of subdivision of tracts of land, and pathways. Paths, or 'trails', are capable of providing the normally elusive information on contemporaneity which settlement archaeologists have to obtain by cutting long sections. Unlike the section they can supply a cultural link over several kilometres.

It is of some significance that the major field programmes have concentrated on garden plot systems where the boundary markers are visible on the surface. Admittedly it would not be feasible to excavate whole buried fields in the search for garden structures, yet a large proportion of prehistoric gardens must lie unrecognised beneath alluvium. Many thousands of pit sites in the North Island testify to the proximity of such gardens. In the search for horticultural evidence site location devices such as the proton magnetometer, may have an important future role. Instruments capable of detailed mapping

from above surface will be necessary if the buried gardens are to be examined without the expense of excavation. Already infra-red photography has proved useful in revealing partially obscured features (Newman, 1970:137).

In the Wairarapa, mapping of large areas was facilitated by working directly from aerial photograph enlargements together with systematic field checking. In retrospect it is apparent that the method should have been followed in selected areas by more detailed surveying, in order to obtain measurements of plot width accurate enough for identification of the original units of measurement. The more detailed survey would in many cases need to be accompanied by small excavations to determine the true position of each boundary line. Even at this stage, however, a correlation with two ethnographically recorded units of measurement has been established.

Beyond the Wairarapa it may be possible to identify and study slope gardens seen by 18th and early 19th century explorers, and by comparison to evaluate the evidence of swiddening in earlier gardens. As more field systems utilizing trench boundaries are identified from the northern part of the North Island, they too may provide valuable comparative data on land use and ownership. Eventually it is hoped that data on community size and area under horticulture will accompany every regional report.

As indicated earlier, direct identification of food plants is seldom possible. In this field progress may be aided by plant crystal analyses (p. 147) and by identification of significant quantities of charcoal. Even if the charcoal is only rarely found to derive from cultigens, a picture of vegetation on and around the garden areas will emerge which may answer such important questions as "how long was the fallow period?" or "how easy was it to clear the garden initially?". As has been shown, complementary data can be obtained from land snail analysis.

One of the advantages of a programme conducted in a horticulturally marginal area is that methodological deficiencies such as a lack of charcoal identification or failure to find carbonised portions of the crops can be overcome by eliminating possible cultigens on the basis of their physiological needs for warmth and

moisture. Thus it has been possible to establish that of all the Polynesian cultigens, modern conditions in Palliser Bay would support only the kumara and gourd. Naturally a careful assessment of prehistoric climate is required if the conclusion is to be considered valid for an earlier period. Climatic variation is sufficiently marked in parts of island Polynesia for the same method of elimination to be used, again with due consideration for climatic change (for example, Yen, 1974:316). Climatic variation between leeward and windward zones of high islands often encompasses the crucial moisture thresholds of yam and taro, a factor which as yet has been utilized only in Hawaii. Systematization of this method is seen as an important step, especially the establishment of the limiting conditions on the growth of other food plants besides taro, yam and kumara.

There is little doubt that the archaeology of horticulture has much potential in Pacific studies. Before this can be realised, however, some adjustment may be needed in site surveying methods. In Easter Island, for example, the concentrated efforts of Heyerdahl, Ferdon and others (Heyerdahl and Ferdon, 1961) ignored or failed to recognise field systems which were apparent to the experienced observer Yen (1974:145-7). Of course the scale of horticultural sites is often different from the habitation site, and the more appropriate site location technique might be detailed analysis of aerial monochrome or infra-red photographs rather than on-foot surveys. In densely vegetated areas, however, ground reconnaissance will still be the only means available.

With the completion of the Palliser Bay research, it is an appropriate time to return to Yen's pioneering paper on prehistoric kumara horticulture in New Zealand, and to ask whether his model of adaptation of a tropical system needs revision. One aspect of the original publication has been changed by Yen himself. Following Law's (1970) enumeration of underground storage and fermentation devices in many parts of tropical Polynesia, the claim that "the agricultural procedures established in New Zealand did not have parallels in any putative area of provenance in Polynesia" (Yen, 1961:338) could no longer be made without qualification (see Yen, 1974:285-6, 300). Yen maintains that the transformation of a perennial plant to an annual was "an innovation of some magnitude that could not have been arrived at

by a sudden and inspired agricultural deduction" (Yen, 1961:339 c.f. 1974:301). Although semi-subterranean food storage and fermentation techniques may have been included in the early Polynesian repertoire there is no hint in archaeological or ethnographic literature that kumara was ever harvested in bulk and stored in pits for 6 - 7 months in any tropical island. Such prolonged storage was simply not necessary, and in view of the prevailing temperatures could not have succeeded without refrigeration to temperatures below 15°C to prevent vigorous sprouting and weight loss.

The claim that propagation by small tubers was a New Zealand innovation is perhaps less certain. Unfortunately it cannot be discovered (at present) whether stem propagation or root propagation was normal in early Polynesian horticulture. In view of the yam planting techniques, however, it should not be assumed that the modern method was always followed (see p.183). Furthermore Yen himself pointed out that Polynesians are aware of the kumara root's reproductive function (1961:338).

A more favourable climate at the time of introduction was regarded as an important factor in the successful adaptation of the tropical horticultural system, allowing sufficient time and stimulus for innovations to occur as deterioration set in. The convincing demonstration from many sources that the New Zealand climate was in fact more settled for several centuries after the presumed arrival of Polynesians in the 9th or 10th centuries A.D. gives even more time for consolidation and experimentation than Yen could allow for in his model. His "significant deterioration after 1200 AD" may now be advanced to at least 1400 AD.

One of the most interesting aspects of this paper was his unwillingness to follow the orthodox view that kumara was introduced by the 'Fleet Maori' about 1350 AD (Duff, 1956:17). In 1961 the only evidence to support him was Golson's tentative correlation of pits at Sarah's Gully with Archaic deposits (1959:45). Wairarapa, Coromandel and Auckland evidence has now vindicated these early claims, including that of Adkin for the Wairarapa itself.

In the light of the new evidence on the antiquity of garden complexes and the extra time available before climatic deterioration set in, there are grounds for elaborating the original three stage model

proposed by Yen. Following the introduction of a range of Polynesian cultigens as well as a wide repertoire of gardening techniques such as grass and gravel mulching, stem and tuber propagation, terrace and slope gardens, and mound and basin cultivation, an initial stage of experimentation may have followed during which short-term storage devices for yams and kumara were developed within the village to protect the tubers from the damaging effects of heavy winter rains. This permitted a stage of expansion southwards along the east coast as far as the Wairarapa and probably through Taranaki into the Horowhenua area. Regional consolidation is then apparent with the development of local preferences for various pit styles such as the rua or the rectangular raised-rim pit capable of storing large quantities of kumara for many months. The raised-rim style seems to have spread from its eastern point of origin into northern parts of the South Island along with simple garden plot layouts involving stone walls. This stage of consolidation and expansion from secondary centres may be equivalent to Yen's third stage of systematic agriculture. Next, a stage of retrenchment may be postulated, during which gardens in the marginal areas of New Zealand were abandoned, for example the coastal Wairarapa, the Marlborough Sounds and the Kaikoura Coast. In the north some areas may have been unaffected by this contraction, although it has been argued that the proliferation of pa in favourable locations in the North Island was the result of increasing pressure on land. In the 19th century there are signs of a horticultural revival, taking advantage of new tools and crops, especially the potato while at the same time propagating the more successful prehistoric species such as kumara and taro. During this stage more vigorous varieties of these two species introduced by whalers and other visitors appear to have become dominant allowing an extension of taro cultivation on to the west coast of the South Island where it was found in potato patches.

