Horticulture and Settlement Chronology of the Waipaoa River Catchment, East Coast, North Island, New Zealand

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ABSTRACT

The Waipaoa River catchment was an important location of Maori settlement, with occupation adjacent to the estuary dating from the twelfth century A.D. The earliest occupation on flood-prone alluvium was in the thirteenth century A.D. in the Matawhero vicinity, another area close to the main river mouth. From this period the same area was flood-free. Settlement at all periods was densest in areas without frosts on the principal fans of the catchment at Waerenga a Hika, Patutahi, Manutuke, and at the mouth of the Maraetaha River. Pa on the fans do not date before 350 years B.P. Population potential on any one of the fans was as high as 1000 people, based on horticulture on soils of naturally high fertility. The horticultural potential of the valley is the reason for the large population and tribal diversity on the plains in the historic period. Some horticulture was practised on soils subject to infrequent flooding to take advantage of the fertility of such soils. Some pa were located on the lower reaches of abandoned river courses to take advantage of eel migrations. Settlement and horticulture occurred on hill slopes on the coast and to avoid frost in the inland parts of the catchment.

Keywords: MAORI, RONGOWHAKAATA, TE AITANGA-A-MAHAKI, NGATI KAHUNGUNU, NINETEENTH CENTURY, PREHISTORIC, KUMARA HORTICULTURE, ALLUVIUM, HILL GARDENING, STORAGE PITS, MARAETAHA RIVER.

INTRODUCTION

The importance of major rivers in Maori settlement pattern is evident from any small-scale site distribution map. Discussion of the reason for this is not well developed. Some of New Zealand's best known sites, e.g., Oruarangi on the Thames or Otatara in Hawkes Bay, occur in intimate association with riverine systems, making this lack of discussion all the more surprising. To some extent this relative neglect arises from the long-standing interest in settlement on coasts and more recent interest in sites on volcanic soils. The Waipaoa River offers an opportunity to discuss riverine settlement in a sizable area with a number of important tribal groupings: Te Aitanga-a-Mahaki, Ngati Porou, Whanau-a-Kai, Rongowhakaata and Nga Tamanuhiri. This river valley is also the traditional origin place of Ngati Kahungunu. What are the origins of this diversity, and how could a single river catchment be the site of such a development? The answer lies partly in scale and partly in the extraordinary horticultural potential of the valley.

Recent archaeological surveys in the eastern North Island have analysed soil data, topography and archaeological sites such as pa and kumara storage pits with a view to establishing gardening practices and population size (Jones 1986; Jones and Law 1987). Critical factors not readily amenable to archaeological study are measures of productivity, and the balance between human effort and crop production. Studies to overcome these limitations, based on the 1769 *Endeavour* visit to Anaura Bay, are proceeding.

The principal methods of gardening in the study area are swidden (slash-and-burn) on hill slopes, and intensive gardening on naturally fertile soils such as river levees or the

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near-level slopes at the foot of hills. Gardening methods have an intimate bearing on the nature of tribal society, since where a resource is concentrated in area, there is potential for the growth and concentration of larger populations and some stratification in leadership. The high-fertility alluvial silt loams in river valleys in New Zealand can occur in compact areas on river fans, but generally they occur in strips along river banks some 20–60 m wide (Jones 1986). Another area of concentrated high-fertility soils is recent volcanic soils, which are compact in shape since they derive from concentrated sources of ejecta.

This paper reports the results of an extensive site survey of the catchment of the Waipaoa River, East Coast, New Zealand, with particular reference to settlement and horticulture on alluvial and hill soils. The balance between the usage of the two soil types and the age of settlement on alluvial soils up to and including the nineteenth century is also considered.

PHYSICAL SETTING (Figure 1)

The Waipaoa River has a catchment of some 6000 square kilometres, and rises in the principal dividing range of the eastern North Island. It is amongst the largest of the river catchments of the North Island. The river runs approximately north–south, and rises to a catchment rim over 1200 m in altitude to the west, with heights to the east of the order of 500 m. The catchment is therefore exposed to occasional very heavy rainfall in cyclonic storms from the east. The rocks of the catchment consist mainly of siltstones and sandstones, with some hard rocks in the west. On older surfaces of mild slope there is a mantle of volcanic ash derived from the Taupo volcanic zone to the west (New Zealand Geological Survey 1972). The principal tributaries of the river are the Mangatu, Waihuka and Waikohu Rivers, all rising in the western ranges. The Wharekopae and Waihora Rivers run into the main river from the west and east respectively, while the Whakaahu and Te Arai join the river from the west and closer to the sea.

Above Te Karaka, the Waipaoa channel has a steep gradient, with a braided river which has cut down through some 80 m height of an extensive area of Pleistocene terraces. These terraces have a mantle of volcanic ash about one metre thick overlying boulders and gravels. Below the vicinity of Ormond, the river debouches on to the Waipaoa plains which are some 15 × 30 km in extent. A large alluvial fan has formed at this point and on it lies the important settlement of Waerenga a Hika. Two fans of lesser extent, which were also important areas of prehistoric settlement, have formed on the western margins of the valley at the debouchment of the Whakaahu and Te Arai Rivers. The Te Arai fan is the site of the important Maori settlement of Manutuke. On the latter fans, at one time, the river courses ran southwards along the intersection of the hill country and the backslopes of the Waipaoa River. As their fans built up, the rivers broke out to the east directly into the main course of the Waipaoa River. On the eastern side of the plains there is a series of smaller fans, the most important of which is near the Waihirere settlement at the head of the Taruheru River (Pullar and Penhale 1970). However, the obvious access to the Waihirere vicinity is across the Waerenga a Hika fan from the Waipaoa River itself.

The plains themselves have broad expanses of poorly drained backlands which originally had a cover of pukatea and kahikatea forest while there were areas of manuka, kanuka, cabbage trees, and karaka groves on the river banks (Pullar 1962: Fig. 3). There were also extensive swamps or wetlands, particularly on the western margins of the valley between Manutuke and Waituhi. Abandoned river courses would also be important swamps or wetlands, with examples occurring at Matawhero, Waerenga a Hika, and the old course of the

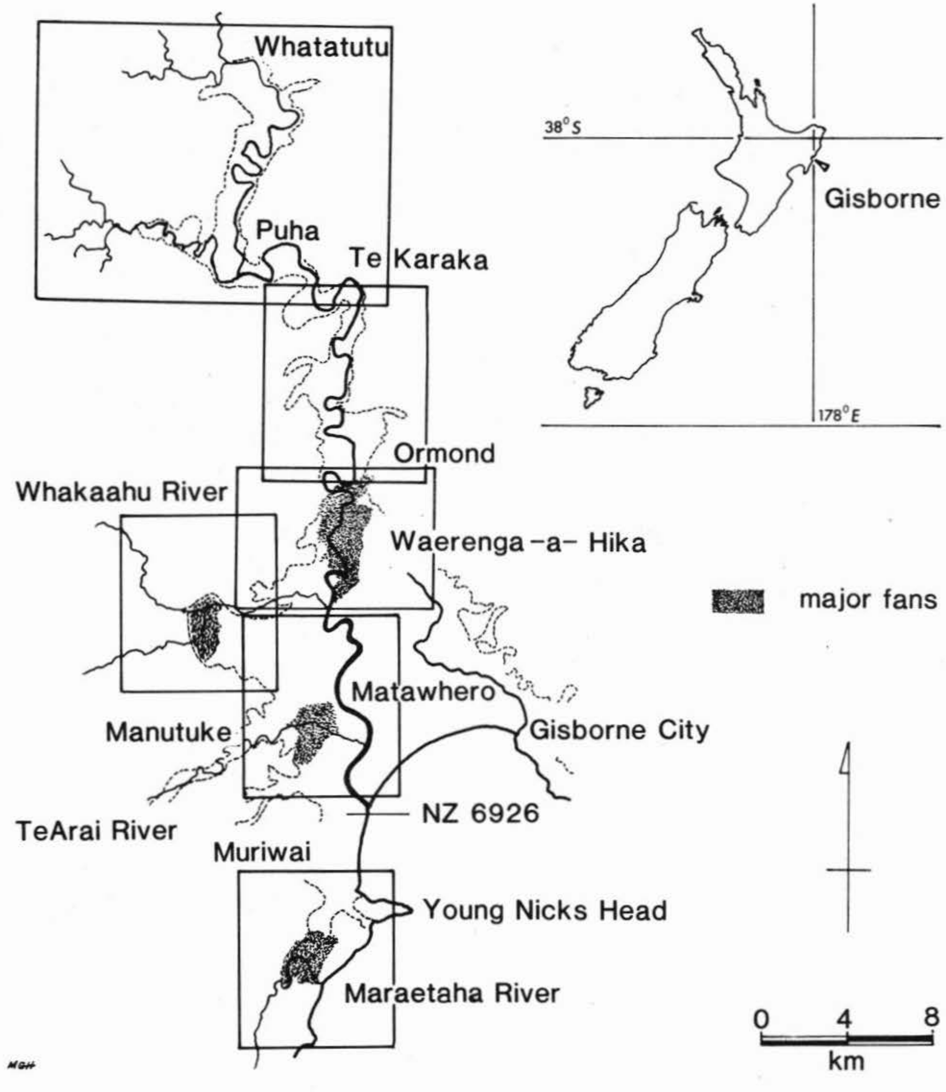


Figure 1: Locality map of Gisborne Plains and Waipaoa River.

Te Arai. These would have been important reservoirs of sizable eel populations. Migration routes of eels, of critical importance in mass harvesting considerations, would have been along the western margin of the valley from the Waipaoa estuary to the large swamps north-west of Manutuke.

Another element in the riverine soil pattern of prime importance to settlement were the terraces and levees of the river (Fig. 2). In the classic formulation of Pullar (1962), these may be divided into three sets: (1) the high flood-free terrace comprising Waihirere soils with well developed topsoils and subsoils; (2) somewhat lower terraces flooded infrequently and in which the topsoils are deep because they are formed of a gradual accumulation of flood silts—the Matawhero soils; (3) the modern flood plain comprising fine sands of a largely mineral character—the Waipaoa soils. The Waihirere and Matawhero soils are distributed as narrow strips (40–500 m) along the edges of the flood plain. In some localities, areas are compact in shape rather than strip-like and also extensive, principally on the lower valley fans at Waerenga a Hika, Patutahi, the Whakaahu fan, Manutuke, and in the neighbouring Maraetaha valley to the south. The Waihirere and Matawhero soil types can be either light or heavy in texture depending on the balance of silt or clay in the parent materials, with the lighter silt loams tending to be closer to the original river banks. This is where floods first overtop the levees at some velocity depositing larger particles, while the clay particles are carried some distance in water travelling at lower velocity.

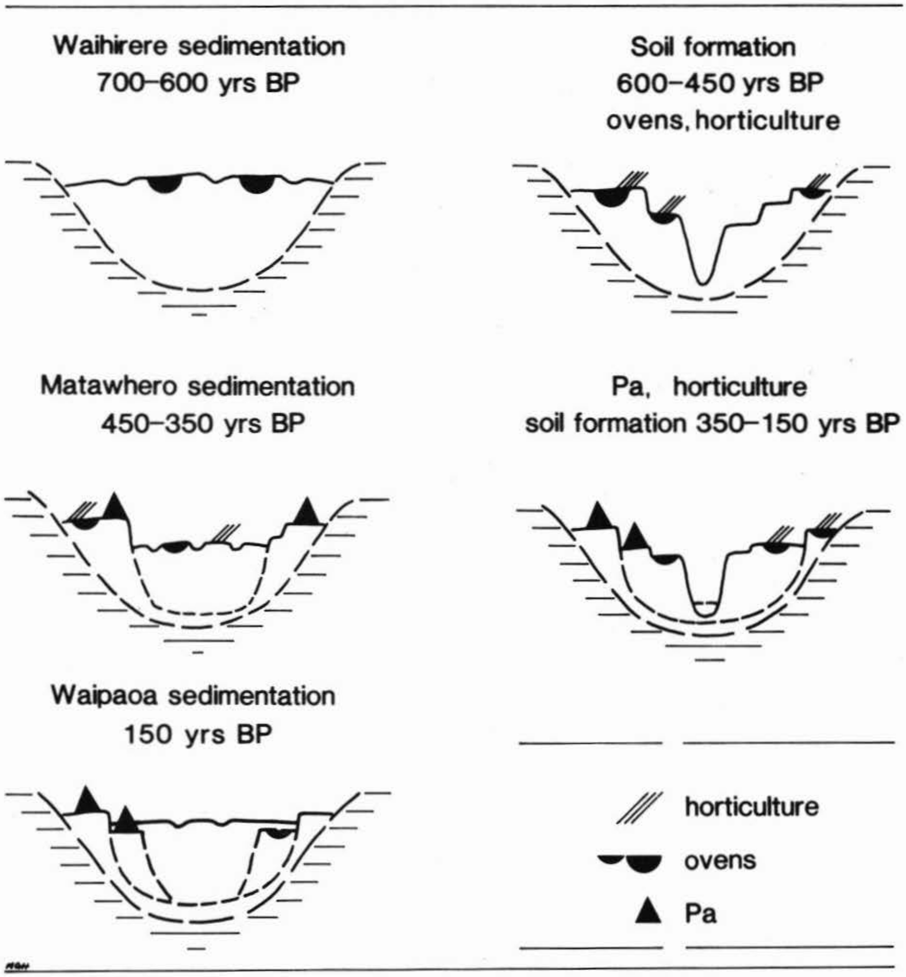


Figure 2: Schematic rendering of river terrace formation (after Grant 1985), and approximate chronology of main archaeological features.

