Maori gardening

An archaeological perspective

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Cover: Pa, stone row enclosures and puke (garden mounds) at Waikekeno, Wairarapa.
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A B S T R A C T

Polynesian settlers to New Zealand brought with them tropical cultigens, but the temperate climate imposed restrictions on where crops could be grown. The adaptations Maori gardeners made to the landscape in order to grow their vegetables can be seen archaeologically. The types of evidence are described, drawing on specific archaeological sites and archaeological investigations. Regional variation is also discussed. Kumara (*Ipomoea batatas*), in particular, was an important source of carbohydrate, but equally importantly it played a major role in discharging social obligations and exchange transactions with other groups. New vegetables and plants were introduced by Europeans. These were embraced into the Maori gardening system, and the traditional crops were either dropped or replaced with superior varieties. These new introductions were also taken up into the Maori cultural system of gifting and exchange, and sales of vegetables formed the basis of the Maori commercial economy in the first half of the 19th century.

Keywords: archaeology, cultigen, kumara, kumara storage pits, taro, yam, Maori, Maori gardening, Maori horticulture, New Zealand

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1. Introduction

The Polynesian ancestors of Maori, when they settled in Aotearoa New Zealand, brought with them long-established traditions and techniques for growing staple food crops. Within the New Zealand landscape, there is ample and varied evidence of the continuation of those gardening practices, and of the changes and adaptations that were made over time to accommodate local circumstances and environmental conditions. This report describes the nature and location of that garden evidence at a broad regional level. The discussion about different types of Maori garden sites draws on archaeological excavations and research.

Field evidence of Maori gardening, and the growing conditions necessary for each cultigen, is summarised here at a very general level. Other publications provide a more extensive examination of this diverse subject (e.g. Best 1976; Leach, H.M. 1976, 1979b, 1984). Since the late 1960s, there have been archaeological investigations of Maori garden sites at a range of localities, with an intensification of interest in the mid-1970s to late 1980s (Barber 2004). The results of these studies are selectively reported here, the aim being to demonstrate the extent of understanding of field evidence and soil horizons. For some sites, there may be a variety of explanations or opinion as to what the evidence represents. In particular, stone rows and adjacent garden plots in the Wairarapa have attracted divergent views (see section 5.1.1).

Archaeological investigation of garden sites has provided details about their variability and, most importantly, an indication of their age. Maori garden sites that have been investigated are listed in Appendix 1, and the main places that are mentioned in the text are shown on Fig. 1. Major excavations on garden sites have taken place in Palliser Bay, where nine sites were investigated, and in Auckland, where, over a period of 15 years, remnants of several stone field garden systems around the volcanic cones have been excavated in advance of site destruction. Salvage archaeology, carried out prior to site modification, has also provided information about gardening in coastal and inland Bay of Plenty, often in areas where evidence was not visible on the surface. We now know that the tephra (volcanic ash) layers of this area were a productive growing medium. The relationship between borrow pits and modified soils has been investigated in the Waikato Basin, Aotea and Wanganui areas, where Maori gardeners sought to improve surface soils by adding coarser material, such as sand and gravel, excavated from under the surface soils (see section 5.4).

Archaeological research on Maori garden soils followed on from earlier soil survey studies; in particular, research on the modified soils in the Waikato and Tasman Bay areas has provided primary sources for archaeological discussion of Maori gardening practices. Experiments have been carried out by archaeologists and others, to test in a rigorous way the yields of kumara (sweet potato, *Ipomoea batatas*) obtained from different garden situations, replicating practices believed to have been used by Maori, or examining the effect of moisture and heat retention in an attempt to explain archaeological stone features.