As with any stagal model it is not necessary for each stage to be reached simultaneously in each area. In this case, probably only restricted northern or northeastern localities witnessed the introductory and experimental stages. Judging by the Wairarapa evidence expansion had occurred by the 12th century and regional consolidation is evident on the east coast by the 15th century, possibly earlier on the west. If retrenchment is correlated with marked climatic deterioration, this

stage would have been reached uniformly in the early 17th century. The model may be set out in tabular form to demonstrate the chronological relationships:

<u>NORTHERN AREA OF INTRODUCTION</u>	<u>WAIARAPA</u>
AD 900 Introduction	
1000 Experimentation	
1100 Expansion	1100 Expansion (from northern area)
1200 Regional Consolidation	1200 Regional consolidation
1300 Consolidation	
1400 ?Secondary Expansion	
1500 Expansion	1500 Secondary Expansion (from E. Coast)
1600 ?Retrenchment	1600 Retrenchment
1700	
1800 Revival	1800 Revival

At present the secondary centres of expansion cannot be identified. There is, however, evidence from variety names collected in the 19th century of distinct regional groups. Colenso (1880:34-5) listed 32 kumara names from northern districts, "namely - Bay of Islands, Hokianga, and Kaitaia" and 21 names from "Hawke's Bay and on the East Coast". Only 5 names were duplicated. A later list of 25 names compiled by Williams (1894:144) for East Cape contained 15 which did not appear in Colenso's list, 5 of which were duplicated in the northern list, 4 which appeared in both northern and Hawkes Bay lists, and only one which was shared exclusively with the Hawkes Bay list. Hammond's (1894) compilation for Patea, South Taranaki included 6 new names, 4 shared with Colenso's northern and eastern lists, and 2 shared with his eastern list.

If it is assumed that only a few varieties were originally introduced into New Zealand, a stage of regional consolidation is needed to give sufficient time for the proliferation of varieties by seed, or more likely, bud mutation, and to give rise to regionally distinct kumara collections. This need not have been more than a few hundred years, for bud mutation is relatively common in the kumara (Coleman, 1972:33-5). With individual handling of tubers at planting and harvesting time (an important characteristic of horticulture as distinct from agriculture *qv.* Barrau, 1965:56), what are considered to be desirable new varieties can be increased rapidly. At the same time unconscious selection was taking place for kumara that stored well,

and from the practice of planting small whole tubers, selection for plants that produced abundant small tubers rather than fewer larger ones. The tuber selection procedure may also have led to a progressive increase in disease in kumara varieties, for "diseased plants will produce a high proportion of small tubers" (Coleman, 1972:34). Certainly all European visitors commented on the small size of Maori varieties. Yen (1974:217-8) found that resistance to cold was not marked in his Maori varieties, an indication that over-wintering in the ground (and thus selection for hardiness) was not a significant practice here as it is in the New Guinea Highlands.

At the time Yen published his major essay on the Oceanic history of the kumara (1974) he did not have proof of its early introduction into New Zealand, or other marginal island group of Polynesia, to tie down the time of its arrival in Oceania. He was obliged to assume that

"in estimating the plant's first date of arrival in the Pacific, that the human population of New Zealand, Easter Island, or Hawaii was the result of a single contact"

(ibid.:330)

Similarly he was only able to regard its inclusion in the "original agricultural cargo to peripheral Polynesia" as a "possibility" (ibid.: 331). The Wairarapa evidence of gardening, under circumstances which preclude other Polynesian cultigens except gourd, by communities bearing the stamp 'New Zealand East Polynesian' and at a time (from about the 12th century AD) close to the settlement of New Zealand, is as close to proof of Yen's contention as may ever be obtained.

APPENDIX ONE - Horticultural Sites in Palliser Bay

Site Number: this refers to the New Zealand Archaeological Association Site Recording Scheme number relevant to the New Zealand Map Series 1 (NZMS1) maps

Grid Reference: the North-South co-ordinate followed by the East-West co-ordinate on NZMS1 maps

Map NZMS1 N165

<u>Site Number</u>	<u>Grid Reference</u>	
6	746037	Natural terrace above Hurupi Stream reputed to have had stone walls, ditch and midden
9	737066-754051	Moikau Valley terraces and river flat. Stone rows, alignments, pathways, mounds, raised-rim and other pit types, houses (qv.N.Prickett, 1974)
12	641109	Kiriwai, on western edge of Lake Onoke. Stone rows on narrow strip of land between hills and lake. Now destroyed.

Map NZMS1 N168-9

<u>Site Number</u>	<u>Grid Reference</u>	
5	803828	Enclosure formed by stone rows. Part of Cape Palliser complex
6	805828	'Made' soil, part of Cape Palliser complex
14	736993	Modified soil, sandy with charcoal enrichment at northern end of Whatarangi complex
16	736990	Whatarangi wall complex including raised beach ridge known as 'Great Wall of Whatarangi'
18	734985	Traces of stone rows and modified soils south of Whatarangi Stream
19	737980	Modified soils buried by alluvial fan at Whatarangi Woolshed. Possible walls
20	735974	Washpool wall complex on coastal platform between Shag Rock and Makotukutuku River. Part of area known as M1. Stone rows, alignments, modified soils. Adjacent to Archaic settlements
24	735967	Horticultural terraces on north bank of Makotukutuku River, close to circular raised-rim pits
25	736966	Modified soils and possible rows and terraces partly obliterated by alluvial fan on coastal platform on south bank of Makotukutuku River

<u>Site Number</u>	<u>Grid Reference</u>	
26	743971	Stone rows and mounds, and possible terrace garden in Makotukutuku Valley (M2). Known as the 'Cricket Pitch'
29	756978	Stone rows and mounds on consolidated fan. Known as 'Cross Site' (M4). Habitation terrace and pit overlooks site
35	731946	?Stone rows and modified soils, possibly ovens, beneath recent alluvium in Hamenga area
36	729943	?Garden terraces on northern side of Hamenga homestead on consolidated fan
37	729938	Stone rows close to hills south of Hamenga homestead
39	727932	Te Humenga wall complex; many rows and alignments
41	732924	North Pararaki wall complex; rows, alignments, walls containing midden, mounds, modified soils
46	737919	South Pararaki wall complex
48	752918	Possible walls near trig NN WAVE
50	750905	Isolated rows on inland side of terraced ridge, on north bank of Kawakawa River (Otakaha)
52	747904	North Kawakawa wall complex on coastal platform
54	752902	Small wall complex beside Kawakawa homestead on south bank of Kawakawa River
55	751898	Possible walls on consolidated fan overlooking 3 raised-rim pits, South Kawakawa coastal platform
57	757899	South bank, Kawakawa River. Possible walls partly buried by shingle
58	758900	Possible garden terraces and raised-rim pits on river terrace, South Kawakawa
59	760900	Stone rows on river terrace, South Kawakawa with rectangular raised-rim pits along edge of adjacent gully
61	763900	Stone rows and rectangular raised-rim pits on river terrace, South Kawakawa
63	748893	Stone rows partly obscured by alluvium on consolidated fan, coastal South Kawakawa
64	752890	Stone rows and raised-rim pit close to hillslope, coastal South Kawakawa
65	751888	Stone rows on consolidated fan, coastal South Kawakawa