The age at which the terraces or soil surfaces became flood-free has a bearing on the apparent intensity of settlement likely to be found in archaeological survey, and is also a key to possible maximum ages for settlement on the surface. Soils of the principal fans of the river system mentioned above could well be older than the fairly consistently aged river terraces. The fan surfaces could have become flood-free well before the Waihirere terraces, even although they receive a general classification as Waihirere soils (Rijkse pers. comm.; Pullar and Penhale 1970: Fig. 6). There have been recent, detailed estimates of age based on radiocarbon dates (Grant 1985). The ages are important because they set limits to the likely span of human occupation on these soils. Figure 2 summarises these ages.

The desirability of the alluvial soils for horticulture depends on their properties relative to hill soils, and their natural fertility. The Waihirere soils have good natural fertility (Rijkse and Pullar 1978), reflecting in part their origin as an earlier phase of massive erosion of topsoil. Matawhero soils are of slightly poorer natural fertility than Waihirere soils. Both classes of soils would have been capable of continuous use.

Waipaoa soils are substantially mineral sands with poor fertility. Natural fertility is generally poor in hill soils but adequate for the Polynesian root crops grown in New Zealand, with the exception of soils of very low fertility derived from sandstone. A low intensity of cultivation in a swidden regime would be likely on hill soils. Aspect and elevation, with the ready choice of sites that were frost-free and warmed readily in the growing season, would be important advantages in the use of hill soils. Extensive tracts of elevated, rolling hill country occur in the Waipaoa settlement/Ormond vicinity on the eastern flanks of the valley, where they are used today for the growing of early potatoes.

Climate of parts of the Waipaoa valley set limitations on horticulture. The plains proper, i.e., the area south of Ormond, is reliably frost-free in the September–May growing season for kumara. This is based on records for the Manutuke Research Station which lies on a typical valley-entrance fan about 8 km from the coast (Goulter 1981: 44). In the enclosed main valley above the Waerenga a Hika fan, and in the side valleys west of the Te Arai and Whakaahu fans, there is a risk of frost. At Te Karaka, Puha and Whatatutu, frosts are likely in the growing season. Kiwifruit orchards at Te Karaka, for example, have large motorised fans to keep air moving in frost periods. The frost risk has led to at least two responses on the part of Maori horticulturists which are to be further discussed in relation to settlement in the Ormond vicinity, and have already been discussed in related work on the inland parts of the Whakatane River catchment (Jones 1986).

SETTLEMENT REVIEWS BY DISTRICT

This paper now turns to detailed considerations of segments of the valley, analysing distribution of the archaeological evidence, including pa. Radiocarbon dates on shell are cited in the text using new $T\frac{1}{2}$. Further details, including notes on stratigraphic context, are in Appendix 1. Consideration is given to pit storage volume in relation to the likely areas of available horticultural land. Pit volumes are indicated in the following figures by circles representing inferred gardened areas of crop using the following equation.

A_p = predicted area of crop (m^2)
r = radius of circle representing area of crop (mm)
V_s = volume of pit storage (m^3)
k_1 = fraction of pit volume used for storage
k_2 = proportion of crop actually stored in pit
k_3 = metres expressed in mm at 1:25,000 scale
t = weight of crop per unit volume of storage (kg/m^3)
p = productivity of crop per unit area (kg/m^2)

$$A_p = \pi r^2 \frac{V_s k_1 t}{p k_2} \quad (1)$$

$$L = k_3 \sqrt{\frac{V_s k_1 t}{\pi k_2 p}} \quad (2)$$

The volumes shown are not for individual pits, but for pit volumes per discrete site (see Jones 1986). The maps show circles plotted with the following constants:

$$p = 4\ \text{tonnes/ha}$$
$$k_1 = 0.5$$
$$k_2 = 0.4$$
$$t = 760\ \text{kg/m}^3$$
$$k_3 = 0.04$$

Of these figures, k_1 and t follow those of Jones and Law (1987: 92). The figures for p and k_2 are assumptions derived from the apparently low productivity and low proportion of crop stored in pits at Anaura Bay in 1769 (Jones and Law 1987: 105). The proportion of the crop stored in pits may well be lower than 0.4 at Anaura Bay since it is a coastal location with little risk of frost. These assumptions give the result that for every $20\,\text{m}^3$ of pit storage, 3 ha of land are cultivated. This does not allow for the accumulation of pit storage over time, where the deduced area of crop would have to be reduced considerably. Nevertheless, the procedure offers a reasonable means of assessing the importance of areas of land in relation to crop production and storage.

Reference is made in the text to the results of test pits and available sections. Interpretation of the test pits, particularly with respect to the difficult matter of mixing resulting from horticultural activity, is based on the depth and to some extent thoroughness of mixing; blackening generally; and the disturbance of subsoils, which is partly the result of depth of mixing. Only verbal summaries of test pits are given, and the original site records should be consulted for further details.

PUHA–WHATATUTU (Figure 3)

This area comprises the higher country of the catchment. Most of the archaeological evidence is on the edges of a very extensive area of Pleistocene terrace. Pa typically occupy an area on the edge of the steep-sided terrace. The ditches may be single or double and occasionally enclose the terrace edge in a rectangular form (Golson 1957: Plate 6; Wilson 1987: 122). Usually, however, pa are formed by ditches cutting narrow promontories in the terrace. In addition to those surveyed here, the localities of several pa may be established from records in *The Pa Maori* (Best 1927).

With few exceptions, pit volumes are very small, even in association with pa of relatively large size. There would have been some gardens on the ash soil of the Pleistocene terrace. Areas would have been restricted since the terrace soils tend to have a hard pan with poor drainage. Elevation and a northern aspect were clearly important to avoid frost. Cultivated soils were noted in one section on an "island" of the Pleistocene terrace incorporating a pa (X17/4) and pits. The site is in the Waihuka River valley on the inland margin of settlement.

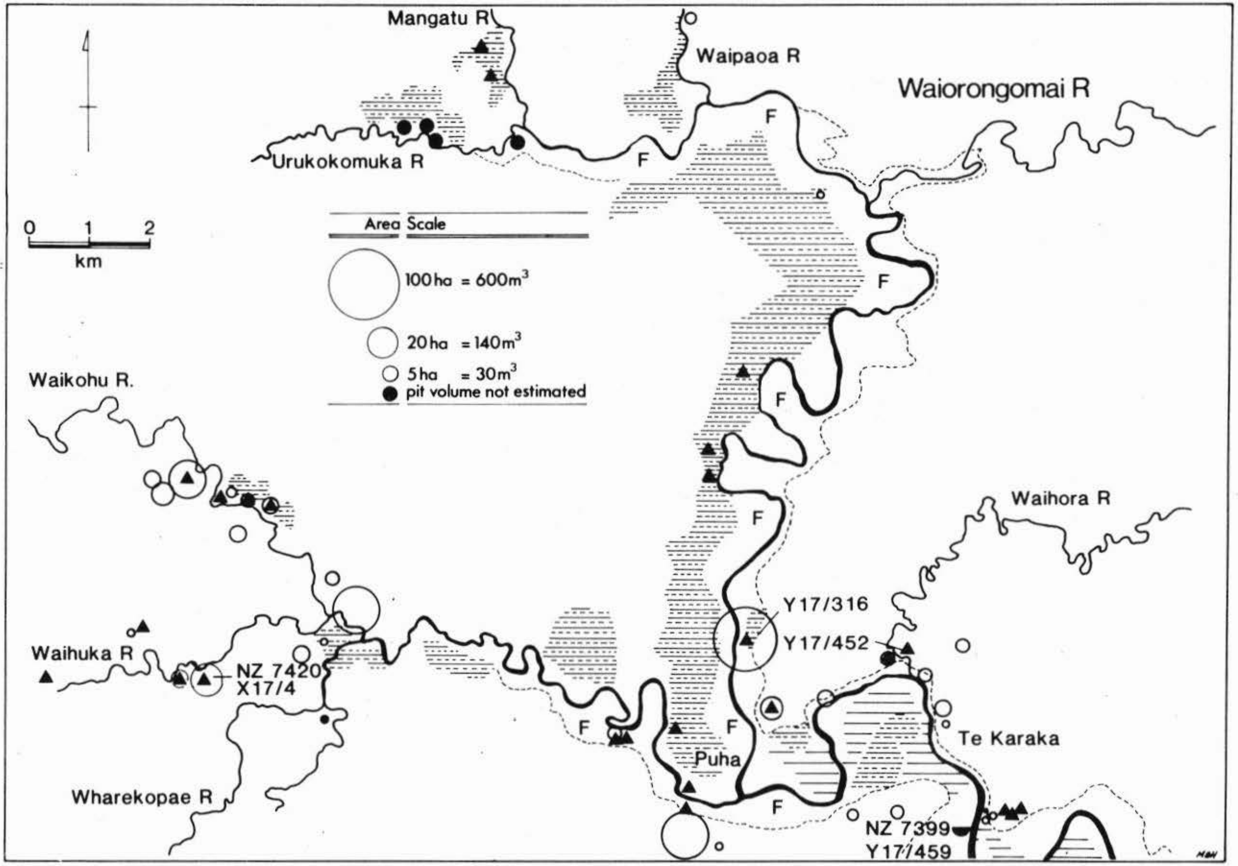


Figure 3: Pa, extent of Pleistocene terrace, and area of crops inferred from storage pit volumes, Puha and district. Note that this figure is reproduced at a different scale from those following. The Pleistocene terrace is adjacent to the hill country.

The section showed charcoals mixed into a silty ash subsoil at the top of a north-facing slope. A radiocarbon date on these charcoals is 400 ± 61 yrs B.P. (NZ 7420). The date is on wood which may be old, so that a younger date for occupation here in about the seventeenth century is acceptable. The pa is that of Mahaki, the eponymous ancestor of Te Aitanga-a-Mahaki. Several dense concentrations of pa exist on the sole, small remnant of Pleistocene terrace in the Waikohu River valley, indicating the importance of this particular landform in settlement.

A pa (Y17/316) on the east bank of the river opposite Puha has a very substantial volume of pit storage (600 cubic metres), in contrast to the general area. The pa occupies the full extent of a small island of Pleistocene terrace, indicating that the gardening must have been on the adjacent rolling hill country. The pits survive in part because the poor access and restricted site area have made ploughing uneconomic. The Pleistocene terrace on the west bank of the river has had relatively little ploughing, yet there are still very few pits, indicating a low intensity of gardening elsewhere in this area.

The Waihora River is shown on Figure 3 and intersects with the Waipaoa River through a distinct 1000-m-long meander belt. Pa occur on the two principal points adjacent to each other in this meander belt. The upstream pa (Y17/452) exists in recognisable form although much eroded by river action. There is a large area (some 10 ha) of elevated silt loam adjacent (not in the geographical scope of Pullar (1962)) and some indistinct pits are visible on the pa itself. The Waihora River valley has not been intensively surveyed but air photograph scans suggest that further evidence of pits and horticulture is limited or non-existent. The river is nevertheless notable for its interlocking pa, a pattern that usually occurs in coastal meander belts such as the Te Arai or Maraetaha Rivers to be discussed further below.

The Mangatu River and the Urokokomuka Stream have a number of pa/pit complexes on remnants of the Pleistocene terrace. This is an area of great importance in nineteenth century Maori tradition (Binney and Chaplin 1986) but it was only surveyed from aerial photographs in the course of the present survey. The other principal headwater river of the catchment is the Wharekopae River and this has at least one small pit complex on the Pleistocene terrace, again recognised only from aerial photographs. The lower reaches of the Waingaromia River have few sites, mainly small sets of terraces, with no pits except for one of the historic period.

TE KARAKA–ORMOND (Figure 4)

This part of the river valley is exposed to some risk of frost in the growing season. The valley is narrow, averaging some 2 km in width with a flood plain taking up a large proportion of the valley floor. Narrow strips of Waihirere silt loams occur generally close to the hill slopes. Occasional more compact areas occur on the inside of substantial bends in the river. Because of the risk of frost and the presence of significant areas of Waihirere silt loam, the area lends itself to a closer analysis of the balance between gardening on hill slopes and on alluvium.