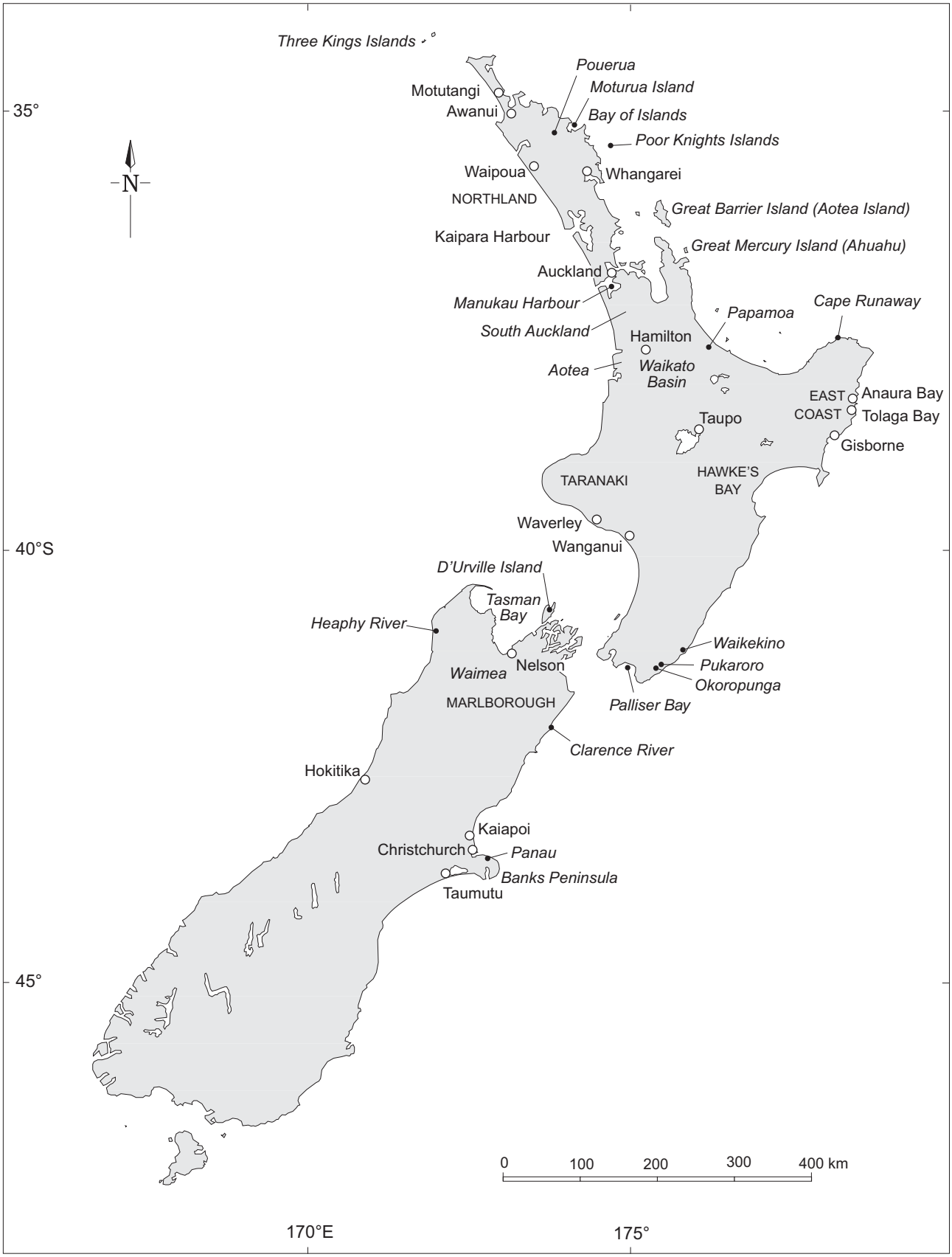

Figure 1. Main Maori garden areas and places mentioned in the text. *Map: C. Edkins, DOC.*

Information in this report on the locations and types of garden sites is derived from the New Zealand Archaeological Association's (NZAA) Site Record File. This file contains over 50 000 records on places of Maori occupation. An electronic index of the paper records on sites is known as CINZAS (Central Index of New Zealand Archaeological Sites) and has basic information on site number, grid reference, site type, site condition, local territorial authority and land classification. Site types also have abbreviated codes. From CINZAS, a list of sites in which garden-related field remains featured prominently was produced. This was followed up by consulting the NZAA Site Record File where the paper records are held, to obtain more detailed descriptions of sites.

There are limitations to using this records-based approach to arrive at a regional and national distribution of Maori garden evidence. First, absence of recorded sites in a particular locality does not necessarily mean that no garden sites exist; the distribution of sites may well indicate only where sites have been observed and recorded. Similarly, even though an area may have been walked over and examined for surface remains, the invisibility of archaeological evidence may be due to other factors, such as vegetation cover at the time of the survey, the ability of the recorder to recognise particular site types, and the extent of land-use change.

In addition, the NZAA Site Record File is, to some extent, a historical document, as the site-description records have been submitted over the last 45 years. Many of the records are now more than 30 years old, and the vast majority of sites have not been revisited since they were first recorded. Therefore, the list of sites reflects what was there rather than what might still exist. An upgrade project to relocate sites is in progress, initiated and administered by the NZAA, but it has not yet been carried out in the regions with the greatest amount of gardening evidence. It was not within the scope of this project to determine whether individual recorded sites have survived. However, the status of many sites is known at a broad level. For instance, the garden sites of the volcanic soils of the Auckland Isthmus have been largely destroyed or severely modified in the last 30 years (Clough & Plowman 1996).

Locating garden sites in the site file has been dependent on individual sites being assigned a suitable garden-related category or code in CINZAS. For instance, where the garden evidence has been considered peripheral or secondary to the main site description during coding for CINZAS, it will not be possible to extract that site from the list of sites. This is most apparent in Auckland, where stone field gardens surrounding the cone pa have not been identified separately. In this case, personal knowledge of the landscape enabled the problem to be identified, and anomalies in the records to be rectified. In other areas, browsing through all the site files for selected map sheets allowed any additional sites with garden evidence to be picked up. A further example of the problems associated with identifying garden sites from the site files is Matakana Island in the Bay of Plenty, where gardening soils were noted in reports and in site records but were not included in the CINZAS coding. Overall, this deficiency in the records would account for less than 1% of the more than 1400 recorded sites with garden evidence in the NZAA site file. It should also be noted that the particular coding assigned to individual sites is exclusive, even when several categories of site type are represented in the description. Therefore, the number of recorded sites in each category is indicative only.

A significant limitation to identifying the distribution of Maori gardening in the landscape is the lack of visible field evidence. Large areas were able to be gardened without the addition of stone or trench boundaries, stone clearance or soil modifications. The vast majority of Maori gardens will therefore be invisible—it is generally only the specialised or unusual methods of cultivation field evidence that are detected in field remains. Determining the extent of Maori gardening at a broad level is best derived from wider evidence, including the distribution of kumara storage pits. Examination of pre-1840 vegetation patterns (e.g. Beever 1981) may also be relevant when identifying where forest was cleared or modified.

The number of sites recorded per topographic map sheet, or per Department of Conservation (DOC) conservancy as an indicator of broad geographic regions, mainly reflects recording activity, which is variable. There is no consistent approach to the recording and identification of garden sites. Thus, the 32 sites representing garden evidence at Ambury Park near the Manukau Harbour in South Auckland carry no more weight or significance than the one site for the Wiri Mt/McLaughlin's Mt stone field gardens, which also has a number of individual features.

Although there is a large amount of garden evidence, the extent to which cultivated crops provided a staple food has been questioned (Shawcross 1967; Leach 2000). Seasonal crop failures and political unrest contributed to fluctuations in the supply of kumara. Energy expended in gardening was possibly as much about social needs, hospitality, obligations and aspirations as it was about nutrition and survival. Compared with tropical Polynesia, even the northern North Island was marginal for gardening, as the population could not be sustained on garden produce alone. Instead, there was a mixed economy, based on gardening, gathering and fishing; the relative importance of each of these changed with distance south. Gardening provided essential carbohydrates when there was little other wild food (except for bracken fern *Pteridium aquilinum* var. *esculentum*) that could provide it in quantity.

Cultivated food was not a consistent dietary staple (even in the most suitable regions), but it was nonetheless very important in the cultural sense. The ceremonies, rituals and strict rules associated with kumara gardening, and to a lesser extent gourd (hue, *Lagenaria siceraria*), are well reported in Best (1976). The lack of information about rules governing the growing of taro (*Colocasia esculenta*) does not necessarily imply that taro was grown without attention to ritual and ceremony. Gardening practices in the pre-European period may have differed from those carried out in the 19th century, when taro was not an important crop.