<u>Site Number</u>	<u>Grid Reference</u>	
66	753884	Stone rows and possible pit close to hillslope, coastal South Kawakawa
68	751874	North Waiwhero wall complex on coastal platform
69	753868	South Waiwhero complex on south bank of Waiwhero Stream
71	759864	Stone rows and pits on edge of consolidated fan, close to hillslope, South Waiwhero
72	761860	Stone rows and pits on northern side of creek at north end of Ngawi township
74	759857	?Stone row buried by alluvial shingle in Ngawi
76	762843	Black Rocks wall complex on coastal platforms and consolidated fans
79	782837	Mangatoetoe wall complex on coastal platform south of Mangatoetoe River
81	795831	Stone rows on slope at northern end of bay including Cape Palliser and Cape Palliser Lighthouse, part of Cape Palliser complex

APPENDIX TWO - pH Measurements at the Washpool Walls Site (N168-9/20,
M1/XI-XXVIII)

Before excavation commenced 10 g pH samples were collected from a depth of 10 cm every metre over the 30 x 15 m grid. A 1 : 2.5 soil suspension of each sample was prepared with distilled water and left overnight in a constant temperature. Following the method outlined by Metson (1961:20-22) the samples were measured with a glass electrode pH meter and the values appear in Figure 47.

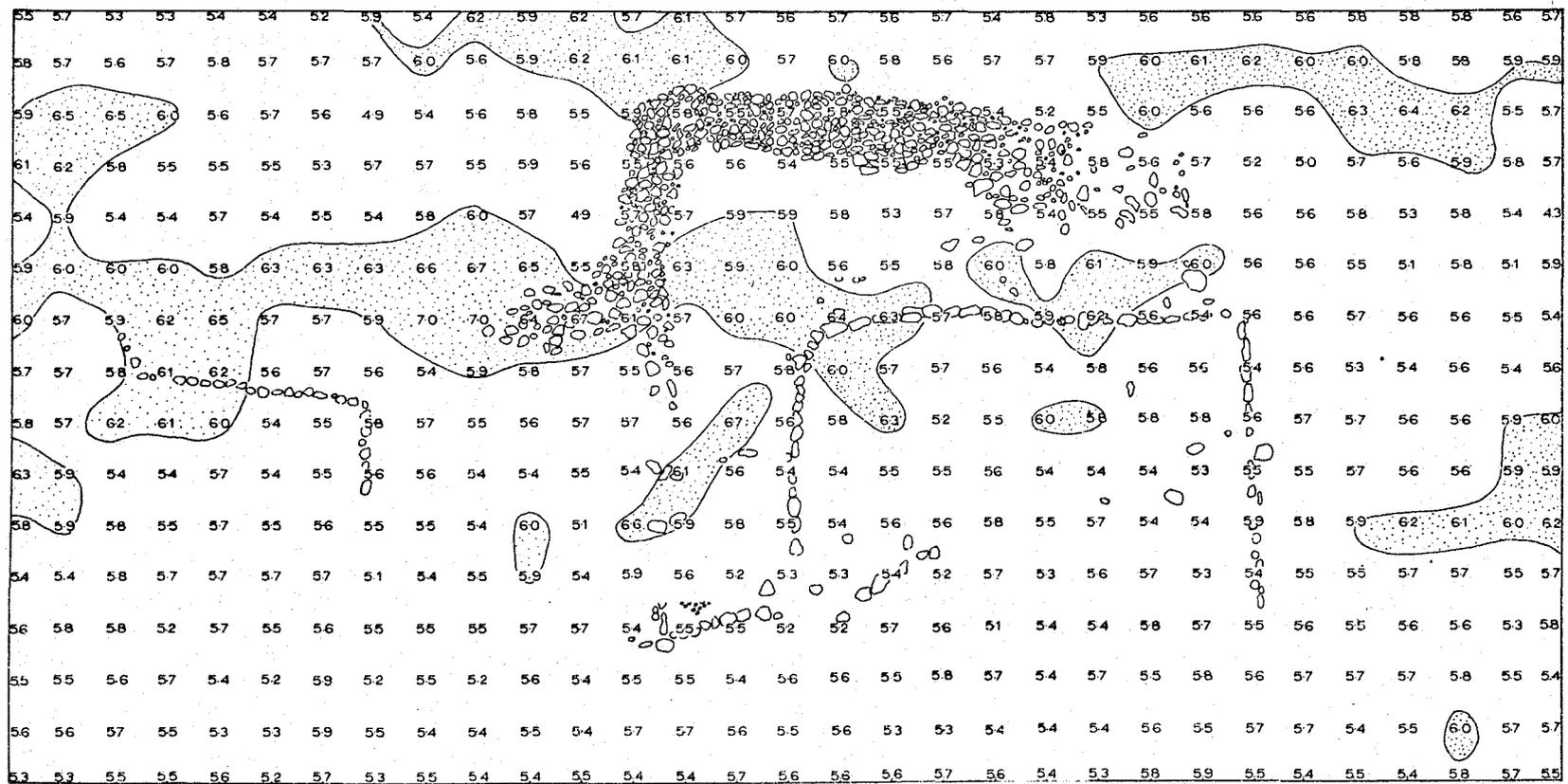
The test was conducted to determine if pH values varied with respect to the stone structures lying within the grid. If for example, pH had approached neutrality on one side of the stone row, but had remained at a more 'normal' range of acidity on the other, this might have indicated that the wall marked the restriction of cultural activity, involving modification of soil properties, to within the enclosure. In retrospect, two factors that were not taken into account may have reduced the value of the test considerably. Firstly samples were taken just below the grass root mat from a soil zone which sometimes included prehistoric material, but was often several centimetres above the prehistoric cultural layer. Secondly, the effects of European farming practices on local soil pH values were not explored.

A few tentative conclusions may be drawn, however, especially concerning higher ground surrounding the stone row. Here pH values approach neutrality in a broad band on either side of the row and extending northwards. Elsewhere the majority of readings fell between 5.4 and 5.8 (± 0.1). The less acid soils adjacent to the stone walls may reflect human interference by addition of lime-rich materials such as bone or shell, but their virtual absence from the excavated squares argues against this. Without further study no other explanation can be suggested. It should be noted that the range 4.9 to 7.0 covers soil conditions described as "strongly acid" to "near neutral" (Metson, 1961:168). The co-existence of these states within a 30 x 15 m area suggests that pH testing of archaeological sites should not be limited to one or two samples.