An oven cut into Waihirere silt loam subsoils and sealed by a developed topsoil is exposed in a road cutting about 2 km south-east of Te Karaka and not far from Takipu Marae (Fig. 3). This has a radicarbon date for twig charcoals from its base of 607±55 years B.P. (NZ 7399). This indicates early occupation of the upper valley flood-plain environment.

Massive volumes of pits associated with possible gardening on the Waihirere silt loams occur on the eastern ridges above the Waipaoa Bridge and on the western bank on Tangihanga Station and opposite Kaitaratahi hill. Much of the originally gardened soil may have eroded away in the course of the flood plain working out to its present extent. In the Ormond vicinity there is a small area of the gravelly topsoil phase of Waihirere silt loam which is blackened and deeply mixed with some prehistoric artefactual material.

The area east of the Waipaoa Bridge rises steeply and then runs in easy hill country over which pits are spread to a distance of some 2 km from the river. In this locality the Waihirere silt loams are concentrated on the west bank of the river, with the possibility that crops could be carried across the river for storage on ridges on the eastern bank, where substantial pa are found. The pa, Mapouriki (Y17/31), has 750 cubic metres of storage, while on the west bank there is an area of 58 ha of heavy silt loams with gravels. However, the easy hill country associated with these pa strongly indicates that hill gardening was an important source of crops in this area. Areas of hill country with slope less than 30 degrees and aspect from east through north to west total 75 ha. These areas are within a short distance of the pa.

The hill country between Kaitaratahi and Ormond is separated from the main river course by the first extensive tract of poorly drained backslopes of the levees. There are no pits in the hill country here, although there is some evidence of oven building and darkened soils generally on the levees themselves. The Waipaoa River occasionally breaks out to the east in flood immediately to the south of Kaitaratahi Hill, with the resultant sediments obscuring sites on the levees there. On the slightly elevated slopes at the foot of the hill, where floods cannot reach, there is a significant area of ovens and blackened soils with associated pits and pa in the hill country.

On the western side of the river there are very substantial volumes of pit storage in close association with Waihirere silt loams. Pa Y17/36 (Wilson 1987: colour plates) has 630 cubic metres. Both this pa and Popoia Pa (Y17/37) (Tairawhiti Maori Association 1932: 12–14) have limited areas of accessible hill soils totalling some 30 ha. Unfortunately, river erosion has removed much of the closely associated areas of ovens and gravelly soils on the flats (Y17/398, 450). Typical test pit stratigraphy on the flats at Y17/398 consists of 30 cm of grey flood silts over 10–25 cm of dark grey silt loam with gravels and some burnt sandstone. This site covers an area of some 2 ha. On both sides of the river in this general location there are tracts of gravelly soils in positions where the natural levees have been eroded away and gravel-bearing floods have topped the Waihirere silt loams. The soils are nevertheless also mixed and cultivated.

WAITUHI-WAERENGA A HIKA FAN (Figure 5)

South of Ormond the river valley widens rapidly and a large fan has formed which has had some subsequent erosion. To the west is Lake Repongaere in low hill country. To the east, on the back slopes of the levee, rises the Taruheru River, flowing south-east until it enters the sea through Gisborne City. There is some evidence of prehistoric cultivation on the levee soils of the river, and pits occur on the substantial colluvial fans on the east of the valley. The present-day Maori settlement of Waihirere on one of these fans supplied the type name for the group of soils of principal concern in this paper.

Archaeologically, the density of surface-visible settlement both on the fans and hill country in this general locality is reduced because of intensive modern cropping and horticulture. Nevertheless, aerial photographs taken in the 1950s (RN 2159/4–8; 2160/4–8, August

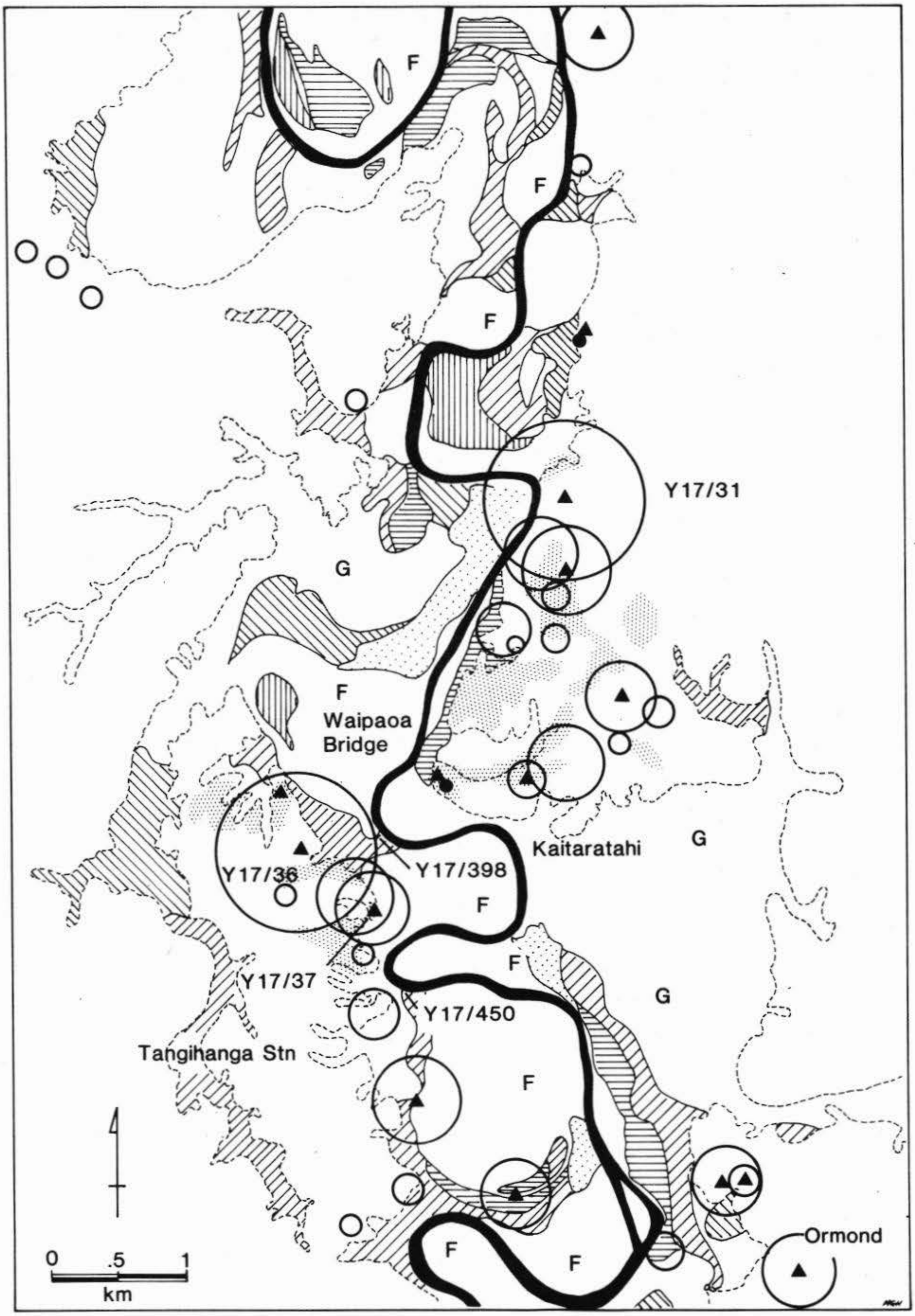
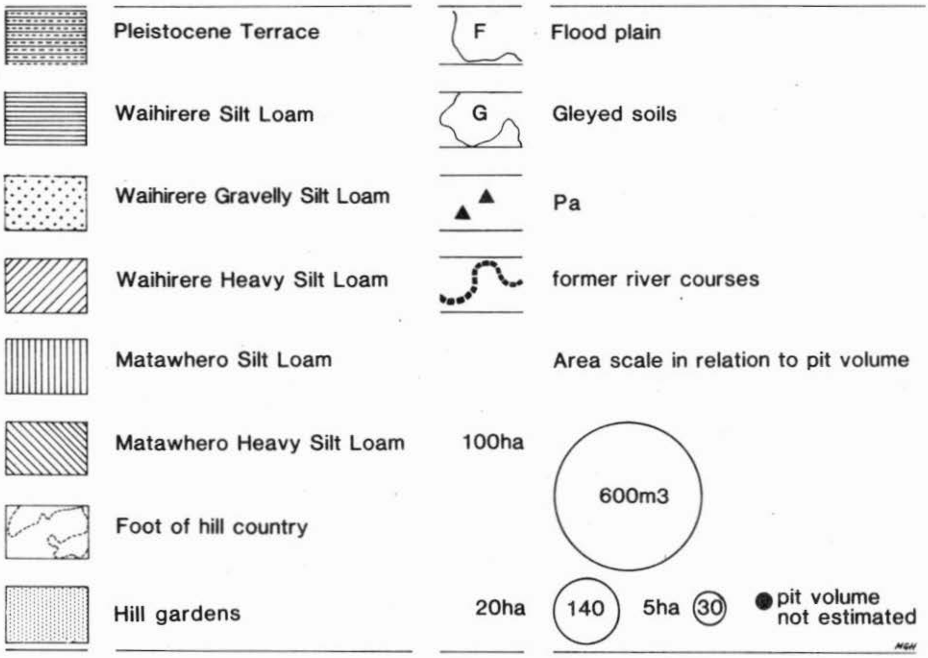


Figure 4: Pa, soils, and inferred area of crop from storage pit volumes, Te Karaka/Oromond. Hill soils shown only for the Waipaoa Bridge locality. Key to this and subsequent figures on opposite page.



1953), in the spring ploughing season, strikingly confirm the density of settlement by the presence of traces of ploughed-out ovens. The massive Waerenga a Hika fan deposit comprises some 200 ha of Waihirere silt loams (including 110 ha of the gravelly topsoil phase), with a somewhat larger area of heavy silt loams on the back slopes draining towards the Taruheru River. The Maori settlements on this fan were the principal focus of the conflict between Pai Marire and European forces (with Maori allies) in 1865 (Belich 1986: 210). The conflict was not primarily about land, but it is not without significance that this area was and still is the prime horticultural locality of the Waipaoa plains.

Horticulture and settlement took place in strips up to 1 km wide along the river edge of this belt of soils, as evidenced by concentrations of ovens, blackened soils, artefact find spots, and fractured gravels, with particular concentrations on the Waihirere silt loams (Fig. 6). Typical test pit sections at Y18/159 showed 15–20 cm black soil with charcoal, fractured ovenstones, and gravels, with a yellow-brown silt loam subsoil at 25–30 cm depth. This locality is known for the large numbers of type 2B argillite and nephrite adzes found. Besides the original heat-fracturing, ovenstones have generally been further comminuted by ploughing and discing.

The gravelly topsoil phase which is located nearest the edge of the fan was particularly heavily settled, with deep mixing and blackening of topsoils. Such gravelly topsoils occur on fans and levees elsewhere in the eastern North Island, where they are the result of massive floods overtopping eroded levees and leaving a deposit of gravels (Jones 1986). Soils with naturally occurring gravels are likely to have been used opportunistically. With subsequent mixing by gardening, general considerations of the likely pattern of levee erosion and massive flooding provide the best insight into the correct source of the gravels. The saving in labour arising from the natural occurrence of gravels in topsoils is evident.