2. Maori cultigens

Only six imported cultigens were grown at the time of European arrival—kumara, taro, yam (uwhi, *Dioscorea* spp.) and gourd, with ti pore (*Cordyline fruticosa*) also grown in some areas. Aute (paper mulberry, *Broussonetia papyrifera*) was grown specifically for use as a textile. These six cultigens represent a very restricted range of crops compared with what was grown in tropical Polynesia, where a total of eight root crops and 11 tree crops were available, although not all were grown on each island group and the number cultivated tended to diminish away from the high islands of Eastern Polynesia (Leach 1976: 148). In addition to the root crops that survived in New Zealand until European contact, other crops may have been introduced but failed to grow or reproduce. Crops such as arrowroot, banana, breadfruit, coconut, kape or giant taro, smaller yams, sugar cane and turmeric may have been unable to survive the local conditions encountered. The major difference between temperate New Zealand and tropical Polynesia is New Zealand's seasonal temperature range, which influences whether or not root crops are able to mature. This seasonal range becomes more pronounced with increasing latitude. Detailed information on the growing requirements of each cultigen is presented in Leach (1976, 1984).

The successful introduction of Polynesian root crops to New Zealand not only required skills in plant husbandry, but also modification of the garden environment to improve conditions for plant growth and maturation. These modifications included the addition of gravel and sand to soil, mulching, fences and windbreaks, and possibly stone rows, to provide shelter for the growing plants, heaped soil and stone for warmer ground temperatures, and mechanisms for storage of kumara tubers once harvested. Over time, there may have been some selection for varieties that were more tolerant of cooler growing conditions or that were faster maturing.

2.1 KUMARA

Kumara (sweet potato, *Ipomoea batatas*) was the most extensively grown Maori cultigen in New Zealand, although it was of minor importance in most of tropical Polynesia. Only on Rapa Nui (Easter Island) did kumara attain a similar importance as a principal food crop. It was absent entirely from some islands, notably in the southern Cooks (with the exception of Mangaia), until it was introduced by Europeans in the 19th century (Green 2005). Kumara may have attained primary crop status over yam or taro due to its greater tolerance of drier or cooler conditions, or because it was faster maturing, an essential factor in the seasonal, temperate climate of New Zealand. Kumara was most likely introduced into East Polynesia by the end of the first millennium, with convincing arguments being put forward now for Polynesians voyaging to northern Peru or Ecuador and returning with tubers (Green 2005). It was being grown on islands likely to be the homeland of the New Zealand Maori and therefore was brought here at the time of settlement, or soon after. In contrast, kumara was a later introduction on both Rapa Nui and Hawaii, which were settled prior to kumara reaching

Polynesia; it was well-suited to the dry growing conditions on Rapa Nui and the leeward side of the Hawaiian islands (Green 2005).

Of all the cultigens, kumara is tolerant of the widest range of conditions. Some of the growing characteristics and requirements identified by Leach (1984) and others are summarised below. Kumara is a member of the Convulvolaceae family, and the earliest varieties grown in New Zealand were erect and bushy. In tropical Polynesia, sweet potato is treated as a perennial, with stem cuttings planted and tubers harvested year-round. In temperate New Zealand, kumara is grown as an annual, with sprouted tubers planted in spring and tubers lifted in autumn. Temperature is a critical factor in tuber propagation and plant growth. Experiments have shown that plants do not survive in soil temperatures < 12°C, and at 15°C they will survive but not grow. A temperature range of between 15°C and 35°C is the optimum for the assimilation of nutrients and rapid growth (Worrall 1993: 4). Because kumara is sensitive to cold, small increases or decreases in temperature are important. Plants achieve full canopy within 6 weeks of sprouting and tuber formation commences 2–8 weeks after planting; yield increases occur in the last 4–5 weeks before harvest (Worrall 1993: 47). The crop takes 5 months to mature. Plants are frost tender, but frosts late in the growing season will not unduly affect the tubers, provided they are mature enough and can be lifted soon after the event. However, frosting does affect germination of the tubers in the following spring (Leach 1976: 150). Similarly, low soil temperatures and excessive moisture while the tubers are forming can lead to tuber rot. Kumara can be grown as far south as Banks Peninsula in coastal areas, but at this latitude the yield is usually low and, depending on conditions, the crop may be unsuccessful in some years (Law 1969: 238; Yen 1961, 1990).

The best soil type for kumara is considered to be a light and porous sandy or gravelly loam. Free-draining soil heats up faster early in the growing season and retains heat for a longer period. Certainly, in more marginal areas from the lower North Island south, success or failure of the crop may have been dependent on having lighter, more porous soils. However, granular loams and clays, and yellow-brown earths predominate over a significant proportion of the North Island, and some of these soils were also extensively gardened (Welch 2000). Soil type may not have been such an important consideration if the range of maximum-minimum temperatures encountered during the growing season was narrow, as in the far north of the North Island.

Several methods were used for planting kumara. Captain James Cook observed kumara grown in rows, on mounds, in a quincunx (offset spacing) pattern. A feature noted by many Europeans was the neatness and weed-free state of Maori gardens, but this may have been easier to achieve in the absence of introduced European weeds, which aggressively colonise open ground today. A high level of maintenance was required during the growing season to remove caterpillars, which ate the leaves, to keep the ground around the plants tilled and heaped up, and to trim dead leaves (Best 1976).

During the growing season, small immature tubers were removed, scraped, and dried in the sun. These dried kumara were called kao, and were considered a sweet delicacy when cooked, mashed, and eaten at feasts (Best 1976: 138–139). The mature main crop was carefully dug in autumn, sorted to remove damaged tubers, and stored in kete in storehouses (including the semi-subterranean store

pits found archaeologically) or in above-ground structures such as pataka or whata (ibid).

The exact number of varieties of kumara originally brought to New Zealand by Maori ancestors is unknown. Colenso (1880: 34–35) named 32 varieties from Northland and another 16 from the Hawke's Bay and East Coast areas. These ranged from white-skinned with white flesh through to purple-skinned with purple flesh. Although kumara do not set seed in New Zealand, mutation of buds can lead to new varieties, which might explain the large number reported by Colenso. Elsdon Best recorded over 100 names from different districts, but the original introductions may have only numbered about a dozen (Leach 1984: 103). Different varieties were known for specific characteristics, such as sweetness, flavour, the production of large tubers, or high yield. Only three of these varieties now survive, but experimental work may show that some varieties were more suited to particular conditions or to marginal climates. DNA analysis of the remaining traditional varieties—Hutihuti, Rekamaroa and Taputini—has confirmed that they have lineages separate from the kumara cultivars grown in New Zealand today (Harvey et al. 1997). Rekamaroa and Hutihuti are closely related, and distinctly different from Taputini.

Kumara continued to be grown after the introduction of European crops, but by the early 1800s Maori kumara was being replaced with the European-introduced varieties, which produced larger tubers and were considered sweeter (Coleman 1972: 5; Best 1976: 114).