FIGURE 47 WASHPOOL WALLS M1/XI-XXVIII pH VALUES

☐ >5.9

0 1 2 3m



APPENDIX THREE - A Technological Assessment of Stone Artefacts from the Washpool Walls Site (N168-9/20, M1/XI-XXVIII)

The task of determining the various activities which produced a particular assemblage has always been a stumbling block for the New Zealand archaeologist although attempts have been made recently to associate edge damage patterns on flakes with particular work operations by experimentation (Morwood, 1974; Roe, 1967) and by striation analysis (K.Jones, 1972). These studies must be regarded as preliminary approaches to the problem rather than solutions, for they have been confined to one material, obsidian, and to one type of 'tool', the conchoidal flake with modified edges. So far it has not always proved possible to distinguish edge alteration in preparation for use from that of damage incurred during use. Jones commented that

"Both the archaeological and the ethnographic evidence suggest therefore that the idea of 'retouch' may be a more complex inference than has previously been thought and that edge morphology may be the result of deliberate modification prior to use, deliberate modification during use and actual damage or blunting of the edge."

(K.Jones, 1972:151)

The treatment of other classes of tools is no further advanced. The drill point, for example, is identified on morphological grounds and in most publications is assumed to have functioned in drilling out the centres of one-piece fishhooks (for example Millar, 1971). There have been no comparative studies of drill diameters and hole diameters in fishhook tabs from the same site, nor of the edge damage and depth of penetration of the drill point. However, Millar (1971:169) noticed "a brownish deposit (bone powder?)..... ingrained in the small flake fracture concavities of some points". Nicholls (1964:36) in a study of 61 flaked points from Ponui Island revealed an anomaly which may be present on many sites when she failed to find:

"much correlation between the distribution of flaked points, sometimes called drills, and the fishhook bone material that is normally assumed to have been worked with them.....The relatively small amount of worked bone to the large number of 'drillpoints' does tend to suggest that they were used on a wider range of material."

There have been no detailed studies of 'files', 'saws',

'abraders', 'grindstones', or any of the other categories of tools so readily (if prematurely) identified by the European archaeologist. Technologically, the manufacture of a fishhook requires a tool to cut out the bone tab, a drill to bore out the centre by one large or a series of smaller holes, and files of various sizes to shape and smooth the hook. The problem for the archaeologist is twofold: to identify the various tools which served as files, saws and drill points, and to determine what was being made with them.

In this site there are 19 retouched flakes and small cores which have been shaped to a point and which show signs of crushing and ultimately smoothing of the point, together with gloss on raised edges or other protruberances for some distance back from the point. This type of wear is consistent with use as a drill point. Five of these drills have been rendered in argillite, believed to have been originally in adze form. The amount of wear varies from a freshly flaked drill with only minor crushing on the tip to a drill in which polishing has extended to the sides so that the capacity to bite into bone or wood would have been negligible. This drill was broken and the sharp edge of the break shows unifacial edge damage. Another argillite drill suffered a blow from the upper end which rendered it useless but rather than discard it the artisan flaked another point at the opposite end, perhaps a further indication of the value of argillite to these people.

The largest drill in the assemblage was made from siliceous limestone and is a very well flaked core of regular triangular section. Although this material appears to be softer than argillite, the drill is not the most worn example in the collection and may not in fact have had much use. The most surprising choice of material for a drill point is undoubtedly obsidian. Only one obsidian drill point is present but its crushed tip and circular striations close to the sides leave no doubt as to its function. The opposite end of this flake is also pointed and shows lateral edge damage consistent with rotation but the point itself has very little wear. This phenomenon was encountered with several of the drills and indicated the use of the drill in a cavity which has already broken through to the outer side of the tab or block. In such circumstances the point would suffer minimal damage compared with the edges.

The most commonly employed material for drills was chert. Of the 12 examples, 2 have quite sharp points but possess lateral gloss, and another has been broken so close to the point that its identification as a drill tip rests on the similarity of edge preparation rather than any use criteria. One complete drill is a fine example of a double ended drill with crushing and gloss obvious on both ends and adjacent margins. The other chert drills come in a variety of cross sections and the extent of the gloss indicates varying depths of penetration of the drill during use (see Table below). The gloss is not always visible to the naked eye, especially where the drill has had little use in abrasive materials but can usually be detected with a low power binocular microscope (x10). Once this zone of gloss was identified, the drill tip was inserted through a sheet of cardboard until this depth was reached and then rotated. This proved to be a quick and useful method of determining the diameter of the largest hole ever drilled by a particular tip in a hard material. It is argued that this measurement is of much greater cultural significance than any overall length or breadth measurements which it has been customary to make (for example, Nicholls, 1964:30). In the absence of any drilled items from this site, an initial comparison was made with holes drilled in bone and shell tabs from the Washpool Midden. The bone tabs and hooks showed that two methods had been used: either a ring of intersecting straight-sided and small diameter holes around the edge of the tab, or a single larger hole with sloping sides. The small holes were 3 - 6 mm in diameter, and no drill in the entire Washpool Walls collection described below was small enough or narrow enough to have functioned in this way. The single-hole fish hooks possessed diameters up to 9 mm, but only 9 of the 21 drills were of comparable size. Similarly the shell fish hooks from the Washpool Midden, on which the ring method was not employed, possessed central holes of surface diameters 6 - 9 mm (measured from the surface because of the sloping sides to the holes).

TABLE OF DRILL DIAMETERS AND DEPTHS OF PENETRATION

Accession (All Layer 2)	Material	Diameter (mm)	Depth (mm)
XVIII/4	Chert	9	3
D.E.	Chert	10	7
XVIII/17	Chert	5	2
XVIII/17	Chert	11	5 *
XVIII/8	Chert	14	11
XVIII/17	Chert	9	7
XVIII/7	Chert	10	9
XVIII/6	Chert	9	9
XVIII/7	Chert	7	5
XVIII/8	Chert	14	10
XVIII/7	Chert	6	6
XIX/21	Chert	7	12 *
XVIII/12	Obsidian	12	11
D.E.	Obsidian	12	9 *
XVIII/21	Siliceous limestone	16	19
XVIII/16	Argillite	9	8
D.E.	Argillite	6	5
XVIII/17	Argillite	14	10
XXII/2	Argillite	11	12
XVIII/13	Argillite	14	12 *
XVIII/22	Argillite	14	16 *

Mean = 10.43

α = 3.17

NB 1: D.E. = Double-ended, accession as above

NB 2: * = No tip damage

Archaic sites show evidence of drilling in several types of artefact: bone and shell one-piece fish hooks and tabs, stone reels, whale tooth pendants, sharks teeth and other amulets, the eyes of minnow lures and sometimes the attached hook base, harpoon points and tattooing chisels. Furthermore a wide range of wooden objects would have been drilled for suspension or lashing. It is clearly unwise, then, to assume at the outset that drill points on this or any other

site were involved in the manufacture of one-piece fish hooks. In this case 12 of the drills exceeded the diameter of holes drilled in bone and shell tabs from local sites; indeed they fell into the range of the perforations in stone reels from Wairau Bar (Duff, 1956: 354-5).