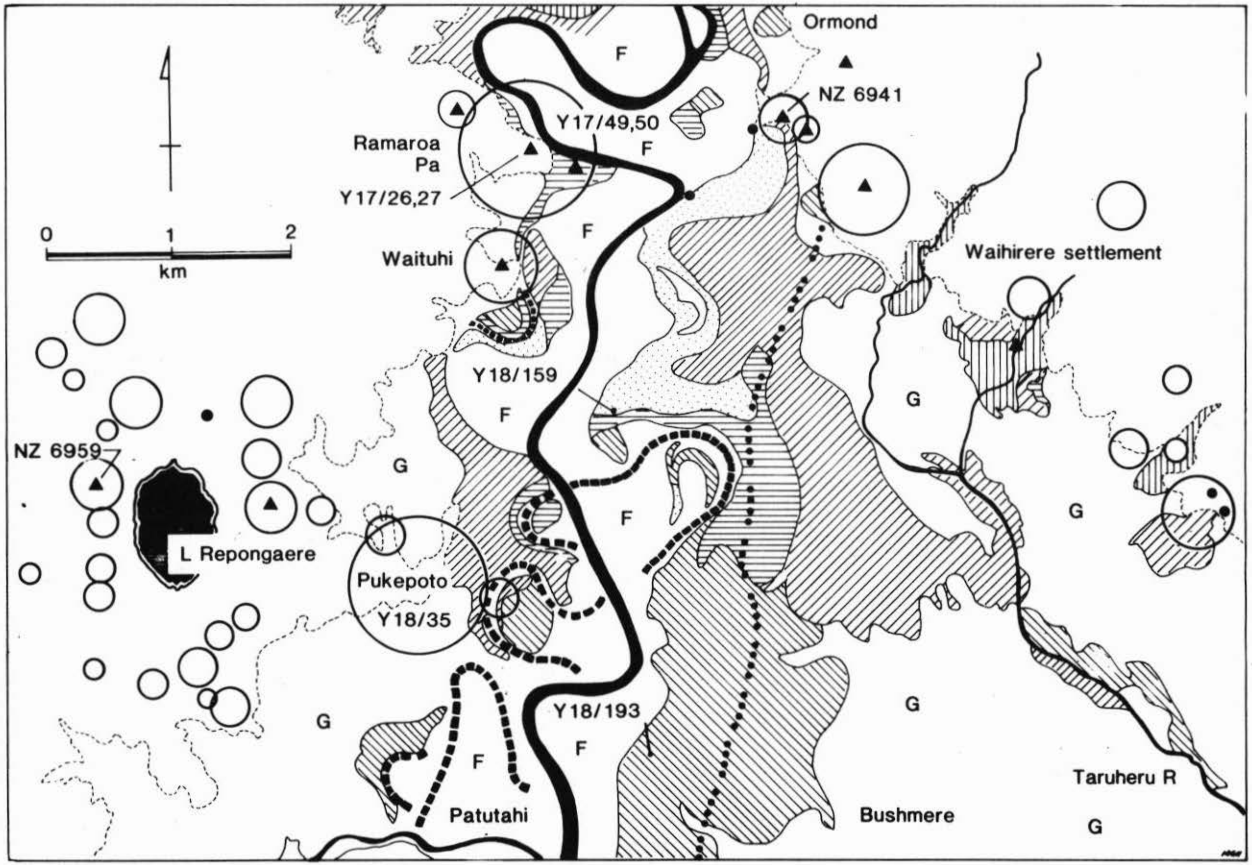


Figure 5: Pa, soils, and inferred area of crop from storage pit volumes, Wairenga a Hika/Waituhi. The bold dotted line indicates the eastern edge of oven concentration.

Figure 6: Vertical aerial photograph of the Waerenga a Hika vicinity. Note ploughed ovens within 800 m of Waihirere terrace edge. The black patches are up to 30 m across. SN 818, 2159/7, 24.8.53. Note dendritic drainage pattern to the south-east in the area of the gleyed backslope soils. Photograph: Department of Survey and Land Information.

Topsoil gravels have added importance where levees have had their silty near-river margins eroded leaving only the heavier backslope clay loam variants of the soil. The presence of gravels, improving the physical qualities of a soil, would have been essential in such circumstances.

The carrying and addition of gravels by human beings is difficult to establish. Any such addition would comprise gravels of the same type as flood gravels, since they came from the same river course, and would be masked by the volume of naturally occurring gravels.

In the Bushmere vicinity to the south of Waerenga a Hika, the soils are mainly Matawhero silt loams. This is the area where the Waipaoa River broke out to the east in the 1948 flood (Pullar 1962: Fig. 4). There is a lesser concentration of black patches in this area. Y18/193 has areas with up to 40 cm of grey, gravelly topsoils, and smaller areas of black topsoils, charcoals, and fractured ovenstones.

Emphasis has been placed in the course of this paper on the association between levee silt loams and the volume of storage pits in adjacent hill country. In this particular area, because of the separation of the main area of garden soils from the hill slopes, this cannot be argued except by reference to the likelihood that evidence of pits has been destroyed by subsequent activity. Moreover, there is an area to the north-east of the Waerenga a Hika flats where there is a close association between settlement on the flats and pit storage and pa on the adjacent hill country.

To the west, the association of pit storage and gardening on silt loams is clearer. Unfortunately, the general sweep of river erosion has been to the west and the bulk of the terrace silt loams has been eroded. The silt loams are mainly heavy in character, reflecting their origin on the back slopes of the original levees. There are also no Matawhero silt loams, a situation similar to that which occurs in the narrow parts of the valley to the north (see Fig. 4). These silt loams only become important in the lower broader parts of the valley where the levees are re-worked and eroded to a lesser extent.

Two very large pa and pit complexes occur in this area. North of Waituhi is the large Ramaroa Pa complex (Y17/26, 27) which is on a ridge facing down river and adjacent to an area of Waihirere silt loams. This vicinity was also the site of the first Pai Marire settlement on the plains, Taureka (Y17/49,50), indicating continuity into the nineteenth century (Halbert 1932). The Pukepoto pa complex (Y18/35) is at Repongaere to the south of Waituhi. The flats here are mainly heavy silt loams which have very strong concentrations of fractured oven stone (the result in part of modern discing) and areas of blackened soil. The fractured oven stone masks the possibility of determining whether gravels have been added to these soils, although they would be prime candidates. Both the pa complexes have massive volumes of pit storage. Ramaroa Pa in particular has individual pits of considerable size with total pit volumes well in excess of that suggested by the area of silt loams in the vicinity using formula 2 above.

To the west in the hill country in the Lake Repongaere vicinity, there is a considerable volume of pit storage dispersed in small discrete pit/terrace sites. These are interpreted as hamlet-style gardening by extended family units. Two pa also occur here. One of these pa has a minimum age for defensive construction of 460 ± 54 years B.P. (NZ 6959).

Apart from the Lake Repongaere pa, there are no radiocarbon dates for settlement in this segment of the valley. The pattern of oven crop marks is similar on both the Matawhero and Waihirere silt loams, although somewhat denser on the latter. Given the maximum age of the Matawhero silt loam surfaces of some 300–400 years, this suggests that the bulk of settlement is late prehistoric or nineteenth century in age.

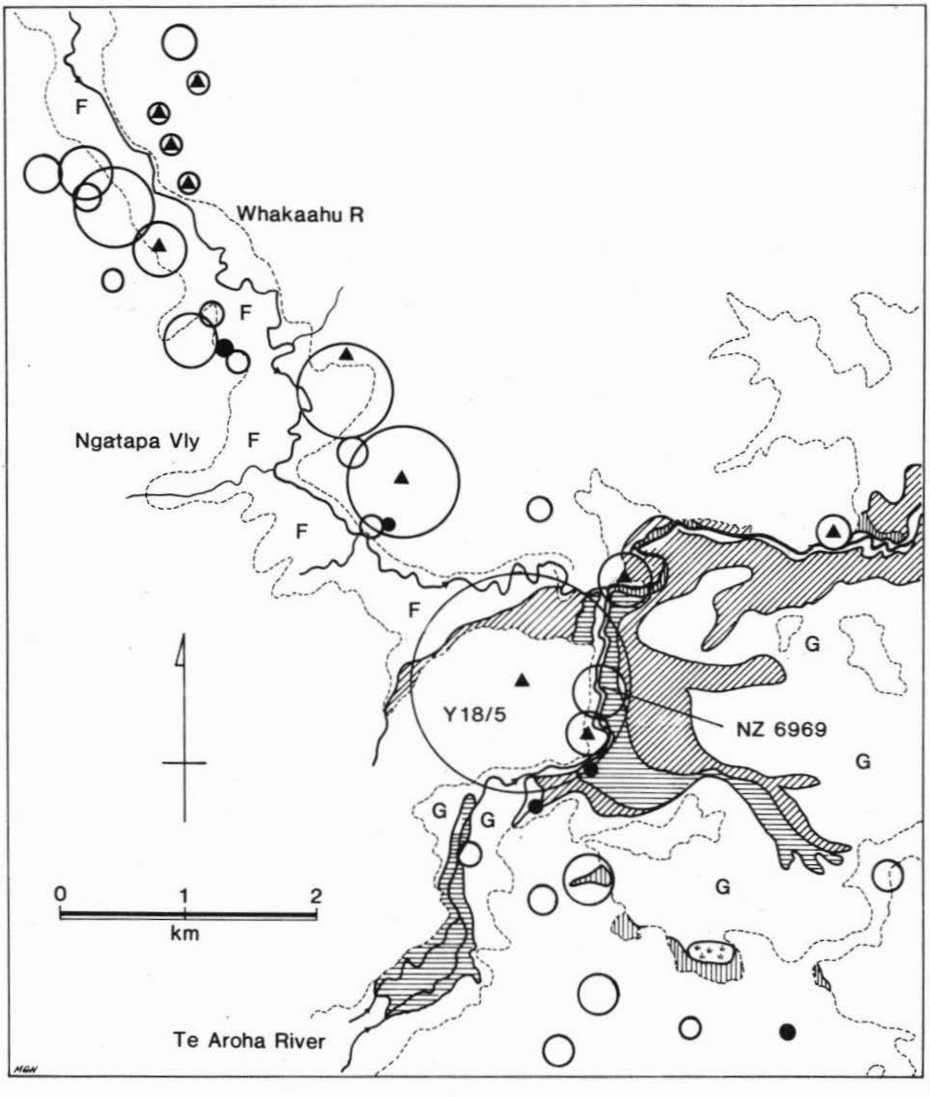


Figure 7: Pa, soils, and inferred area of crop from pit storage volumes, Whakaahu fan.

NGATAPA VALLEY—WHAKAAHU FAN (Figure 7)

This fan lies at the entrance to the foothills west of Patutahi. It is the product of two streams, the Whakaahu Stream running in from the Ngatapa Valley to the north-west, and the Te Aroha Stream running in from the south-west. On debouching from the hill country, the two streams at one time flowed to the south-east with the attendant building of fans. As the sediments built up, the combined course of the streams altered direction to the east, entering the Waipaoa River in the vicinity of Patutahi. The fans comprise one of the larger compact areas of Waihirere silt loam in the whole valley with a total area of some 83 ha and a somewhat larger area of heavy silt loams downslope. The age at which the fan ceased to build up following the eastern change in the course of the streams is not clear but it is likely to be older than the accepted maximum age of Waihirere terraces in the main part of the valley. Pullar and Penhale (1970: 433) date this cessation to the period immediately after the Taupo eruption, i.e., about 1900 years B.P. There could be a correspondingly larger maximum age for human settlement on this fan. A radiocarbon date for shell adjacent to a raised rim pit (Y18/309) is 653±42 years B.P. (NZ 6969). The pit is on a small promontory formed by the deeply incised bed of the Te Aroha River.

The association between the date and the pit (and hence horticulture) is not secure, since the shell could either have been thrown down by the rim or the pit could have been excavated into dense shell midden. The latter is relatively unlikely since this is one of the most inland locations for midden in the catchment and its volume is considerable. The land snails from a bulk midden sample from this site require "a primary woody plant cover" (Climo pers. comm.).

A forest cover at this date could only have developed on silts older than that expected for Waihirere silt loam, confirming the interpretation of age put forward by Pullar and Penhale.

One of the largest pa/pit complexes (Y18/5) on the Waipaoa Plains lies on the ridges west of the fan with a pit storage volume of 1300 cubic metres. Part of this complex is shown in Figure 8. Other smaller pa occur in the immediate vicinity. The significance of this pa complex adjacent to a major frost-free fan is further discussed in a later section of this paper which discusses population potentials of the valley.

The enclosed valleys of the Whakaahu (Ngatapa valley) and Te Aroha Rivers are both prone to frost, although there is a small volume of pit storage on Waihirere silt loams in the

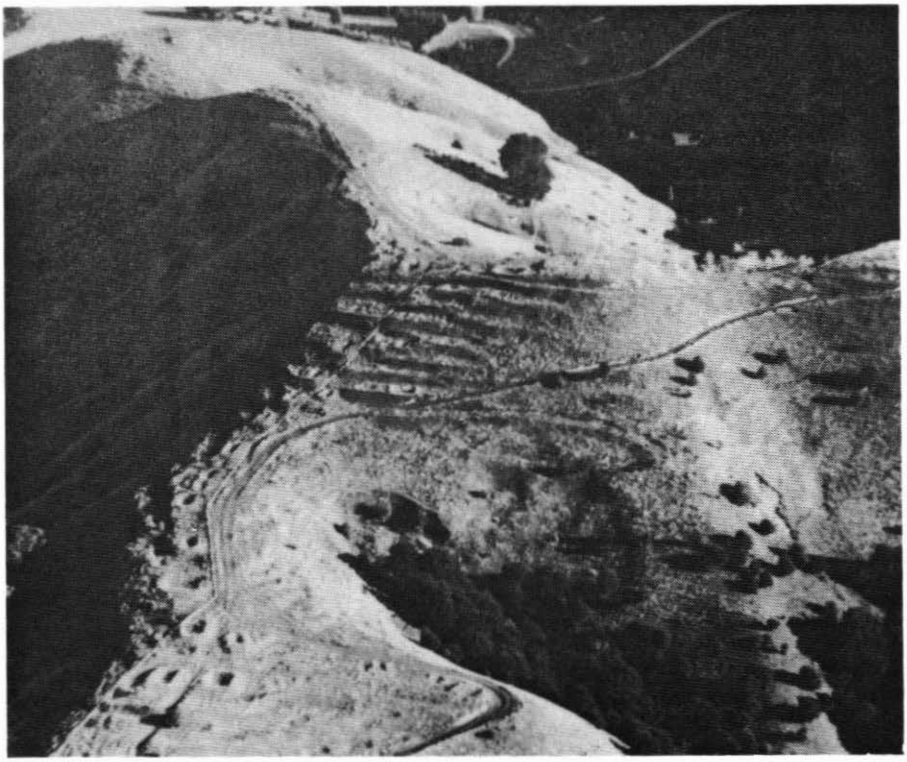


Figure 8: Terraces and raised rim pits on ridge above Whakaahu fan. Photograph: Kevin Jones.