Kumara tubers have only been recovered archaeologically from two sites: Waioneke on the Kaipara Harbour (Leach, H.M. 1979b: 241), and NZAA site number P05/288, known as Haratua's Pa, at Pouerua in Northland (Leahy & Nevin 1993; Yen & Head 1993). In each case, the kumara were carbonised, or burnt, and excavated from storage pits. Tubers from P05/288 were identified as being from the varietal types Rekamaroa and Hutihuti/Taputini (Yen & Head 1993: 58).

Kumara plants do not flower or set seed in temperate New Zealand. However, microscopic examination of soils shows some promise for identifying phytoliths (silica deposits) from leaves (Horrocks et al. 2000) or the starch grains found in tubers (Horrocks et al. 2004), which may enable confirmation of the types of crops that were grown in specific localities. The technique may also establish whether some identified modified soils were gardens. However, caution is needed in the identification of kumara phytoliths, as New Zealand tree species such as rewarewa (*Knightia excelsa*) and beech (*Nothofagus* spp.) produce phytoliths of similar appearance, and rewarewa in particular is frequently present in vegetation patterns after forest disturbance (Horrocks et al. 2000).

Experimental gardening with traditional kumara at Robin Hood Bay in coastal Marlborough and at Whatarangi in Palliser Bay have demonstrated that harvest results can be mixed, with some plants producing well and others having very few, or no, tubers (Harris et al. 2000: 308; Burtenshaw et al. 2003). Harvests in successive years, with different climatic conditions during the growing seasons, also produced variable results. In the 1999–2000 growing season at Robin Hood Bay, a 5 m × 5 m plot containing 65 plants yielded 29.4 kg, or the equivalent of 11.8 tonnes/ha. The following year the yield was the equivalent of 7.6 tonnes/ha (Burtenshaw et al. 2003: 178).

2.2 TARO

Taro (*Colocasia esculenta*) was grown primarily for the starchy tuber, although the leaves could also be eaten after cooking. In tropical Polynesia, there is both wetland cultivation, based around the use of ditches, ponds and irrigation, and dryland cultivation of taro. Early European observers noted only the latter in New Zealand. Colenso (1880: 36–37) named ten varieties from Northland, some of which were only eaten on particular occasions, and another nine varieties from Hawke's Bay and the East Coast, where some of the known Northland varieties were also grown. Like kumara, these varieties could be distinguished by size, sweetness and colour.

Taro has higher moisture requirements than kumara and, in the wild, often grows on the banks of streams or in swampy areas. Colenso (1880: 8) reported that the best soils were light yet deep, or alluvial, and on the banks of streams or adjacent to the coast, and sometimes at the foot of high cliffs, presumably because soil conditions there were damper. The growing season is 6–7 months long. While taro will grow in cooler temperatures, corms are small or fail to develop. Historically, taro is known as far south as Hokitika and the Heaphy River mouth on the west coast of the South Island, but Leach (1984: 105) suggests that this may have been a European-introduced variety with a greater tolerance of cooler conditions. Joseph Banks observed taro growing at Anaura Bay on the East Coast in 1769 (Beaglehole 1962: 417), but there are no early accounts from further south.

Microfossil analysis of soil samples at Triangle Flat in Golden Bay indicates that taro was grown there (Horrocks 2004). There may have been a number of favourable microclimates in the north of the South Island that were taken advantage of for taro, but the full extent of the growing range is not yet documented.

According to Colenso (1880: 9), taro was not grown on mounds but on a carefully levelled surface, and was surrounded by a fence or screen to provide shelter from the wind. At Anaura Bay, Monkhouse described taro planted in 'circular concaves', similar to the description by Colenso for gourd cultivation. Colenso also referred to hue and taro being grown together in plantations (Best 1976: 134).

Mature taro could be left in the ground or lifted and stored in the open (Colenso 1880: 15), presumably without deterioration, unlike kumara, which required a very narrow range of temperature and humidity conditions to survive storage in either semi-subterranean store pits, rua, or pataka.

Taro can be found in the northern half of the North Island as cultivated or wild plants. Although plants produce pollen, seed production has not been observed in New Zealand (Matthews 1985: 270). While not strictly speaking archaeological sites, the locations where taro has been recorded growing nonetheless provide valuable information on the distribution and hardiness of the crop. There are three taro variants in New Zealand: RR, GR and GP, distinguished by variations in the colour of the petiole and the shape of the leaf blade (Matthews 1985). The most common variant is RR, accounting for 75% of the records made by Matthews (1985) during his survey of taro distribution in New Zealand. The RR variant is now believed to be a historical introduction of Chinese origin (Matthews 2002). GR and GP are most common in Northland. Anecdotal evidence suggests

that these two variants were grown primarily for pig food in historic and recent times and, because of their limited distribution, they are believed to be post-European introductions. The variants growing in New Zealand have chromosome number 2n = 42. The poor representation of plants with 28 chromosomes, which are widespread throughout Polynesia and Asia, cannot be explained at present (Matthews 2002).

2.3 YAM

Little is known of yam (uwhi, *Dioscorea* spp.) cultivation, as the potato (*Solanum toberosum*) soon replaced it in 19th-century Maori gardens, due to its high yields and tolerance to a wide range of conditions (Leach 1984). Like kumara, yams were grown for their starchy tubers. The rapid replacement of the traditionally grown yam suggests that it may have been difficult to grow, low yielding and a marginal crop, even in the warmest parts of the country. The diminished importance of yam in New Zealand mirrors the situation in other East Polynesian islands; this contrasts with the situation further west, where yam played an important role both as food and in the ritual cycle of ancestral Polynesians (Leach 2005: 64).

Yams require a longer growing season than kumara (several months more than kumara's 5 months to maturity), and over-wintering in the ground may have been necessary (Leach 1984: 60). However, like kumara, the successful varieties grown in New Zealand may have been more adaptable to cooler conditions and faster maturing than modern tropical varieties grown experimentally in New Zealand. The tubers can be successfully preserved for 3–4 months, provided there is little variation in temperature during storage (Leach 1984).

Yams were grown in similar conditions to kumara and were planted on small earthen mounds or puke. The plant had a twining habit, different from the creeping structure of kumara. Yams were observed growing in Tolaga Bay and Anaura Bay in 1769, and also in the Bay of Islands (Beaglehole 1962: 444).

Starch grains and xylem cells from yam roots and underground stems have recently been found in microscopically examined soil samples from Motutangi in the Far North (Horrocks & Barber 2005). This is the first archaeological indication of yam (specifically *Dioscorea alata*) being grown here.