The other measurement made on these drills, that of depth of gloss cannot be directly related to the object being drilled. The reason is, of course, that when a hole is broken through to the corresponding unfinished hole drilled from the other side, the tip of the drill may pass right through beyond the tab, especially if the operator wishes to enlarge the opening. This measurement when doubled indicates only the maximum thickness of material that a particular tip could drill.

The drill tips recovered from this site give the impression of having functioned in a relatively soft material such as wood, for they do not show enough wear for stone drilling nor any traces of bone powder in their cavities which might indicate drilling of bone. The holes that they made range from 5 mm to 16 mm diameter with three clusters apparent: around 6 mm (5 tips), around 10 - 11 mm (10 tips), and around 14 mm (6 tips). However, they cannot be interpreted as three different types of finished perforation, for it is a common practice when drilling a large hole to enlarge it to the desired diameter by using progressively larger drills. The smaller hole helps to centre the larger drill. In fact only one size of hole might have been drilled with the three sizes of drills, and this would have been the 14 mm size. There is already some evidence of different drills being used for the one operation in the form of the drill tips with lateral gloss but no tip wear, which were obviously brought into use once the hole had broken through. It can also be established that the holes drilled by these tips would have had sloping sides compared with the narrow, almost vertical-sided holes of the one-piece fish hook tabs. Beyond these conclusions the functional analysis cannot proceed at present except by indirect evidence. For example, the virtual absence of bone from the site (where soil acidity is low enough for bone to survive) could be used to support the view that some other relatively soft material was being worked, such as wood.

The other tools found in layer 2 have been provisionally identified as three attrition saws, a possible hammerstone, a burnisher, two grindstones and a schist file. The saws were originally flakes struck from waterworn greywacke stones, on which one or two edges have been utilized in a to-and-fro sawing operation on a hard, abrasive material almost certainly stone. Likewise the burnisher and grindstones have wear consistent with use on stone. The small schist file (4.6 x 0.9 cm) would have been utilized on some delicate task on bone or more likely stone, since it shows considerable wear at the working end. It has been noted earlier that the only manufactured stone object in this site apart from the stone tools is the broken unfinished schist minnow lure. Although these stone-working tools could have been utilized in minnow lure manufacture it must not be forgotten that the unfinished lure might have been brought to the site, like the argillite adze pieces, as a source of raw material. Whatever stone working was carried out here, one can only establish from these tools that small items were being processed.

The bulk of the stone material is, as usual, flakes. It has recently become common practice to present figures for the numbers of utilized and waste flakes from site layers (for example Morwood, 1974: 83, 88, 90, 92; Leahy, 1974:53-7). Leahy commented that waste material "occurs from the making of core tools", but this is unlikely to be the case for obsidian which is seldom, if ever, manufactured into adzes, drills or other core tools. Morwood also linked waste material with tool manufacture (Morwood, 1974:82, 88, 92). In two sites he claimed that even the small number of "not necessarily used" flakes had probably been utilized but the wear was difficult to identify. This implies that for the Tokoroa site, for example, 409 separate flakes of obsidian had been brought to the workshop area, were utilized and then discarded. Another site with a high percentage of 'unused' obsidian (*ibid.*: 92) was interpreted as a locality where "obsidian tools were being manufactured as well as used". Expressed as a ratio of used to unused, Morwood's obsidian flakes range from 1 : 0.13 to 1 : 1.28. In contrast, Leahy's study of Hotwater Beach produced an average ratio for imported Mayor Island obsidian of 1 : 2.22 with an overall site ratio for obsidian flakes of 1 : 3.29. This amount of variation between sites is difficult to explain without questioning the criteria employed to judge use. In the case of the Washpool Walls site, the

obsidian assemblage was examined for edge modification by both the author and K. Prickett who looked at 222 items and noted 124 with edge damage and 98 apparently waste. The author studied these 222 flakes plus 15 not seen by Prickett and found 80 with significant edge damage and 157 without. In this assemblage, at least 44 flakes had a minor amount of edge modification the causes of which could not easily be determined - whether prehistoric use or subsequent handling or exposure to natural forces. While this degree of variation exists in judgements of use, ratios of used to unused flakes cannot be compared between authors, and any conclusions concerning the manufacture of obsidian tools on the site must be regarded as tentative.

Current views of stone flake utilization among Pacific peoples stress the importance of "the selection of suitable edges fortuitously formed rather than the actual manufacture or modification of edges to suit the task in hand" (Jones, 1972:66). The study of the stone flakes from this site add support to this view, for in overall morphology there is no obvious preferred shape or method of manufacture (as in the blade industry of Murihiku, or the mataa of Easter Island). The assemblage is composed of small flakes struck from rather irregular shaped cores by low angle percussion. The sections of utilized edge, however, show much greater consistency and regularity in their characteristics.

The method of analysis involved the separation from the assemblage of all flakes and cores which showed a degree of edge modification beyond that which might be expected from excavation, cleaning, and transport with other stone materials. Four variables were recorded, essentially following Jones (1972). These were length of utilized edge section, whether the modification was unifacial or bifacial, whether the edge section was concave, straight or convex, and the effective edge angle (Jones, 1972:93-4). These observations together with an examination of all planes of the flake for use striations were made with a low power binocular microscope (x10), and were confined to the chert and obsidian components where the quantity of flakes permitted useful statistical comparison.

Perhaps the most significant conclusion derives from the study of utilized edge section lengths. In obsidian these ranged from

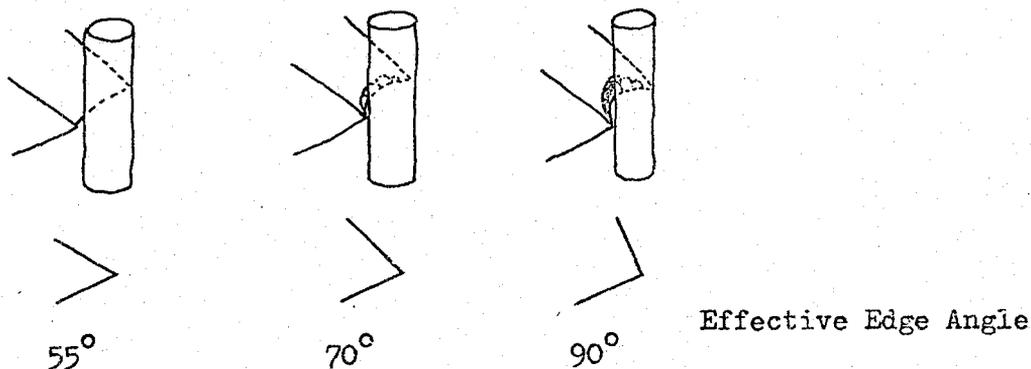
3 mm to 20 mm, and in chert from 3 mm to 23 mm. The mean length for edges on 49 green obsidian flakes was 8.25 mm (SD = 3.03, $SE_{\bar{x}} = 0.303$, $n = 118$) and for 15 grey obsidian flakes 8.26 mm (SD = 4.21, $SE_{\bar{x}} = 0.64$, $n = 43$). A 't' test conducted on these two groups indicated no significant difference ($p = .25$, $t = 0.01601$, degrees of freedom = 141) so it may be claimed that the tasks for which green and grey obsidian were used were probably identical, and further that the artisans did not distinguish between the two types of obsidian in terms of function. It might be argued that these results are to be expected since only one material is involved. What was not expected was that the chert component, consisting of 42 flakes of larger overall dimensions, some twice or three times the size of utilized obsidian flakes, should have a mean modified edge length of 8.20 mm (SD = 3.61, $SE_{\bar{x}} = 0.37$, $n = 97$) which was not significantly different from obsidian ($p = .25$, $t = 0.10542$, degrees of freedom = 195). In this case, therefore, two groups of flakes of different sizes and materials, proved to have identical edge modifications and presumably were both used in the same operation.