Te Aroha valley. The Whakaahu valley floor is substantially a modern flood plain which must have obscured any trace of settlement on the valley floor. The sediment build up here is in strong contrast to the adjacent Te Aroha valley which has quite stable land surfaces. This contrast probably arises because the wider catchment of the Whakaahu valley is large and has no archaeological evidence of settlement. It was not cleared until late nineteenth century European settlement. The only prehistoric settlement in the Whakaahu valley was in the lower 5 km upstream from the main fan. In an area where sandstone bluffs narrow the valley to a width of some 500 m, there is a remarkable concentration of pa and a moderate volume of pit storage. The pit storage would derive from gardens based on the easier elevated hill slopes away from the edge of the valley. The association of small volumes of pits with areas of easy broad ridges close to the valley floor is also evident in several places between the main fan and the sandstone bluffs noted above.

MATAWHERO VICINITY LEVEES (Figure 9)

Matawhero is in the lower part of the Waipaoa River and is the site of the principal road crossing since there is a small, isolated area of Waihirere silt loams both east and west of the river providing a flood-free footing. Both south and north of the bridge are extensive tracts of Matawhero silt loams. The Matawhero vicinity has been in recent times the site of intensive horticultural development, and is the area of Waihirere silt loams nearest the coast on the main river.

The Waihirere silt loams occur in small arc-shaped areas on the main river bank, and around an abandoned loop in the river north of the main highway. There is another larger loop south of the highway cut off by engineering works in the 1950s which is generally known as the "Matawhero loop".

Ovens and gardened soils occur in several places. Soils with added gravels (Y18/161) extend over one hectare or more on the eastern bank of the northern loop. Test pits in this area vary from 25–30 cm of dark grey silt loam topsoil with and without gravels to 30 cm of black topsoil with burnt sandstone fragments, bone, shell, and nineteenth century ceramics. Not far from this, also on the eastern bank of the abandoned loop, a cutting along the original line of the river bank exposed an oven (Y18/162) in silty subsoils. This has a radiocarbon date on shells of 715 ± 45 years B.P. (NZ 6940). A date on shell in silty subsoils beneath oven rake-out mixed with gravelly Waihirere topsoil on the western bank of the river in this locality is 574 ± 56 years B.P. (NZ 6931). These dates provide useful confirmation of a minimum age for the cessation of silt deposition on Waihirere terraces (cf. Grant 1985: Fig. 5). They also indicate early occupation of the Waipaoa River from the earliest time that stable land surfaces were available. The sites of earliest date are very limited in extent, although they exist in association with more extensive evidence of later Maori settlement. Their association with gardening on the levees is not clear, although the fresh surfaces of the recently flood-free terraces would have been very well suited to gardening. The sediments were in large part the product of stripping of fine silt topsoils elsewhere in the catchment, and there would have been little cost involved in the clearing of vegetation. Similar soils with charcoal of slightly later age in the Whakatane catchment had a light forest succession at the time of first burning (Jones 1986: 7).

Matawhero silt loams are also extensive in this area, reflecting the type locality. There are extensive areas of ovens, middens and some gravelly topsoils both in the Bushmere vicinity (discussed above) and in the area of the principal Matawhero loop south of the

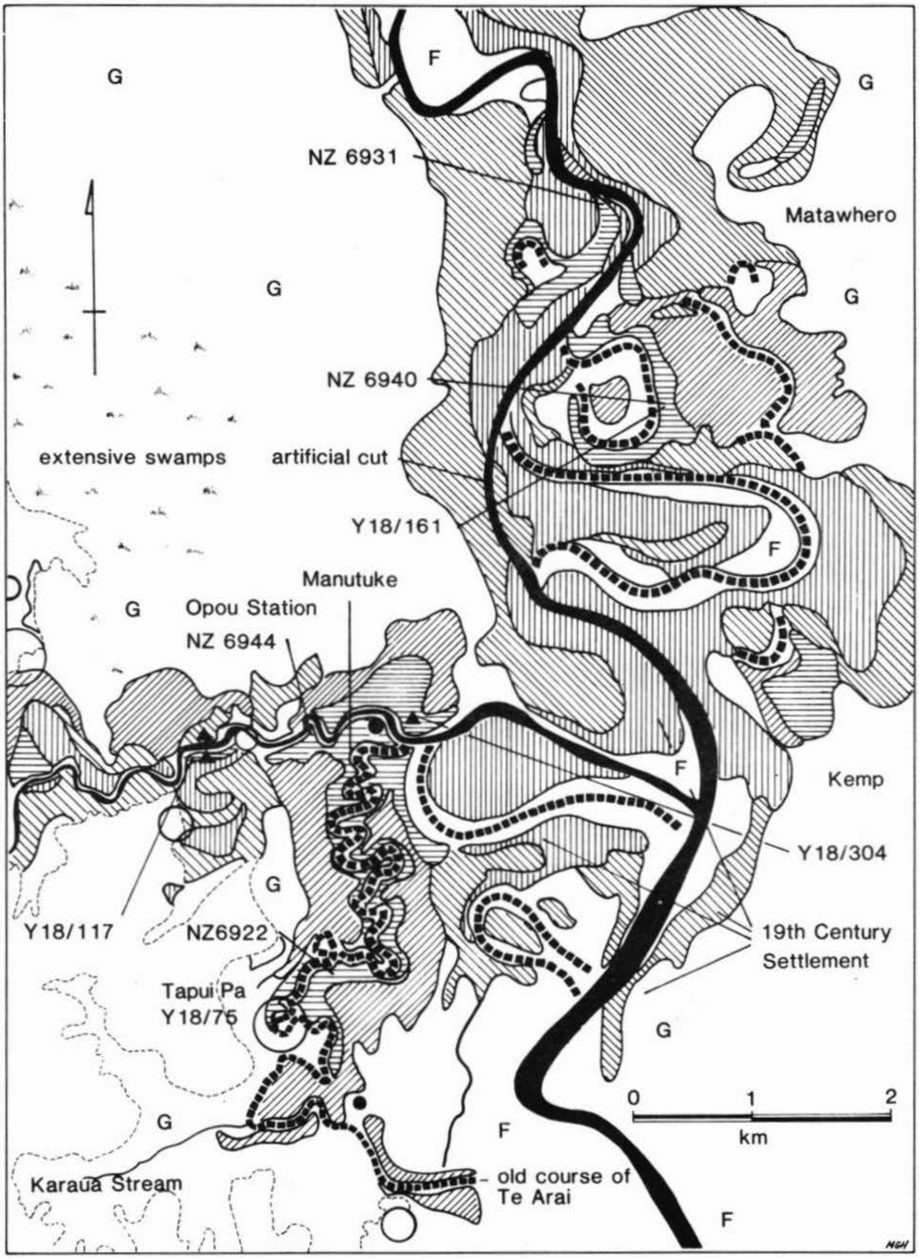


Figure 9: Pa, soils, and inferred area of crop from storage pit volumes, Matawhero/Manutuke. The Manutuke fan extends from the point where the Te Arai River leaves the hill country to the abandoned westwards loop of the Waipaoa River.

main highway on the Kemp property. A substantial midden and oven complex on the latter property has not been dated because it is prehistoric in age, to judge from a nephrite pendant from the site now in the Gisborne Museum, and would have a maximum age no older than the Matawhero soils on which it occurs, i.e., the date lies between 200 and 450 years B.P.

MANUTUKE TOWNSHIP–OLD COURSE OF TE ARAI RIVER (Figures 9, 10)

Manutuke is the principal settlement of the tribal grouping Rongowhakaata, and lies at the nineteenth century confluence of the Waipaoa and Te Arai rivers. The latter river has a large catchment draining the lower western part of the Waipaoa valley. Its original course debouched from the hill country and then flowed south along the western foothills of the main valley, eventually coming out into the Waipaoa estuary. With the build-up of sediments on the fan, the river eventually broke out of this course directly east into the course of the Waipaoa River. The age of this change has considerable relevance to the setting of maximum ages for settlement at various points along the course of the river. Because the abandoned course has only Waihirere terraces on its sides, and no evidence of re-working in the Matawhero period, Pullar and Penhale (1970: 421) dated the abandonment of the course to the period of Waihirere sedimentation, i.e., to about 650 years B.P.

The abandoned course is a dominant feature in present-day Manutuke land use and tenure, and it still serves to drain the low-lying areas to the south of Manutuke township with an ultimate outlet controlled by tidal flood gates to the former Waipaoa estuary. The banks of the old course run for some 7 km from Manutuke to the estuary and have some archaeological evidence along their whole length. Because of the slight gradient, the downstream end of the abandoned course consists of a sinuous lake or wetland for about 1.5 km, while the bed of the river in the Manutuke vicinity is dry.

Waihirere silt loams occur in narrow strips along the meandering channel, but are most compact and extensive in the vicinity of Manutuke township. Their total area is 150 ha. A now-abandoned loop of the Waipaoa River which extends west to the vicinity of Manutuke township has only Matawhero soils on its banks and therefore dates to the period after 450 years B.P. It appears to have eroded some of the area of Waihirere soils once available to the first Polynesian settlers of this locality. The concentration of prehistoric settlement on the Waihirere silt loams, however, developed after the formation of the loop in the Matawhero period, i.e., later than 450 years B.P., since that was the only period in which access to this particularly desirable large concentration of soils would have been possible from the main river system.

At Manutuke, modern town development has effectively destroyed any surface features of prehistoric settlement. Obsidian, adzes, midden and nineteenth century material are common from the principal area of settlement which was on the Waihirere silt loams adjacent to the main Waipaoa River loop, in the general area of the existing and earlier road bridges, and further south for one kilometre along the banks of the old course of the river where the principal marae of Rongowhakaata are today. Crop marks of ditches and banks appear on the 1948 aerial photographs at the point where the old course of the Te Arai was cut by the Waipaoa River at the western extremity of the loop (Fig. 10). These form dogleg enclosures on the banks of the small stream which entered the river at this point. This vicinity, despite very recent building activity, is said to be highly tapu. A description of one of the principal fortifications in this area is given by Williams (1932) and suggests a defensive structure of considerable extent. The detail of this account must be regarded