2.4 GOURD

This cucurbit (hue, *Lagenaria siceraria*) was grown primarily for the large fruits, which, when mature, were used as containers to store water, oils and food. Small immature fruits were eaten during the summer, before the kumara were harvested. A relatively long growing season of 6–7 months is required for the fruit to enlarge and mature. Like other crops, gourd is temperature sensitive and grows most favourably when the mean temperature is above 17°C. Gourd requires a damp rich soil, and it was often grown near taro plantations. In late October 1769, Monkhouse saw gourd vines in flower growing over houses in Anaura Bay (Salmond 1991: 164). This seems very early in the season for gourd to be growing, and training the vines over the houses may have been a particular technique for encouraging plant growth and the early maturation of fruit.

Captain Cook described gourd plants growing in small hollows at Tolaga Bay (Best 1976: 29); Colenso (1880: 9) referred to these features as 'convex bowl-shaped pits'.

Gourd remains have been found in archaeological excavations at Kauri Point Swamp and Kohika in the Bay of Plenty, Te Miro in the Waikato, and Waitore in Taranaki (Cassels 1979; Edson 1979; Irwin 2004; Maingay 1984). Gourd fragments have also been recovered from Whakamoenga Cave and Waihora in the Taupo area (Leahy 1976; Hosking & Leahy 1982), indicating that gourd remains are capable of surviving in both wet anaerobic and dry conditions. Gourd pollen has been found in soil samples from a stone mound at Pouerua, inland Bay of Islands (Horrocks et al. 2000), and in coprolites at Harataonga, Great Barrier (Aotea) Island (Horrocks et al. 2002), demonstrating the potential for microfossil studies to assist with the archaeological interpretation of garden features.

2.5 TI PORE

Ti pore (*Cordyline fruticosa*) occurs throughout Asia and the Pacific, and was part of the suite of plants carried into Polynesia by Polynesian ancestors. It also occurs on Raoul Island in the Kermadec Group where, in a tropical environment and in the absence of grazing animals, it has continued to thrive (Simpson 2000). It has not been so fortunate in New Zealand, where it was reduced to a few plants by the beginning of the 20th century (Walsh 1900) and is now very rare in the wild, being confined to Northland. *Cordyline fruticosa* differs from native New Zealand *Cordyline* species in having a shrub-like habit with broad leaves on thin clumping stems. The thick rhizome was used as food. *Cordyline fruticosa* was previously identified in the literature as *C. terminalis*.

The pre-European distribution of ti pore in New Zealand is unknown, but Walsh (1900), after reviewing Northland distributions, concluded that it was a tropical plant suited only to favourable parts of Northland. Ti plants were observed in gardens in the Bay of Islands in 1772 (Crozet, reported in Salmond 1991: 412).

Ti para was also cultivated in New Zealand (Colenso 1880: 16). This is now identified as a cultivar of *Cordyline australis*, the native cabbage tree (Simpson 2000: 144), that was developed by continually selecting plants that suckered. According to Colenso, ti para was grown extensively in the Waikato, Wanganui and Hawke's Bay, as well as further north. Ti para was not cultivated in the South Island, but the name was adopted there for *C. australis*. The tap root of *C. australis* was an important source of carbohydrate after it had received lengthy steaming in a distinctive type of earth oven, known as an umu-ti (Fankhauser 1990; Simpson 2000: 144).

Both ti pore and ti para were reproduced by replanting the stalk with a small portion of root attached, or by planting small side shoots (Best 1976: 257). Ti pore did not produce flowers, and could therefore only be reproduced by vegetative methods. Ti plants do not produce phytoliths, so it will be difficult to determine from microscopic analysis of soils where ti pore was cultivated (Horrocks 2004).

Like the yam, ti pore disappeared from Maori gardens soon after Europeans introduced new plants and sweet alternatives to eating ti root.

2.6 AUTE

Aute (paper mulberry, *Broussonetia papyrifera*) is a fast-growing shrub or small tree widely grown throughout Polynesia, and is used to manufacture tapa cloth by beating and felting strips of bark together. The plant has male and female flowers on separate plants, but it was probably reproduced vegetatively in New Zealand (Matthews 1996). It is unlikely that this tropical plant was ever able to be cultivated in sufficient numbers in New Zealand to produce large quantities of cloth. Dependence on aute for clothing was not necessary, since other fibre-producing plants, particularly flax (harakeke, *Phormium* spp.), were present in abundance. At the time of European contact, use of aute cloth was confined to small pieces that were rolled up and inserted through a perforation in the ear lobe.

In 1769, aute plants were growing wild in Anaura Bay and Tolaga Bay (Monkhouse, quoted in Salmond 1991: 168, 172), but it is not clear from the descriptions whether plants were plentiful or only a few were observed. A few cultivated plants were also seen in the Bay of Islands. Distinctive square-sectioned wooden beaters, which were used to make tapa from the bark, have been found as far south as Taranaki (Neich 1996). This may indicate the southern tolerance of paper mulberry. Aute became extinct in New Zealand after 1844 (Colenso 1880).

Pollen and phytoliths of aute have recently been found in a swamp core at Rangihoua in the Bay of Islands (Horrocks 2004). This discovery reinforces the potential of microscopic studies to contribute to our understanding of the distribution of individual cultigens in Maori gardening.

3. Gardening techniques

Unfortunately, there are few first-hand accounts of Maori methods of gardening and preparing soils. Elsdon Best (1976) is acknowledged as the most authoritative source, but his work is derived from observations made by individuals such as Cook, Banks, Colenso, Wade, Cheeseman, Nicholas and various Maori informants, principally from the East Coast and Waikato areas. It is unclear whether he observed any of the reported gardening techniques himself. Nonetheless, there is a wealth of information present in his book on Maori agriculture about the growing requirements of the various crops. However, there is less specific information about topics of interest to archaeologists, e.g. stone rows, or the reasons why other materials were added to soils. There are also contradictions in some of the reported information, which are explained as differences in custom and practice in different parts of the country (Best 1976: 278).

The available information can be summarised under several headings. These relate to the preferred locations of gardens, the length of time a garden plot was used before fertility declined and the soil was left to recover, how gardens were made ready and specific preparations for kumara, the size of individual garden plots, and comments on soil additives.