The majority of flakes had more than one modified edge: in the case of obsidian an average of 2.6 per flake, and 2.3 for chert. This average may be used as some indication of the relative value of an imported material. Since obsidian was transported over a greater distance than the chert, it is not unexpected that it should have had more intensive use. The ratio of used to unused flakes echoes this, as obsidian has a value of 1 : 2.04 and chert 1 : 3.17. It should be remembered, however, that this is only an indirect measurement of amount of use, since it recognizes only two states, 'used' or 'not used'. The edge count is preferable for it can distinguish an infinite range of use.

As Jones (1972:66) had indicated, it proved difficult to distinguish deliberate retouch from the flake scars resulting from use. A further complication was the presence of areas of crushing and multiple scars which could easily be mistaken for harsh use scars but for their contiguity with a striking platform and position on the opposite side from the bulb of percussion. This sort of damage was caused by a hammerstone before the flake was detached. It was found that most of the low angle edges had been used without any attempt at retouch and had suffered damage in the form of 'bites' irregularly

spaced along the edge. With higher edge angles ($> 45^{\circ}$) the problem of detecting retouch became critical (Jones, 1972 : 130). Indeed the technique of retouch may have been identical with the actual work operation performed, that is, pressing the flake edge against a hard surface. In this case the archaeologist cannot readily determine whether the hard surface belonged to a tool for retouching or the object being worked. There is some evidence to suggest the latter. On several flakes of both obsidian and chert all the sections of modified edge possessed identical characteristics (edge length or diameter of concavity, type of edge and effective edge angle) indicative of use on the same task. Of course this is most apparent where the type of use has produced notches or indentations, an observation also made by Jones (ibid.:132). One may infer that the various notches were the end product of scraping a single shaft. Further, some idea may be gained of the size of the shaft from the diameter of the notch. In this site 20 obsidian edges were of this type and with the exception of 2 edges, all fell within the range 5 - 9 mm, a comparable shaft size to a modern pencil. The notched edges amounted to 13% of the obsidian, and 27% of the chert edges. All were unifacially modified with a high effective edge angle often greater than 70° .

It has been argued by Jones (1972:132) that such configurations of notches "suggest that what is being measured as the features of a unifacially altered edge are the terminal stages of usage when the edge has become too blunt for further use". If the edges were employed scraping a circular shaft until indentations formed by unintentional 'pressure' flaking, then the resulting effective edge angle should be able to be used as an index of bluntness, that is to say, the higher the angle, the blunter the edge. This may be illustrated in a diagram:



In this site, therefore, the high edge angles of what might at first be identified as spokeshaves would indicate that the notched flake was a bi-product of shaft scraping not an intentional tool type.

As with the majority of flake collections from New Zealand sites, unifacial modified edges are well represented (Jones, 1972:148). Morwood puts forward a somewhat different view, based on the following statement:

"If an acute angled edge is used for scraping then it will incur bifacial edge damage."

(Morwood, 1974:82)

The standard definition of an acute angle is, of course, less than 90° , and since all modified edges are 90° or less for functional reasons it is not surprising that bifacial damage is such a high percentage in Morwood's assemblages (for example 78%, 87.5%, 77%). Morwood's statement, however, seems to be an oversimplification. Certainly during the course of scraping a few flakes will detach from the leading surface if a rough protruberance is struck, but far more will come off the trailing surface (c.f. Morwood, 1974:77). It is to this category of modified edge that the term unifacial is best applied, a usage followed by Jones (1972) and earlier by White (1969). Jones found that the relative proportion of these two edge alteration states in his study was 50%, while White established that for Highland New Guinea assemblages unifacial alteration (referred to as 'chattering') amounted to 80%. In the obsidian component from the Washpool Walls site 85% of edges were unifacially modified, and 93% in chert, a situation which White and Jones would interpret as a concentration on scraping.

The 15% bifacially modified obsidian edges had a number of characteristics in common: the presence of marked crushing on both surfaces, straight edges, effective edge angles of $40 - 60^{\circ}$, and very similar edge lengths (range 3 - 8 mm, average 5.3 mm). This consistency of features suggests a discrete task was being performed by the edges, of a different nature to the scraping carried out with the high angle unifacial edges. Judging from the degree of crushing and the short edge length the task may have involved incising or chiseling away unwanted material in a confined space, such as an angled adze helve or bird lure.

Striation analysis has been recognised as a useful method of determining function since the pioneer studies of Semenov (1964). Without special treatment, the traces of wear are invisible on most materials such as chert, but are particularly clear on obsidian. However if the obsidian collection is derived from a sandy matrix and has been used in sandy conditions, edges, surfaces, and flake scar intersections invariably display pitting and scratching which may prove difficult to interpret. The utilized obsidian edges from this site were disfigured to such an extent that only 28 edges had adjacent striations which could be unquestionably related to their functioning. Only 4 of the 28 possessed striations running parallel to the edge, a type of wear which results from a to-and-fro sawing action. In 3 of these cases the edge angle was unusually low (c.20°). With such a thin edge the material being cut must have been fairly soft and the striations caused by sand or broken-off obsidian particles dragged along the edge. Of the remaining 23 edges with associated striations, all but 2 had an effective edge angle of 45° or greater, all were unifacially flaked edges and the striations were to be found on the unflaked sides, running at right angles to the edges. This may be interpreted as evidence of uni-directional scraping: as the edge is drawn towards the body the smooth surface facing into the material becomes scratched by any particles adhering to it and small flakes are detached from the opposite or trailing edge surface. If the edge was pushed away from the body at the same angle the flakes would come off the trailing edge on the same surface as the striations. Only the former type of wear is recognizable in this collection. The 24 edges which showed right-angle striations belonged to a much larger class of unifacial edges with medium to steep effective edge angles (>50°). This suggests that the unmarked edges were employed in similar tasks to those which received scratches, and that in most cases actual working conditions were relatively grit-free.