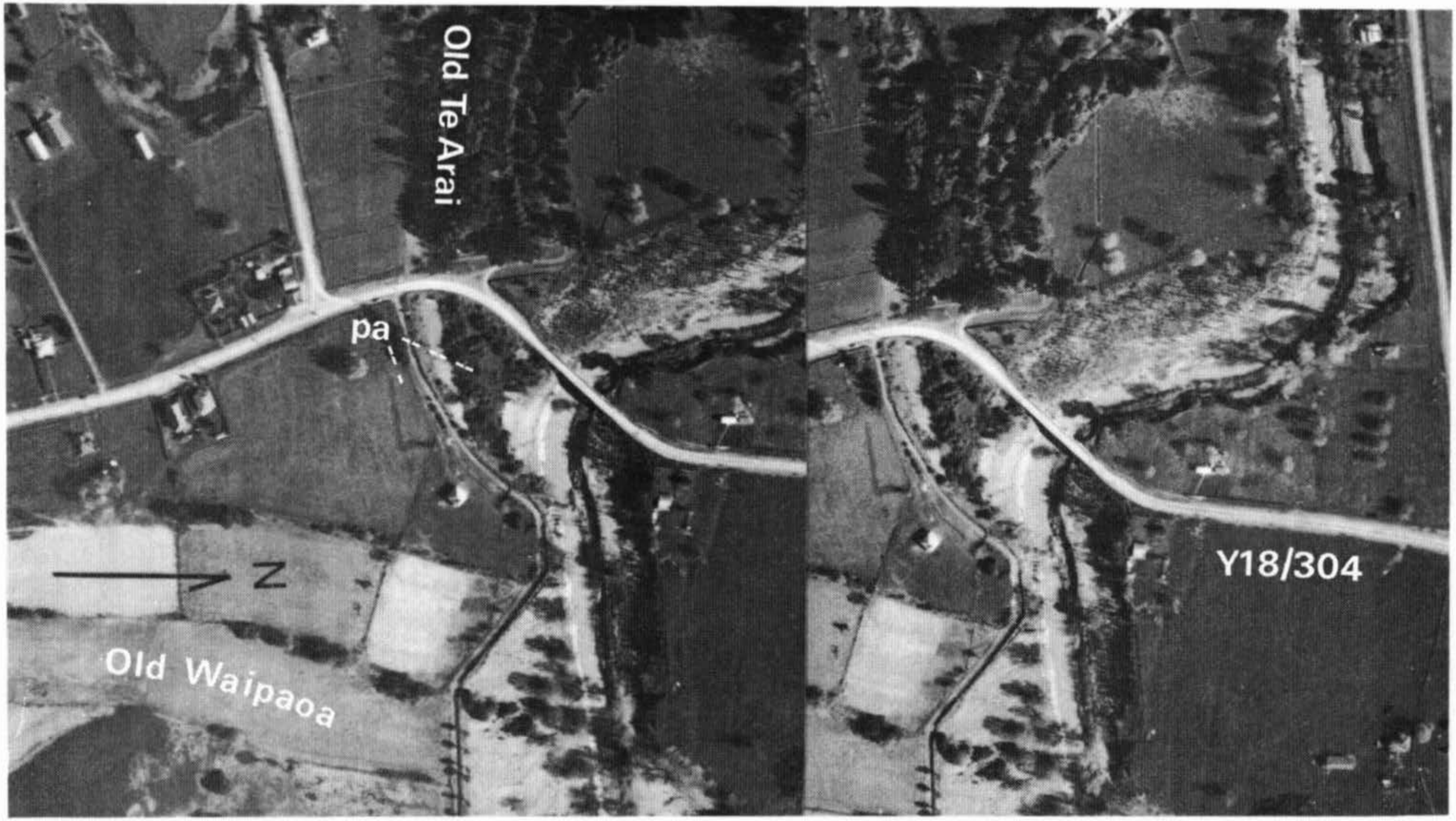


Figure 10: Partial stereo pair photograph of Manutuke after the 1948 flood. Scale 1 : 5000. Two pa show in relief at the intersection of the Te Arai River (flowing east on the northern edge of the photograph) and the former river courses. Photograph: SN 521, D/34, Department of Survey and Land Information.

as apocryphal since the date of the structure concerned precedes any possible eye-witness account on Williams' part.

The only possible fortification still surviving in the Manutuke vicinity is on Opou Station, east of the Te Arai River bridge on the Waihirere terrace on the north bank of the river. It would therefore have been on the north-eastern outskirts of the main settlement. It comprises a faint ditch and bank enclosure of the river bank (Y18/304), and is sometimes known as Tapatahi Pa. A line of pronounced ditch and bank lies at right angles to the line of the river bank in the 1948 aerial photograph (SN 521, D34–35). This is an extension of a pa which runs into the site complex mentioned above. Enclosing this area again is a second very faint ditch and bank line enclosing a larger area. Shell midden and oven debris are exposed in the edge of the Waihirere terrace; in the course of gathering a sample, earthenware and a bone button were found. It is probable that such a shell sample would provide a date older than the nineteenth century age suggested by the button since the midden had been mixed in the topsoil. The general vicinity of this site was an important landing place in the nineteenth century, navigable by ocean-going vessels until the main Waipaoa River course reverted once again to the east. The only radiocarbon date available for the Manutuke vicinity is for a midden (Y18/298) exposed in the edge of a Waihirere terrace on the Te Arai River about 1 km upstream from the bridge. This is on cockle shells and dates to 408 ± 30 years B.P. (NZ 6944). This is consistent with the maximum age of concentrated settlement at Manutuke, earlier suggested to post-date the onset of Matawhero sedimentation at 450 years B.P.

About 1.5 km upstream from Manutuke on the Te Arai River there were two pa forming rectangular enclosures of the river bank in mirror images on opposite sides of the river bank. They were bulldozed out in the 1940s and 50s, although aerial photographs exist of one of them (Y18/117) (SN 521, D34–35).

The Tapui Pa complex (Y18/75) lies on either side of meanders in the former course of the Te Arai River about 4 km south of Manutuke. As at a number of other pa in riverine meander belts in the Gisborne area, the interlocking bends of the river have ditch and bank defences in mirror images one of the other (Fig. 11). This clearly amplifies the defensive effect of the work as a whole, with the linear swamp forming another zone of defence within the pa. It is also conceivable that the construction is designed to restrict movement along the river or to secure access to resources in the river, such as migrating eels.

The pa lies entirely on Waihirere silt loams, which suggests that it could have a maximum age of 650 years, i.e., the latest age when the river still actively flowed through this point. If the pa was built on the dead course of the river it would date to the period after 650 years B.P. and we are left with the problem of why it is located where it is. It is actually on the first area of Waihirere silt loams on the old course of the river, proceeding from the former estuary of the river to the north. The course of the river is quite obscure from this point to the estuary because of sediment build-up from flooding in the adjacent Taurau Valley. However, there must have been some residual drainage from the old course of the Te Arai into the estuary, with the possibility of fairly direct canoe access from the sea and estuary to the pa, hence the location. A further resource that the pa would have been in a prime position to control would be eels in the old course of the river. The same observation applies to the pa at Waerenga a Hika, earlier discussed, which also lies adjacent to the downstream end of an abandoned course of the river.

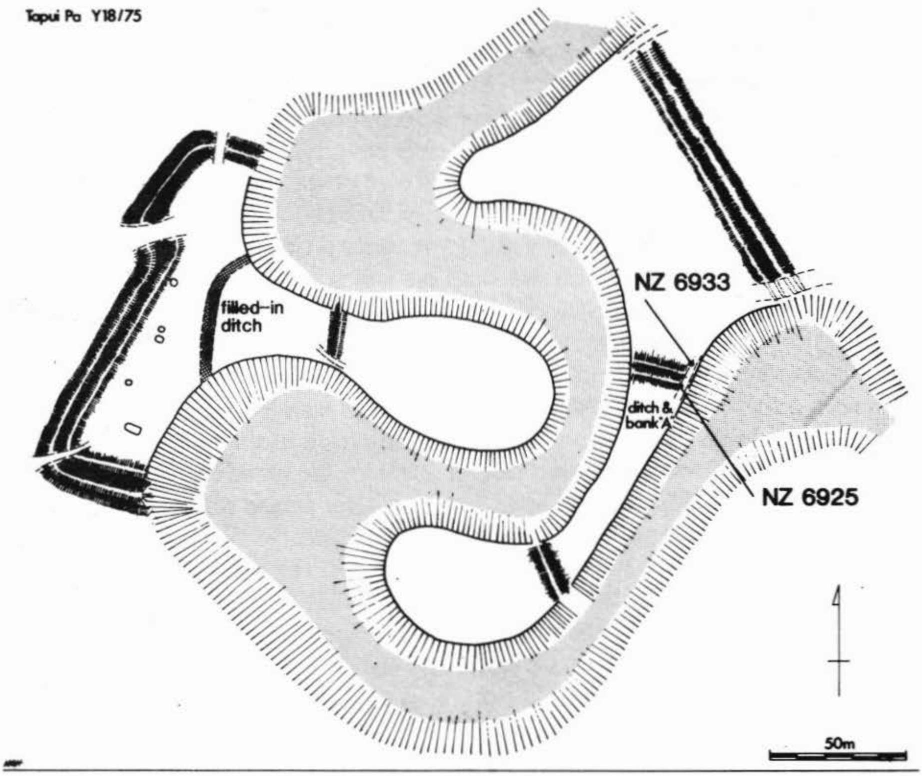


Figure 11: Tapui pa (Y18/75) on the old course of Te Arai River. Plan after map prepared by Department of Lands and Survey, Gisborne.

The pa survives in good condition and warrants closer discussion of the detail of its construction. The eastern side of the river forms a tongue of land which has been cut by three ditches and banks. All three have had both ends cut by roads, exposing midden in the original topsoil sealed by the ditch and bank. Dates for these are discussed later. On the western side of the river course a further tongue of land extends parallel to the eastern side. This is cut by two ditches and banks similar to those of the eastern side. The outer of the ditches has been infilled and shows only as a slight linear depression across the base of the tongue of land. Outside this again is a visually impressive double ditch and bank running for some 200 m and enclosing a relatively small area of the river bank. Rather inefficiently, considering the size of the work, it adds only 3,000 square metres to areas already defended of 4,000 square metres (western bank) and 8,000 square metres (eastern bank). The corresponding outer ditch and bank on the eastern side is stylistically similar, but much more efficiently encloses a relatively large space. Both the sets of outer ditches and banks are judged to be of the same age because of the stylistic similarity, and they were presumably constructed later than the inner ditches and banks, since one of the inner ditches appears to have been deliberately infilled. The middle of the three eastern ditch and bank sequences provides the following radiocarbon dates (Fig. 12). From a buried topsoil beneath bank fill there is a radiocarbon date on cockle shell of 300 ± 34 years B.P. (NZ

6925). From topsoil adjacent to this bank there is a date on shell of 360 ± 26 years B.P. (NZ 6933). This gives a minimum age for occupation of the area of about A.D. 1600 and a maximum age for construction of the bank of about A.D. 1650. Some 300 m north of the pa, a midden exposed in a road cutting in the river bank is dated at 324 ± 54 years B.P. (NZ 6922).

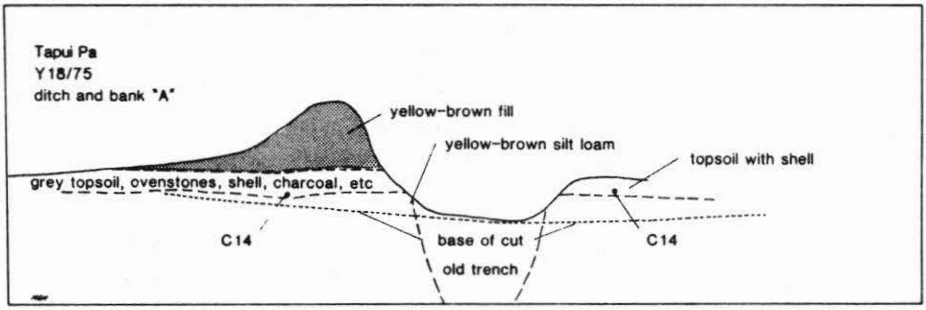


Figure 12: Ditch and bank sequence, eastern side of Tapui pa.

Greenstone adzes are known to have come from the site, and there are storage pits enclosed in the southern part of the western defences. The river loop to the south of the main pa complex has middens and nineteenth century evidence on it, and a number of crop marks show on air photographs. This loop may also have had transverse ditches (Y18/292, 293) shown by trench or pit-like fills in road sections around the edge. The soils here are Waihirere heavy silt loams, whose usage probably reflects the small area of light soils in this particular vicinity. This was also the case at Pukepoto north of Patutahi, discussed above.

MURIWAI VICINITY (Figure 13)

Muriwai is on the coastal plain by the former estuary of the Waipaoa River to the southeast of Manutuke. The Maori settlement of Muriwai proper is on a small area of Waihirere heavy silt loams deposited by the small stream to the south. On the highway to the north of Muriwai, midden is exposed as a distinct layer beneath mixed fill at the foot of the principal slope to the south-west of the former estuary. This midden has a date of 840 ± 25 years B.P. (N.Z.6926) (Fig. 1).

Rangihoua Pa (Y18/89) (Wilson 1987: 110–111) lies on the cliff edge forming the southern end of Muriwai Beach. There is a radiocarbon date of 350 ± 32 years B.P. (NZ 6916) for midden in fill forming a major terrace. The lower course of the river from Manutuke to Muriwai appears to have had a considerable number of Maori settlements in the nineteenth century (SO 6392, 1868) but they have been prone to flooding and their archaeological visibility is low.

MARAETAHA RIVER AND VICINITY (Figure 13)

On the south-east coast between Young Nick's Head and the Maraetaha River mouth a sequence of middens is exposed at the sea-eroded edge of a colluvial slope (Y18/54) in Orongo Bay. Although no radiocarbon dates are available, the earliest layers are very closely stratified on Taupo pumice and a very early date for settlement here is likely (Green and Pullar 1960).