3.1 GARDEN LOCATION

Sloping land was preferred for kumara because flat land was too damp (Best 1976: 158, 163). In addition, the garden should have a northerly aspect or face the sun (Best 1976: 163). Archdeacon Walsh (1902: 13–14) stated that 'almost any soil will do for the kumara, so long as the situation is dry and the plants are not exposed to the cold southerly winds, or to the spring and autumn frosts…advantage was taken of well drained sheltered spots on higher ground for the early plantings'.

Colenso (1880) reported that hue was often sown in and near taro plantations, as both species had similar soil requirements. Kumara, however, appears to have been planted in separate gardens. This segregation is in keeping with the observance of ritual associated with the planting and harvesting of kumara (Best 1976).

3.2 GARDEN SIZE

The early European accounts are generally in agreement on the size of gardens. Joseph Banks reported that gardens in Anaura Bay ranged from 1–2 acres to 8–10 acres. In the Bay of Islands, a garden of 40–50 acres was seen planted around a village on Moturua Island (Salmond 1991: 164, 230). Smaller gardens were seen in various locations, but the size was not recorded, except at Mercury Bay, where there was a half acre planted in kumara (Salmond 1991: 205). In 1769 in the Bay of Islands, the French explorers noted plantations 12–20 ft^2 near fishing villages

(Ollivier & Hingley 1987: 33); however, these are unlikely to have been the main gardens. There was little change in garden size over the next half century. Gardens in the Bay of Islands in 1814–15 were of a similar size to those recorded earlier (Shawcross 1967: 334).

3.3 FALLOWING

There is little information on the amount of time gardens were left fallow, and also on how long gardens were used. Both of these would be dependent on variables such as natural fertility of the soil, soil type, climatic conditions and previous vegetation. Richard Taylor reported that soils could be cropped for 3 years then fallowed (Best 1976: 143). The length of time depended on the type of vegetation: if bracken fern was present, the ground was fallowed for 7–14 years before reuse, but if scrub or light bush was present, the interval was variable and depended on how long it took for the vegetation to grow up. Maori Land Court records for the Waihou area in Hauraki suggest that gardens could be cropped for 2–3 years, or possibly up to 6 years, before the soil was rested (Phillips 2000: 58). The fallow period in the Tamaki area may have been between 10 and 20 years, following 3 years of cropping (Sullivan 1985: 485). Jones (1989: 62), following a different methodology, attempted to calculate the amount of hillslope that was in garden in Anaura Bay during Cook's visit in 1769. Based on a total usable space of 240 ha, he estimated that the amount of land in use compared with the amount lying fallow was in the range of 1:5 or 1:6 in any one season.

3.4 GARDEN PREPARATION

Following the burning of vegetation, the ash was spread around, and loose branches and stones were cleared to the outer corners of the garden (Best 1976). Prior to planting kumara, the ground was loosened at regular intervals then formed up into puke: '… when the ground was cleared, it was not turned over as with us; the earth was loosened and formed into puke or little mounds at certain intervals, but the space of earth between such mounds was not turned up or loosened, it was simply cleared from weeds and rubbish' (Best 1976: 157). However, if bracken fern was present, the ground was fully dug over to remove the roots. It is not clear, however, whether the same puke were reused in following years, or whether the ground was smoothed out and new puke dug. This comment is particularly significant when considering what might be observed in an exposed soil profile. If ground was only used once, soil might show a pattern of disturbed and undisturbed soil horizons in close proximity.

Puke for kumara are described by Archdeacon Walsh as 9 inches (23 cm) high, and 20–24 inches (50 cm) in diameter, with the bases about 4 inches (10 cm) apart (Best 1976: 149, 155). The mounds were set out in rows, in a quincunx pattern, which Best describes in detail. Yams were planted in a similar fashion.

The concave circular bowls in which taro were grown on the East Coast were about 24 inches (60 cm) in diameter and 8 inches (20 cm) deep, and between 18 and 36 inches (45–90 cm) apart. The holes were filled with gravel, three or four taro tubers were planted, and gravel was drawn back around the tubers and firmed (Best 1976: 236). Also on the East Coast near Te Kawakawa, Colenso described a taro plantation planted in quincunx layout, with sand laid on the ground between the tubers. Fences of manuka (*Leptospermum scoparium*) intersected the plantation to act as wind breaks (Best 1976).

Best (1976: 173) also mentions mounded ridges of soil called tuaka kumara, which were used to form raised beds for kumara growing on damp soil. These may be similar to hummocky surface features that are still visible on some archaeological sites.

Fences were commonly observed around the gardens. These may have been windbreaks, and/or barriers to keep ground-dwelling birds and animals out. Rats (*Rattus* spp.) are frequently mentioned as possible garden marauders, probably because snares were seen on the ground around the gardens in Anaura Bay, but weka (woodhen, *Galliralus australis*) are also a possibility. The fences were constructed of closely spaced reeds and were about 20 inches high (Monkhouse, in Salmond 1991: 164). Best (1976: 39) lists a number of terms for fences around gardens. Later, after European animals arrived, gardens had more sturdy fences around them to keep out pigs (*Sus scrofa*).

3.5 SOIL ADDITIVES

There are many Maori names recorded for different types of soils including clay, alluvial soil, gravel soil, fertile dark soil, sandy soil, and a stiff brown soil, which was fertile but needed breaking up and to have sand or gravel added (Best 1976: 42–43). Best, quoting other observers, makes several references to the addition of gravel to soils. Archdeacon Walsh (1902) indicated that while a light, porous soil was preferred, soils could be improved by adding a layer of sand from the river-bed or, in the Waikato area, sand from the river terraces. Sand or gravel, when added to clay soil, kept it porous and able to take up water (Best 1976: 132–133). Colenso (1880: 138) reported that adding gravel was an annual activity.

A description of gardening reported in Best (1976: 163–172) by an informant of Ngati Kahungunu contributes further information. Heavy loam soils were improved by gravel, but they were not favoured because of the amount of work involved. Lighter, rich soils were preferable for kumara, and small amounts of gravel could be used to put under the leaves to protect them from mud and dampness; grass was used if no gravel was available. Gravel was poured between the puke, then scooped up and added to the soil in the mound before the kumara was planted. This warmed the soil and allowed air in.

These accounts suggest that there were multiple reasons why sand or gravel was added to soils; archaeologists should, therefore, beware of simplistic, universal interpretations of the evidence.

4. Limitations to growth of Maori cultigens

As outlined above in the requirements for individual cultigens, mean temperature and length of growing season are the main limitations to the regional distribution of Maori gardening. The ability to store the tubers in appropriate conditions is also a consideration. Historic observations suggest that only kumara could be grown in the South Island and southern North Island, and while taro was more cold-tolerant than yam, neither could be grown south of Poverty Bay or Hawke's Bay.