Striations were not visible on chert flakes but 9 long, low angle edges showed a type of edge damage indicative of sideways drag or 'sawing'. These modified edges were all above 12 mm in length and no comparable forms existed in the obsidian collection. It should be noted that the majority of long edges on the larger obsidian flakes had discontinuous edge wear sometimes at two or three locations on the one edge, a situation which suggests that the objects being scraped were narrow and thin. Jones (1972:133) would interpret this as evidence of

"use of the edge in the manufacture of rectangular section artefacts".

APPENDIX FOUR - Estimates of Community Size from the Area of Stone Wall Garden Enclosures

Whatever method is chosen for estimating community size must take into account 8 different variables (see below). Two of these are the length of the cropping period of a particular plot, and the length of fallow. For a horticultural system involving a given block of land to operate in perpetuity, only a proportion can be cropped at any one time, while the remainder is 'rested'. This proportion can be calculated approximately by the following formula

$$\frac{A}{T} = \frac{C}{C+F} \dots \dots \dots (1)$$

- where A is the area of the plot cultivated each year (ha)
- T is the total area of the block of garden land (ha)
- C is the cropping period for a particular plot (years)
- F is the fallow period for a previously cultivated plot (years)

In addition, the following variables are relevant to estimates of community size:

- Y is the yield of kumara (†/ha)
- L is the over-wintering storage loss of the crop (%)
- S is the amount of seed needed for replanting (†/ha)
- E is the average amount of energy taken from this food crop (calories/person/day)
- P is the steady state population which can be supported by this block of land

Calorific values of both kumara and taro are close to 1 calorie per gram (Bellwood, 1972:41-2).

A Worked Example

If the area of a stone wall complex (T) = 30.3 ha, the cropping period (c) is 1 year for any plot, followed by a fallowing interval (F) of 14 years, then the area of any yearly plot must have been

$$A = \frac{TC}{C+F} = 2.02 \text{ ha}$$

If the yield of kumara (Y) = 17.9 †/ha then the total yearly crop = AY = 36.16 †. During winter storage 10% is lost by decay (L), leaving a nett amount of 36.16 - 3.62 or 32.54 †. Seed requirements (S) are

2†/ha, which for the plot of 2.02 ha requires an additional 4.04† to be extracted from the remaining kumara leaving 28.5†. This figure then is the amount which can be consumed in any one year. At 1 calorie per gram this represents 28.5×10^6 calories. If the average energy intake (E) from this source is 2000 calories per person per day, then this crop would feed $28.5 \times 10^6 / 2000 \times 365$ or 39.044 persons. Collecting terms:

$$P = TC(Y (1 - 0.01 L) - S) / (C + F) \cdot 10^6 / 365E \dots (2)$$

Areas of Stone Wall Complexes in Palliser Bay

Major Groups

Washpool (M1)	9.71
Te Humenga	9.31
North Pararaki	9.31
South Pararaki	11.74
North Kawakawa	8.90
North Waiwhero	7.49
Black Rocks	16.19
Mangatoetoe	<u>3.64</u>
	Total = 76.29

Minor Groups

Makotukutuku (M2)	1.76
Makotukutuku (M4)	0.87
Hamenga (0.30, 0.63, 0.50)	1.43
South Kawakawa (1.88, 0.25, 0.25, 0.88, 0.25, 0.13, 0.13, 0.50, 0.50, 0.30)	5.07
South Waiwhero (0.25, 0.15, 0.73, 2.00, 2.35)	5.48
Cape Palliser (1.50, 1.00)	2.50
	<u>Total = 17.11</u>
	<u>Grand Total = 93.40 ha</u>

'Best Estimates' for Palliser Bay

F	- Fallow Period	14 years
C	- Cropping Period	2 years
Y	- Kumara Yield	10t/ha
L	- Storage Loss	10%
S	- Seed Requirements	2t/ha
E	- Energy Taken	700 calories

Using the above estimates and the areas of individual complexes, the following community sizes can be calculated using equations (1) and (2)

<u>Complex</u>	<u>Yearly Area under Cultivation</u>	<u>Community Size</u>
Washpool (M1)	1.21 ha	33 people
Te Humenga	1.16	32
North Pararaki	1.16	32
South Pararaki	1.47	40
North Kawakawa	1.11	30
North Waiwhero	0.94	26
Black Rocks	2.02	55
Mangatoetoe	0.46	12
Makotukutuku (M2)	0.22	6
Makotukutuku (M4)	0.11	3
Hamenga	0.18	5
South Kawakawa	0.63	17
South Waiwhero	0.69	19
Cape Palliser	0.31	<u>9</u>
	Total	319

Averages for major groups

$$\bar{x} \text{ Community Size} = 33 \pm 4.3$$

$$6 \quad \quad \quad 12.1 \pm 3.0$$

$$\bar{x} \text{ Yearly Plot Size} = 1.19 \text{ ha} \pm 0.16$$

$$6 \quad \quad \quad = 0.44 \pm 0.11$$

APPENDIX FIVE - Prehistoric Units of Linear Measurement Used in Garden Layout

The distances apart were recorded for 189 pairs of walls, working from the field plans to an accuracy of approximately 1 m. It was argued that if the garden plot widths were based on multiples of some unit of measurement (U) then on an average the difference (R) between the closest multiple of U to any recorded measurement (F) would be smaller than that of the multiple (M) of any other distance estimate (E) to the same measurements.

It was expected then that if the residuals (R) were calculated for a series of estimates (E) of prehistoric units, and these were totalled for all the measured distances, any approximation to a real prehistoric unit would be signified by an inflection in the residuals. Admittedly, the minimum recording interval of 1 m was likely to be a significant portion of any unit used, and this factor might mask the inflection. At the same time it was thought that if the residuals were calculated for a large number of measurements, the 'signal to noise' ratio would improve.

Several residual methods could have been used, such as total raw differences, root mean squares, or proportional differences. Trials were made with the aid of a small computer program written by B.F. Leach and each method consistently showed two points of inflection. After some experimentation random fluctuations of the residuals (which are greatest for the smallest estimates of the supposed unit) were minimized with the following algorithm:

$$R_{E_J} = \frac{100 * \sum_{I=1, N} |F_I - M|}{E_J * N}$$

N = number of measurements

F_I = any one measurement of plot width

M = the multiple of E_J closest to F_I

E_J = an estimated value for the unit (iterated 0.5 to 3.0 m in steps of 1 cm)

R_{E_J} = the average residual as a percentage of the current estimate

Two inflections can be identified and these are illustrated in Figure 45. The first is between 1.7 and 1.9 m, probably centred about 1.8 m, and the second at from 2.1 to 2.4 m, probably centred about 2.25 m. These

two lengths are very close to the protohistoric units of maro and takoto, about 1.8 and 2.2 m respectively.

Although the technique of assessing these units is statistical in nature, no simple test could be devised to assess the statistical significance of the departure from randomness of the two inflections. Greater accuracy in measurement would undoubtedly provide more confidence in the results. At this stage it is felt that the proof lies more in the coincidence with maro and takoto than in any mathematical manipulation.