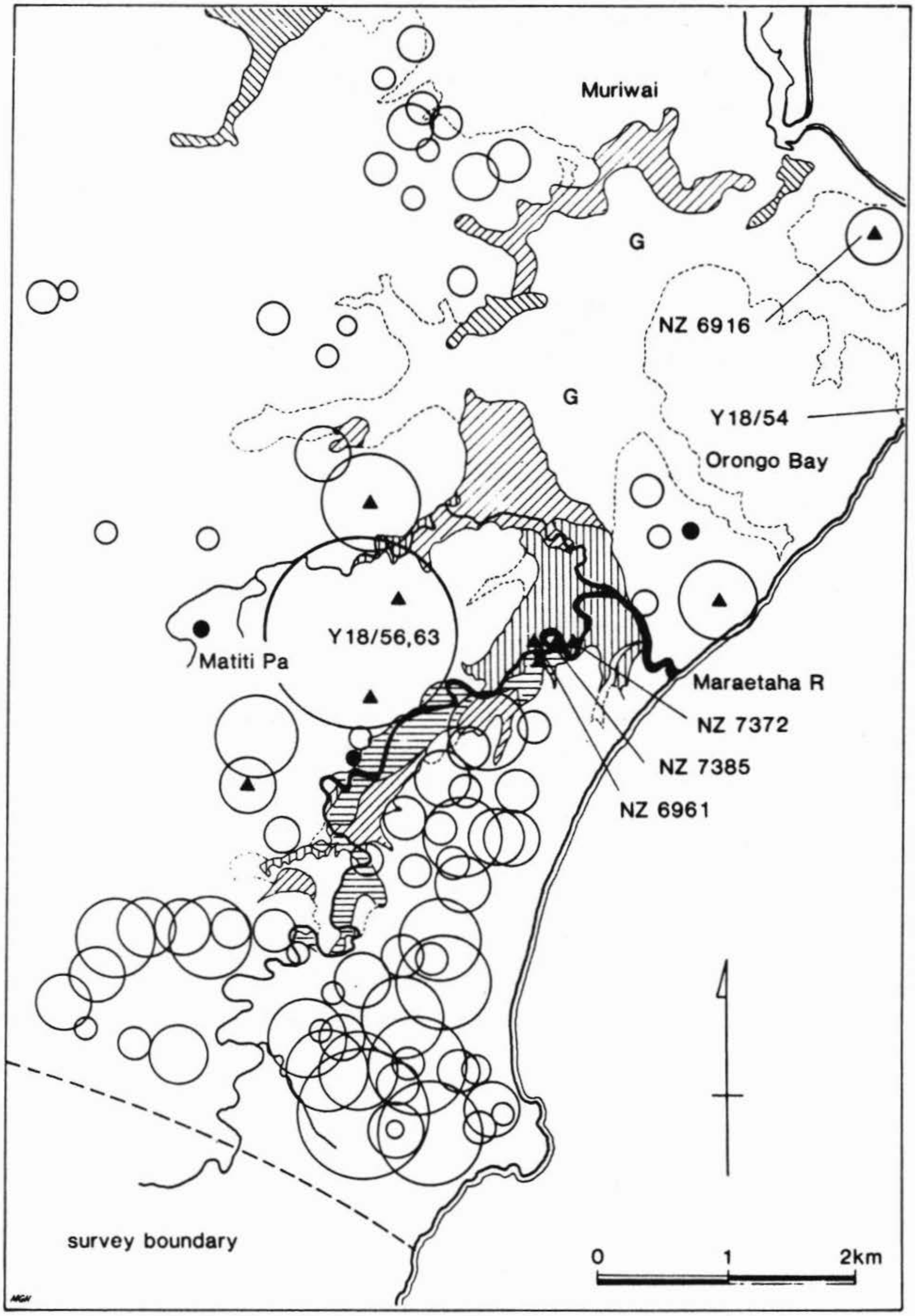


Figure 13: Pa, soils, and area of crop inferred from storage pit volumes, Maraetaha River.

The Maraetaha River drains a catchment of moderate size in the hill country to the south of the Waipaoa River mouth. The upper valley floor is restricted in width down to a point about 2 km from the sea, where it is abruptly confined by siltstone abutments below which a substantial fan has formed. Below the fan the gradient of the river is slight and it enters a broad meander before ariving at the sea. The hill country in the valley has a high density of pit volume, pit/terrace sites and ridge pa. One of the pa, Matiti pa (Y18/56, 63), runs along a ridge above and west of the fan for a distance of about 1.2 km. The density of horticultural activity reflects the advantages of coastal access and a warm, frost-free climate.

A complex of four pa on bends on the fan (Wilson 1987: 119) has often attracted attention and one of them was the subject of an unpublished excavation in the early 1970s. Wellman (1962: 42) recorded a section at the Maraetaha "diggings" and noted that the pa complex "cannot be more than a few hundred years old". Such an observation could be made of virtually every pa in New Zealand, but this particular pa complex has no associated traditions and is built in large part on the oldest flood-free Waihirere terrace (soils beginning to form at 600 years B.P.). Therefore the assumption that the pa are recent needs some examination.

The Maraetaha River is the most important of the few places in the Gisborne area where substantial numbers of riverine pa have survived in good condition. An opportunity is therefore provided to set maximum ages for the pa in relation to river terrace formation, and to check these against radiocarbon dates. This cannot be pursued in detail in this paper but it should be noted that the ditches and banks of these pa generally run for most of their length on Waihirere silt loams but do trend down on to Matawhero silt loams. The ditches at these positions and even the enclosed areas of the pa show evidence of flood scouring, and re-working of the ditches and banks in different positions. Two principal conclusions arise: first, the pa are built on surfaces that are no more than 350 years old and were exposed to flooding in parts; second, a response to flooding or population increase has been the re-building of defences away from the course of the river.

Three radiocarbon dates are available for three separate pa on the fan. These range from 296 to 320 years B.P. (NZ 6961, 7372, 7385) and include dates for pit fill, oven rake-out, and a sample in close stratigraphic association with a flood-eroded ditch and bank. Contemporaneity of occupation of the pa is strongly indicated, and occupation in or soon after the period of Matawhero sedimentation is confirmed. This means that a flood-prone but nevertheless productive and easily tilled area of Matawhero soils was available.

Although the pa are built on the remnants of a Waihirere fan which skirts the southern hill slopes, they are also in close association with a large area of Matawhero silt loams. These occur on the lower, northern part of the fan and result from the spilling of flood waters out of the usual course of the river (SN 78, E/8, 26.2.1938). Most of the terraces of the upper valley are Waihirere silt loams. The areas of soils concerned are: Waihirere, 54 ha; Matawhero, 75 ha. In addition there is an area of some 84 ha of Waihirere heavy silt loams on fans at the foot of Matiti pa. The two principal ridge pa west of the fan have very large volumes of pit storage, and were probably the principal storage areas for the products of gardening on the fan. The river bend pa complex has no pit storage visible on the surface since the interiors of the pa were ploughed following a flood in 1938. Pits were recorded in the course of the excavation of Y18/59 (Maraetaha "diggings", McFadgen pers. comm.) and a small pit was recorded in a river-eroded section on Y18/60 in the course of the present survey. In both cases the pits were on the higher flood-free Waihirere terrace.

POPULATION POTENTIALS IN A RIVERINE SETTING

In this review of settlement and horticultural potential of the Gisborne area, seven districts of the Waipaoa River valley and the smaller Maraetaha River catchment provided a range of settings in which it is possible to discuss the effects of climate, the relative importance of different soil types to traditional horticulture, and the potential for population concentration in certain critical areas based on intensification and larger nucleated settlement sizes.

An argument about concentration of settlement on the most desirable soils of the valley is made difficult by the pattern of site destruction arising from the use of the same soils in modern times. The surface destruction of sites is almost total on cropped flatland with the exception of narrow necks of land which are not economic to cultivate or in which a landowner has taken some care to protect the remaining surface evidence. Pit storage on alluvial flats is particularly weakly represented in the archaeological record. Its importance and likely presence on alluvial flats can be gauged from the presence of pits at the Maraetaha "diggings". The strongest evidence comes from areas where the well drained silt loams abut against the hill country as argued elsewhere (Jones 1986). In some locations in the study area, the volume of pit storage adjacent to large tracts of alluvial silt loams is very large, and survives largely because the hill country is not suited to intensive development. Areas with large volumes of pit storage occur near the Whakaahu fan (Fig. 7) and on the margins of the main valley from Repongaere to Waipaoa (Figs 5, 6). A surprising anomaly to this general rule occurs in the southern part of the old Te Arai channel near Tapui pa, where the adjacent hill country has no pit storage. This probably reflects the stable flood-free nature of the old channel area and the generally small area of suitable soils in that vicinity.

The younger Matawhero silt loams were also used but less intensively than the Waihirere silt loams. This could be the result of obscuring of settlement by the build-up of flood sediments, quite noticeable in the upper pa of the Maraetaha complex, for example. Despite this, the accumulated evidence is for a lower density of settlement. These would probably be the type of soils in use in 1853 when a flood "much greater than the oldest Maori remember" occurred. "Much food was washed away ... and a winter of great scarcity ... followed" (Grace 1928: 30). The reference to food here presumably relates to crops in the field, rather than to food stored in settlements. Some nineteenth century photographs of Gisborne township (Negative 101-9, Gisborne Museum) show crops grown on very low river terraces no more than 1–2 m above river level (Fig. 14). These would be on Waipaoa silt loams and although they do illustrate the use of extremes in the soil pattern they are unlikely to be typical. They may not be Maori, and they also reflect the shortage of good soils in Gisborne township which is in an area of sandstone hills, gleyed soils and inland dunes, and to which overland transport of crops from the main Waipaoa River would not be easy.

Gisborne is only marginally in the study area of concern to this paper, but it is not the only area of settlement in which alluvial silt loams were scarce. It must be stressed that soil availability is not the only determining factor in settlement pattern. At Repongaere, for example, heavy or even clay silt loams were used, probably with the addition of gravels. Lighter silt loams may have existed earlier in the span of human settlement here but were subsequently eroded.

Radiocarbon dates show clearly that the Waihirere silt loams were at least visited soon after their last deposition of flood silts. Because of the sparse nature of the sites from which

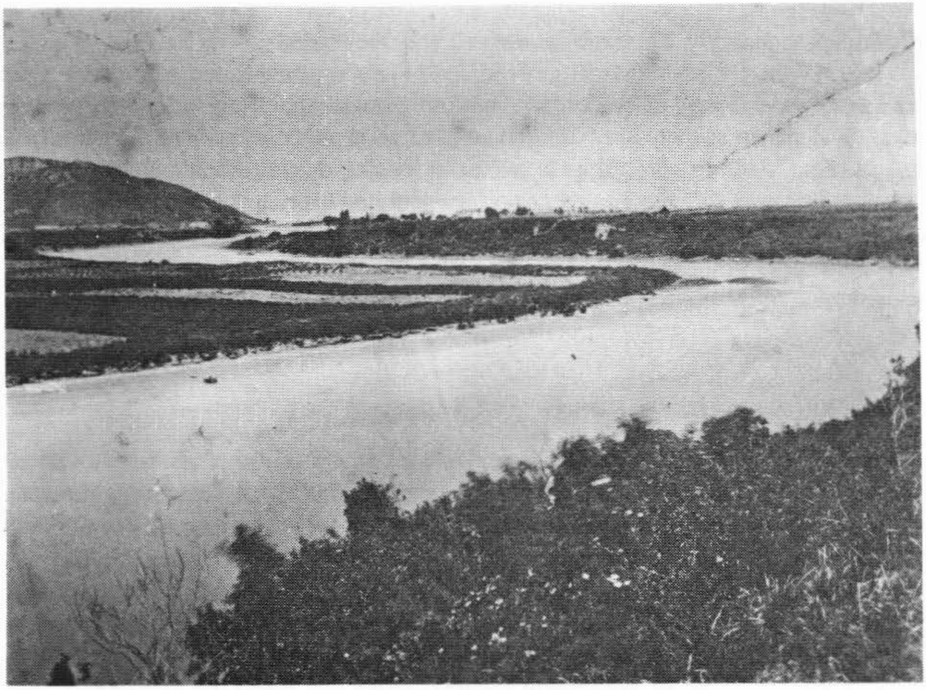


Figure 14: Crops, probably maize and kumara, growing on low terraces of the Waimata River, Gisborne. The locality is that of present-day Anzac Park. Photograph: Gisborne Museum.

the early dates are gained, and the general difficulty of dating physically mixed soils, positive evidence for horticulture at this date is poor. It is reasonable to infer, however, that the plains were in use for horticulture at this period. One advantage in the earliest horticultural usage of Waihirere silt loams would have been the relative absence of woody vegetation. A forest cover would have established rapidly on silt loams of good natural fertility and this would have been difficult to clear. At a time of established forest on Waihirere silt loams in the outer part of the meander belt (say 400 years B.P.), significant areas of Matawhero silt loams, recently flood-free, would be available in a clear or scrub-covered state nearer the main river course. The extraordinary biological richness and diversity of such riverine lowland zones has long been recognised (Odum 1959: 74–75). It is difficult to conceive of the importance of this diversity from the de-natured and manicured aspect of the modern landscape. Nevertheless, there are clues in the traditional nomenclature of the landscape itself. "Waerenga", for example, means "clearing" and suggests that the scale or even the very existence of such a clearing was notable.