There are two critical periods in the growing of kumara: spring and early summer for the sprouting of tubers and for plant growth, and late summer and early autumn, when tuber formation and thickening occurs (I. Lawlor, Auckland Regional Council, pers. comm.). The higher the minimum soil temperatures, the better the growth and yields. Low soil temperatures in late summer and early autumn also affect the viability of tubers, inhibiting germination the following year (Law 1969: 240). Experimental growing of Maori kumara varieties near Christchurch has shown that plant growth and crop yields varied from year to year according to the weather conditions, suggesting that kumara was at the southern limit of its tolerance (Law 1969; Yen 1990; Horn 1993).

New Zealand's climate in the early centuries of Maori settlement is largely unknown. The postulated Little Ice Age, with cooler temperature conditions, which has been used to explain the abandonment of gardening on the Palliser Bay coast in the 15th century, has been based on climatic influences affecting Europe (Leach, H.M. & Leach, B.F. 1979). The severity of the effect of the cold period on New Zealand is, as yet, unknown. However, recent work on the dendrochronology of silver pine (*Lagarostrobos colensoi*) from Oroko Swamp near Hokitika indicates two periods of above-average warmth in the 12th and 13th centuries alternating with periods of below-average temperatures (Cook et al. 2002). This coincides with the Medieval Warm Period experienced in the northern hemisphere. The timing of these warm periods may have been particularly important for the development of horticulture in New Zealand, although the range of temperature change is likely to have been only 2–3°C at most. The same study indicates a sharp reduction in temperature after AD1500, followed by a long period of warming but with temperatures still below the average (Cook et al. 2002). Climatic reconstruction tied to precise chronology over the last 1000 years using dendrochronology, speleotherms and vegetation reconstruction is the subject of ongoing research. Temperature is likely to be only one factor affecting the viability of Maori horticulture—excessive rainfall, or the frequent incidence of cyclonic events, and prolonged dry conditions are also likely to have had significant effects.

Using present-day temperature and frost-occurrence statistics as a basis for determining the viability of Maori horticulture in the past can provide a useful guide, but can also be misleading. Suitable microclimate conditions, related to aspect and shelter from prevailing winds, will exist locally, but are not detected in generalised climate statistics. In addition, bush cover was formerly more widespread and gardens would frequently have been enclosed by bush. The

shelter provided by the bush may have encouraged higher temperatures and protected against frost and wind, thus making gardening more viable. However, in the case of Palliser Bay, general environmental degradation caused by forest clearance in association with climatic change have been put forward as factors affecting the on-going viability of gardening on the coastal platform after the 15th century (Leach, H.M. & Leach, B.F. 1979) although, more recently, this interpretation has been challenged and environmental catastrophe following earthquakes and tsunami have been proposed as reasons why the Palliser Bay area was abandoned (Goff & McFadgen 2001).

In keeping with the tropical and sub-tropical origins of the Maori cultigens, the evidence for gardening is most extensive in the upper half of the North Island. Evidence is mostly confined to coastal areas, where the severity and number of frosts is limited. Table 1, which shows the number of recorded archaeological sites with evidence of gardening by each DOC conservancy, should be treated as indicative only, as it is subject to limitations of site recording and how site features were identified. However, it does quite correctly show that there is considerably more evidence of Maori gardening in the North Island than the South Island, and that evidence increases progressively towards the north.

Storage pits and archaeological garden sites indicate that gardening was viable at the northern end of the South Island and in favourable locations on the eastern coast as far south as Banks Peninsula. Radiocarbon dates indicate that the gardens on the Marlborough coast were in use from the early period of settlement through to the European period (Challis 1991: 104).

TABLE 1. NUMBER OF RECORDED MAORI GARDEN SITES BY DEPARTMENT OF CONSERVATION (DOC) CONSERVANCY.
Information collated from New Zealand Archaeological Association site records.

CONSERVANCY	STONE ROWS	STONE STRUCTURES	STONE MOUNDS/HEAPS	MODIFIED SOIL	TRENCHES/ DITCHES	BORROW PITS	TARO	HISTORIC CULTIVATIONS	TOTAL	STONE-FACED TERRACES*
Northland	59	18	173	18	118	–	87	40	513	40
Auckland	87	28	76	23	32	–	30	28	304	14
Waikato	32	5	15	22	18	40	40	13	185	2
Bay of Plenty	3	–	1	29	4	1	2	15	55	6
East Coast/Hawke's Bay	15	2	–	19	16	2	2	9	65	1
Tongariro/Taupo	4	1	–	7	–	1	–	2	15	–
Wanganui	–	–	5	4	1	64	1	3	78	–
Wellington	79	1	2	9	–	–	–	3	94	–
Nelson/Marlborough	24	1	1	39	–	6	–	–	71	–
Canterbury	7	–	–	5	1	4	–	–	17	–
West Coast	–	–	1	–	–	–	–	–	1	–
Otago	–	–	1	1	–	–	–	–	2	–
Southland	–	–	–	–	–	–	–	–	–	–
Total	310	56	275	176	190	118	162	113	1400	63

* Stone-faced terraces are included to show that they have a limited distribution coinciding with the area of greatest horticultural activity. They may, however, have functions other than gardening.

There are 17 garden sites reported from Canterbury. A series of borrow pits in the vicinity of Woodend and Tuahiwi, near Kaiapoi, suggest extensive gardening (Walton 1985a; Trotter & McCulloch 2001). The Banks Peninsula evidence is variable and generally untested archaeologically. Stone rows and earthen rows are present at Panau and several other northern and eastern bays, and indications of modified soils in association with raised-rim pits and borrow pits are present at Okuora Farm near Birdlings Flat (Gordon et al. 2004). There is a possible modified soil and borrow pits at Taumutu, from where there are also traditional accounts of kumara growing, and agricultural implements have been recovered (Trotter & McCulloch 1999a). However, these are marginal climes, with the southern limit for kumara growing being at or about latitude 43°S. Thus, suitable warm, frost-free and sheltered coastal microclimates would have been used for successful gardening, and it is unlikely that gardening was widespread. Clearly identified storage pits are rare south of Kaikoura (Law 1969: 229), and only a few of the pit features identified on Banks Peninsula are likely to be storage pits (C. Jacomb, New Zealand Historic Places Trust, pers. comm.). In the absence of storage pits, the question of how the crop was stored at this southern extreme of cold tolerance is an important one. Yen (1961, 1990) argued that appropriate pit storage was the key to the success of kumara in New Zealand, as without storage over the winter in suitable conditions (i.e. a narrow temperature range), the crop would not be healthy or viable for planting the following spring.