The raw data for this analysis are listed below:

Table of distances between longitudinal stone walls in Palliser Bay

(all measurements in metres - maximum error 1.0 m)

Washpool (30)

7 7 7 7 9 9 9 9 9 11 12 12 13 13 13
14 14 14 16 17 18 18 19 22 24 26 28 28 28 38

Te Humenga (28)

9 10 11 13 14 14 14 15 16 18 18 22 23 23 24
24 25 25 28 31 32 32 34 36 38 40 50 76

North Pararaki (17)

9 10 11 13 17 17 17 18 18 19 23 23 25 28 29
38 45

South Pararaki (25)

7 7 9 9 9 11 11 13 14 15 16 16 17 17 17
17 19 19 21 21 23 24 26 29 31

North Kawakawa (12)

8 9 13 18 21 25 28 34 34 36 50 50

North Waiwhero (35)

7 9 9 9 9 11 12 12 13 13 14 17 17 18 18
18 18 19 19 19 22 23 26 26 28 28 28 31 31 31
32 32 33 35 70

South Waiwhero (northern section) (10)

10 13 14 18 18 19 28 28 45 55

APPENDIX SIX - Kumara Variety Names According to Region

From Colenso (1880), Williams (1894), and Hammond (1894) a table has been prepared which demonstrates some regional variation in kumara variety names. It should be stressed that these are not necessarily discrete botanical varieties or cultivars.

	Northern	East Coast (Hawkes Bay)	East Cape	West Coast
<u>Occurring in Four Areas</u>				
Monehu/Monenehu	x	x	x	x
Pokerekaahu	x	x	x	x
Toroamahoe	x	x	x	x
<u>Occurring in Three Areas</u>				
Anurangi	x	x	-	x
Parakaraka	x	x	x	-
<u>Occurring in Two Areas</u>				
Kawakawa	x	-	x	-
Koreherehe	x	-	x	-
Matakauri/Makakauri/ Makakakauere	x	-	x	-
Patea	-	x	x	-
Pehu	-	x	-	x
Taputini	-	x	-	x
Taurapunga	x	-	x	-
Waniwani	x	-	x	-
<u>Occurring in One Area</u>				
Anutipoki	-	-	x	-
Aorangi	-	-	-	x
Arikaka	-	-	-	x
Awangarua	x	-	-	-
Hawere	-	x	-	-
Hitara	x	-	-	-
Huiupoko	-	-	x	-
Kaawau	-	x	-	-
Kahutoto	-	-	-	x

	Northern	East Coast (Hawkes Bay)	East Cape	West Coast
Kaikaka	x	-	-	-
Kairorowhare	-	x	-	-
Kanawa	x	-	-	-
Kauto	x	-	-	-
Kauutowhau	x	-	-	-
Kawakawatawhiti	-	x	-	-
Kengo	x	-	-	-
Kerikaraka	-	-	x	-
Kiokiorangi	-	x	-	-
Kokorangi	-	-	x	-
Kopuangaanga	-	-	-	x
Kotipu	-	-	-	x
Kurararangi	-	x	-	-
Makururangi	x	-	-	-
Maomao	x	-	-	-
Maori	-	x	-	-
Mapua	x	-	-	-
Maramawhiti	x	-	-	-
Matawaiwai	-	-	x	-
Mengerangi	x	-	-	-
Moi	-	-	x	-
Ngakaukuri	-	-	x	-
Ngakomoa	-	x	-	-
Paea	-	-	x	-
Paihaukaka	-	x	-	-
Panahi	x	-	-	-
Pane	x	-	-	-
Papahaoa	-	-	x	-
Paretaua	-	-	x	-
Pauaataha	x	-	-	-
Pohutukawa	x	-	-	-
Poranga	x	-	-	-
Puatahoe	-	-	x	-
Punuiarata	-	-	x	-
Puurata	x	-	-	-
Rangiora	-	-	-	x

	Northern	East Coast (Hawkes Bay)	East Cape	West Coast
Raumataki	-	x	-	-
Tanehurangi	-	-	x	-
Taratamata	-	-	x	-
Taikahikatea	x	-	-	-
Toitoi	x	-	-	-
Tokouu	-	x	-	-
Torowhenua	x	-	-	-
Tutaanga	-	x	-	-
Tutaetara	-	x	-	-
Waiha	-	-	x	-
Whakakumu	x	-	-	-
Wini	-	-	x	-

APPENDIX SEVEN - Bird Remains from the Martinborough Caves

		Cave			
		1		5	
Flightless	<u>Anomalopteryx</u> spp. ¹	Moa	x	x	x
	<u>Pachyornis</u> spp. ¹	Moa	x	-	-
	<u>Dinornis</u> spp. ¹	Moa	x	x	-
	<u>Apteryx australis mantelli</u>	N.I.Kiwi	x	x	-
	<u>Euryanas finschi</u> ¹	Flightless Duck	x	x	-
	<u>Aptornis otidiformis</u> ¹	Large Rail	x	x	-
	<u>Notornis</u> sp.	Large Takahe	x	x	-
	<u>Gallirallus</u> spp.	Weka (3 spp.)	x	x	x
	<u>Strigops habroptilus</u>	Kakapo	x	x	-
	<u>Capellirallus karamu</u> ²	Rail	-	x	-
	<u>Capellirallus hodgeni</u> ²	Rail	-	x	-
<hr/>					
Flying	<u>Falco novaeseelandiae</u>	Bush Hawk	x	-	-
	<u>Callaeas cinerea wilsoni</u>	Blue-wattled Crow	x	x	x
	<u>Petroica australis longipes</u>	N.I.Robin	x	x	-
	<u>Hemiphaga novaeseelandiae</u>	Pigeon	-	x	x
	<u>Cyanoramphus</u> sp.	Parakeet	-	x	x
	<u>Anthornis melanura</u>	Bellbird	-	x	-
	<u>Heteralocha acutirostris</u>	Huia	-	x	-
	<u>Megaegotheles novaeseelandiae</u> ²	N.Z.Owlet-Nightjar	-	x	-
	<u>Petroica macrocephala toitoi</u>	N.I.Tit	-	x	-
	<u>Philesturnus carunculatus rufusater</u>	N.I.Saddleback	-	x	x
	<u>Nestor</u> sp.	Kaka	-	-	x
	<u>Prothemadera novaeseelandiae</u>	Tui	-	-	x
	? <u>Garrodia</u> sp.	Storm Petrel	-	-	x
				Y	S

Notes 1 Fully extinct but elsewhere associated with Polynesian man

2 Not found in association with man

Y - Yaldwyn, 1956:2-7

S - R.Scarlett, 1971:pers.comm.

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ABBREVIATIONS

The following abbreviations appear in the bibliography:

A.P.A.O.	Archaeology and Physical Anthropology in Oceania
B.P.B.M.	Bernice P. Bishop Museum
J.P.S.	Journal of the Polynesian Society
N.Z.A.A.N.	New Zealand Archaeological Association Newsletter
N.Z.D.S.I.R.	New Zealand Department of Scientific and Industrial Research
T.N.Z.I.	Transactions of the New Zealand Institute
T.R.S.N.Z.	Transactions of the Royal Society of New Zealand

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