RESPONSES TO CLIMATIC FACTORS

The Maraetaha River case demonstrates the importance of a coastal climate with relatively frost-free conditions, although it should be stressed that the density of settlement here would in part be the result of good access to the sea, both through the river and to a lesser extent overland to a fairly extensive sandy beach. The contrast in pit volumes between the areas north and south of the Maraetaha River (Fig. 13) arises because the northern area is cliffed rather than sandy. The extreme contrast with the coastal case is the Puha/Whatatutu area (Fig. 3), where gardening is largely restricted to elevated areas with a northerly aspect. In this area, the intensity of horticulture measured as volume of pit storage per unit area is much lower than at the coast. Settlement at Puha is nevertheless well reflected in the numbers of pa. Although this paper is primarily focused on settlement and horticulture, it is worth noting the likely importance of non-horticultural subsistence in this area. It should warn against too great an assumption of the importance of horticulture elsewhere in the valley. Special cases of the susceptibility of the traditional crops to frost also occurred in the enclosed parts of the main valley and in the side valleys such as the Whakaahu (Ngatapa) valley.

POPULATION AGGREGATES

In an earlier paper (Jones 1986), the importance of fans in major river valleys was considered in a cursory fashion. At Ruatoki, for example, Best documents many nineteenth century villages on the fan formed where the Whakatane River emerges from the Urewera Range. In that paper, I probably overstressed the response to the risk of frost in inland locations, particularly in dealing with a fan which slopes down to the north. The principal fans of the Waipaoa River are not as far inland as Ruatoki, so the frost risk is even less. In this section, selected pa/pit storage sites and the areas of soils on fans are interpreted in terms of population numbers using the formulae in Jones and Law (1987). Where possible, populations determined from pit storage are compared with the potential productivity of fan areas. Potential fan populations may be derived from the figure for productivity of cropping offered earlier of 4 tonnes/ha, and an annual intake of kumara equivalent to half adult calorific needs (1000000 kcal). At a conversion rate of 1250 kcals per kg of kumara, this gives an annual consumption of 400 kg. With a fallow ratio of 1 : 2 for the whole of a fan, population density would be five people per hectare. The fallow ratio may appear high, but Maori agronomic practice involved very extensive areas and labour-intensive methods such as mounding (Jones and Law 1987).

Table 1 shows a comparison of figures for selected sites adjacent to fans in the Waipaoa River. Populations determined from pit storage in pa in hill country generally exceed the potential population of the fans. The latter do not take account of the availability of Matawhero soils at Manutuke and Waerenga a Hika/Bushmere. The available area of these soils is limited largely by travel time to reach them, and perceived risk of flooding. Both these factors are indeterminate when compared with the well defined areas of Waihirere soils.

In general terms, the main fans had a potential population of 300 to 1000 people. The limitations of these figures are mainly in the question of annual consumption of kumara, fallow ratios, and the extent to which the extensive but flood-prone Matawhero soils were used. Taken generally, the population figures are consistent with those that might be expected for groups of hapu comprising a major tribal grouping such as Rongowhakaata in the prehistoric period, and are comparable with the size of population suggested for Tolaga Bay (Jones and Law 1987) or the larger individual volcanic cones of the Auckland region (Fox 1983).

The figures for individual pa populations presented in Table 1 are above the sizes for the largest populations of pa in Tolaga Bay, reflecting a point made by Jones and Law

TABLE 1
POPULATIONS OF PA ADJACENT TO SIGNIFICANT AREAS OF WAIHIRERE SILT LOAMS OR THE PLEISTOCENE TERRACE (after Jones and Law 1987: 95).

DISTRICT	PA	PIT STORAGE (m^3)	POPULATION (after Jones and Law 1987)	FAN AREA ha)	POPULATION
Puha	Y17/316	600	290	hill only	–
Ormond	Y17/31	620	510	58+	300+
Ormond	Y17/36	630	460	eroded	–
Waerenga a Hika	destroyed			200†	1000+
Whakaahu	Y18/5	1290	860	83	400
Manutuke	destroyed			70†	350+
Maraetaha	Y18/59, 60 61, 208, 56/63	1000+	–	130‡	650

Population of the fans at 5 persons per hectare
†excludes areas of Matawhero silt loams adjacent to the fan
‡includes areas of Matawhero silt loams on the fan

(1987: 109): the biggest sites have relatively large volumes per pit, as if the effects of scale are amplified by a social factor such as more centralised control of larger units of pit storage. The bulk of the sites in the Waipaoa River have pit storage volumes less than 60 cubic metres, and the sites adjacent to the fans have the very highest pit volumes, 500 cubic metres and more. These very large sites comprise only some 2 percent of all the sites in the catchment.

PA FORM IN RELATION TO POPULATION

If populations reach their maximum in alluvial settings, we might expect pa to reflect this over and above the influence of topographic factors. The morphology of pa differs between the hill country and alluvial settings. Hill country pa typically have transverse ditches of modest or small size, occasionally double, and very rarely have lateral ditches. Lateral defensive lines are very often marked only by narrow terracing. Pa on alluvium take advantage of steep, high (up to 12 m) river banks by having emplaced short lengths of ditch and bank, sometimes double, across the necks of points in meander belts. Compound defences on interlocking points were also used. Other variations are rectangular enclosures on linear lengths of bank, or dog-legs on broader points. The compound pa on alluvium frequently show signs of expansion both by replacing ditches and banks to enclose a larger area, and by expansion on to adjacent points (see Wilson 1987: 119, for the Maraetaha case). This suggests population expansion in areas of permanent settlement. In one very interesting case, Tapui pa (Fig. 11), the "improved" defence is so inefficient in increasing defended area that it may be interpreted as an expression of the mana of the occupying group.

CONCLUSIONS

Access to the river and to wetlands generally is the most important factor in determining which soils were used in the Waipaoa River valley. There were areas of Waihirere silt loams, for example, isolated from the main course of the river in the Bushmere locality and south of the main Matawhero loop, which appear not to have had settlement on them. Of soils close to the river, the Waihirere silt loams were used most intensively, and where these are compact and large in area, there was nucleated settlement on a large scale. This occurred at several points in the river, including:

- Maraetaha River fan
- Confluence of Te Arai and Waipaoa Rivers (Manutuke)
- Repongaere (Pukepoto pa)
- Ramaroa pa (near Waituhi)
- Waerenga a Hika/ Ormond
- Kaitaratahi vicinity (both banks)

Of these areas, the most important is the settlement complex on the fan encompassing Ormond, Waituhi, Repongaere, and Waerenga a Hika. Settlement there must have had a self-reinforcing character with a combination of river access, broad areas of stable levee soils, abandoned river channels, active flood plains with some potential for horticulture, and adjacent hill country with easy slopes, lakes and wetlands. No other area of the valley had such potential on such a scale. The relative lack of surviving flatland archaeological sites compared with the Maraetaha or old course of the Te Arai River should not be allowed to obscure this conclusion.

Special cases of intensive settlement occur in association with the lower stretches of abandoned courses of the river at Waerenga a Hika, and in the lower part of the old course of the Te Arai River. These areas all had significant wetlands associated with Waihirere silt loams and they are separated by distinct areas of less heavily settled levee silt loams from the major concentrations of settlement noted above. Eeling was probably an important focus of subsistence at these sites where settlement is not dated before 400 years B.P. and where there is clear continuity of settlement through to the nineteenth century.

Alluvial silt loams were settled from 700 years B.P., even in areas where sediments were still building up at the same time. Manutuke, one of the more important fan settlements, was not settled until about 450 years B.P., after the period when the Waipaoa River had worked its course westwards giving direct access to the Te Arai River fan. Pa were not built in the valley until 450 years B.P.

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APPENDIX 1
RADIOCARBON DATES FOR WAIPAOA RIVER

All samples were dated at the Institute of Nuclear Sciences, Department of Scientific and Industrial Research, Gracefield, New Zealand.

A. DATES ON SHELL

In this list, information for each entry is given in the following order: site number and type, laboratory sample number, age in years B.P. (old half life), age in years B.P. (new half life), age range in years A.D., notes.

Y18/89, pa. NZ 6916. 340 ± 30, 350 ± 32, A.D. 1570–1630. Rangihoua pa, Muriwai. In exposed section of fill of major terrace (Fig. 13).

Y18/294, midden/oven. NZ 6922. 315 ± 52, 324±54, A.D. 1570–1680. Midden in oven rake-out beneath topsoil on meander bank of old Te Arai river course. Minimum age for Maori occupation (Fig. 9).

Y18/75, pa. NZ 6925. 290 ± 32, 300 ± 34, A.D. 1620–1680. Tapui pa. Midden stratified in buried topsoil beneath bank fill on the eastern part of the pa. A maximum age for one of the earlier defences of the pa (Figs 11, 12).

Y18/58. NZ 6926. 810 ± 24, 840 ± 25, A.D. 1085–1135. Midden exposed in road cutting and stratified below 50 cm of mixed fill. Adjacent to former estuary of Waipaoa river (Fig. 1).

Y18/141, midden/oven. NZ 6931. 560 ± 55, 574 ± 56, A.D. 1320–1430. Lens of shell exposed in silts beneath oven rake-out in Waihirere topsoil. Minimum age for Polynesian use of levees near Patutahi (Fig. 9).

Y18/75, midden/pa. NZ 6933. 350 ± 25, 360 ± 26, A.D. 1565–1615. Midden stratified beneath topsoil outside ditch and bank of NZ 6925 sample. Minimum age for Maori occupation of Waihirere silt loams on old course of Te Arai river (Figs 11, 12).

Y18/162, oven/midden. NZ 6940. 695±40, 715±45, A.D. 1190–1280. Oven debris stratified in silts beneath Waihirere topsoil in bank of former river channel. A minimum age for Polynesian use of levees at Matawhero (Fig. 9).

Y17/418, pa. NZ 6941. Less than 250, less than 250, A.D. 1700–? In layer of oven rake-out beneath bank of pa. Maximum age for defences of a pa in Ormond vicinity (Fig. 5).

Y18/298, midden. NZ 6944. 295 ± 30, 408 ± 30, A.D. 1510–1570. In topsoil of Waihirere terrace, Te Arai river. A minimum age for Maori settlement on levees near Manutuke (Fig. 9).

Y18/318, pa. NZ 6959. 445 ± 53, 460 ± 54, A.D. 1440–1540. Concentrated shell midden exposed in topsoil at foot of defensive bank. Minimum age for pa in Lake Repongaere vicinity (Fig. 5).

Y18/208, pa. NZ 6961. 290 ± 50, 296 ± 50, A.D. 1600–1700. Pocket of beach sand stratified behind ditch and bank, and sealed by two flood episodes truncating the ditch and bank. Sample is a minimum age for the pa and probably a maximum age for the ditch and bank (Fig. 13).

Y18/309, midden/raised rim pit. NZ 6969. 635 ± 41, 653 ± 42, A.D. 1260–1340. Talus midden exposed under topsoil and adjacent to large raised rim pit. A minimum age for settlement on Whakaahu fan. Landsnails suggest primary woody vegetation (forest) (Fig. 7).

Y18/59. NZ 7372. 300±55, 307±57, A.D. 1580–1700. Shell in fill of pit dug into Waihirere silt loam. Minimum age for pit and gardening (Fig. 13).

Y18/61. NZ 7385. 311±57, 320±60, A.D. 1570–1690. In oven debris sealed by Matawhero silts. A minimum age for the site (Fig. 13).

B. DATES ON CHARCOAL

For these two dates the information is given in the following order: site number, laboratory sample number, age before present (old half life), age range before present after secular correction, notes. Secular corrections supplied by the laboratory.

Y17/459. NZ 7399. 607 ± 55, 535–675. Sample is from base of oven dug into Waihirere silt loam subsoil at Te Karaka. Charocal is *Pseudopanax arboreus* twigs, ideal for radiocarbon dating (R. T. Wallace det.) (Fig. 3).

X17/4. NZ 7420. 400 ± 60, 310–550. Charcoals mixed into silty ash subsoil on Pleistocene terrace in Waihuka River valley. Charcoal is 98 percent by weight *Podocarpus spicatus*, not obviously young wood (R. T. Wallace det.) (Fig. 3).

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Map and aerial photograph sources

The alphanumeric references in the text are those of the New Zealand Department of Survey and Land Information. Index copies of these documents are held in Wellington and/or the appropriate regional office of the Department. Copies of aerial photographs are supplied by New Zealand Aerial Mapping Ltd., Hastings. The abbreviations SO, SN and RN stand for Survey Office, Survey Number and Run Number, respectively.

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