Evidence of gardening is also present in Nelson/Marlborough, although the density of sites diminishes with increasing latitude (Challis 1991). Soils modified by the addition of gravel have been recorded in the Nelson-Waimea plains area, and stone rows, together with modified soils, are present in the Marlborough Sounds and eastern Marlborough coast, and into North Canterbury. This distribution of direct horticultural evidence is mirrored by the distribution of storage pits, but to what extent this combined evidence is a reflection of site survey coverage is unknown, as large areas (e.g. of the Marlborough Sounds) have not been inspected for sites.

Historically, Captain Cook, on the many visits he made to the Marlborough Sounds during his three voyages, did not report on gardening or evidence of recent gardening, but members of D'Urville's exploring party noted that potato and kumara were being grown on the western side of Tasman Bay in 1827 (Law 1969: 236).

Microclimates and good soils will have been factors dictating where crops were able to be grown, especially in more marginal areas. The possibility that the islands in the northern North Island were particularly desirable, with warmer, frost-free climates, was raised by Edson (1973), who further suggested that kumara could be grown all year round in these locations. Although no climatic data is available to support or refute this claim, it is unlikely that even on these islands the average minimum soil temperature (day and night) is sufficiently high throughout the winter months to encourage tuber growth and maturity. Yen (1969) also dismissed the possibility of two kumara crops a year based on the current climate, but argued that an average temperature of 1–2°C higher in the initial adaptive stage of kumara growing in New Zealand might have been sufficient to extend the growing season.

Predictive modelling of environmental data and archaeological site distribution demonstrates in an empirical way the relationship between certain site types and relevant variables. The implicit assumption of such work is that people chose where to live and carried out certain activities based on consideration of the local environment. Leathwick (2000) compared a range of climatic variables with known pit and pa distributions. There was a high correlation between the location of these sites and warm mean temperatures (14–15°C), high solar radiation, mild winters and dry summers. Soils with limestone, basaltic or andesitic parent materials also correlated well. Predicted rates of occurrence of pits and pa were then calculated. As expected, the highest predicted probability of pits and pa and, by inference, gardening were in the northern North Island. The probability dropped off markedly south of a line from Wanganui to Hawke's Bay. Although such a pattern was already apparent at a broad level from examining the distribution of sites, the model has potential for analysing the relationship between sites and the landscape at a regional level.

5. Archaeological evidence of Maori gardening

Several types of field remains have been interpreted as evidence of Maori gardening. Definitions are taken from the Site Recording Handbook (Walton 1999), with other descriptions added where appropriate. The main types of field evidence include:

- *Stone structures*, where surface stone has been used to construct rows, alignments, mounds and heaps
- *Ditches and channels*, both as shallow parallel lines on hill slopes and as regular series of interconnecting ditches or channels in swampy areas
- *Borrow pits*, where coarse sand or gravel has been removed for inclusion in nearby gardens
- *Garden soils* that have had other materials such as sand, gravel or shell added, or where the natural soil profile has been altered through mixing or artificial deepening
- Other stone structures, such as *stone-faced terraces*, which were often terraces specifically constructed as gardens to retain soil on steep slopes or where soils were thin
- *Taro* locations where wild remnant populations exist

In the following text, each of these site types will be described, outlining evidence from archaeological investigation and any regional variability. This detailed appraisal of each site type, including both representative and unusual features encountered nationally, enables a comprehensive picture to be developed, against which individual sites can be evaluated. This 'defining of the resource' is important in any assessment of site significance. Archaeological research plays a very important role at this level of site description, contributing to the characteristics that allow the site type to be defined in all its variations.

Stone and trench remains have led to an understanding of aspect, details such as plot size and pathways, and preferences for garden sites within local environments. However, it is generally only the unusual features associated with Maori gardening that can be detected in surface remains. In most areas in the North Island, gardening was carried out without the need to add materials to soils, or there was no stone to be cleared from the garden areas. Therefore, for the majority of garden sites, the evidence of gardening is elusive and difficult to identify, let alone interpret.

5.1 STONE STRUCTURES

Stone rows, mounds and alignments are the most visible evidence of gardening in a number of localised areas (Fig. 2). There has been considerable discussion about the purpose of these structures. Was the stone removed from the soil for clearance purposes, or for constructing boundaries and windbreaks, or did the structures themselves function as gardens? The debate is ongoing (McFadgen 1980b, 2003).

Stone structures are found on soils around volcanic cones, on old raised beach ridges, weathered fans, or alluvial terraces and river flats where weathered gravels are exposed on or near the surface. The main areas where stone has been recorded in association with gardening evidence are around the volcanic cones of the Taiamai Plains in the inland Bay of Islands; the central and South Auckland volcanic cone areas; Waipoua Valley; Three Kings, Cavalli, Poor Knights, Taranga, Great Barrier (Aotea), Hauturu/Little Barrier, Great Mercury (Ahuahu) and Moutohora Islands; the Cape Runaway area near East Cape; coastal Wairarapa, including Palliser Bay; D'Urville Island, the Marlborough Sounds and east coast Marlborough; and the north Canterbury coast and coastal Banks Peninsula. There are other sites where the main features are stone heaps and mounds. These generally occur on river flats in a number of areas, such as Hawke's Bay, the Coromandel coast, Auckland and Northland.

Archaeological literature from Eastern and Central Polynesia confirms the use of stone as boundaries between garden plots, and reinforces that such gardening practices, imported into New Zealand, have a long tradition amongst Polynesian horticulturalists (Leach 1976: 134–144).

5.1.1 Stone walls and rows

Walls are defined in New Zealand archaeological literature as 'solidly built, free-standing, and have more or less perpendicular parallel sides' (Walton 1999). Stone rows are described as elongated heaps of stone (ibid). Both features are interpreted as being garden remains, and the terms are often used loosely and interchangeably. An attempt was made in Auckland to differentiate various types of walls, e.g. edged stone and earth walls, and mounded earth and stone walls (Rickard et al. 1983), but this level of detail is often difficult to determine from visible remains. Some of these features do have curbing to confine stones, but they are more akin to rows than constructed, free-standing walls with prepared foundations, and for that reason the term 'row' is used here in preference to 'wall'. These features are most likely to have defined boundaries around plots,

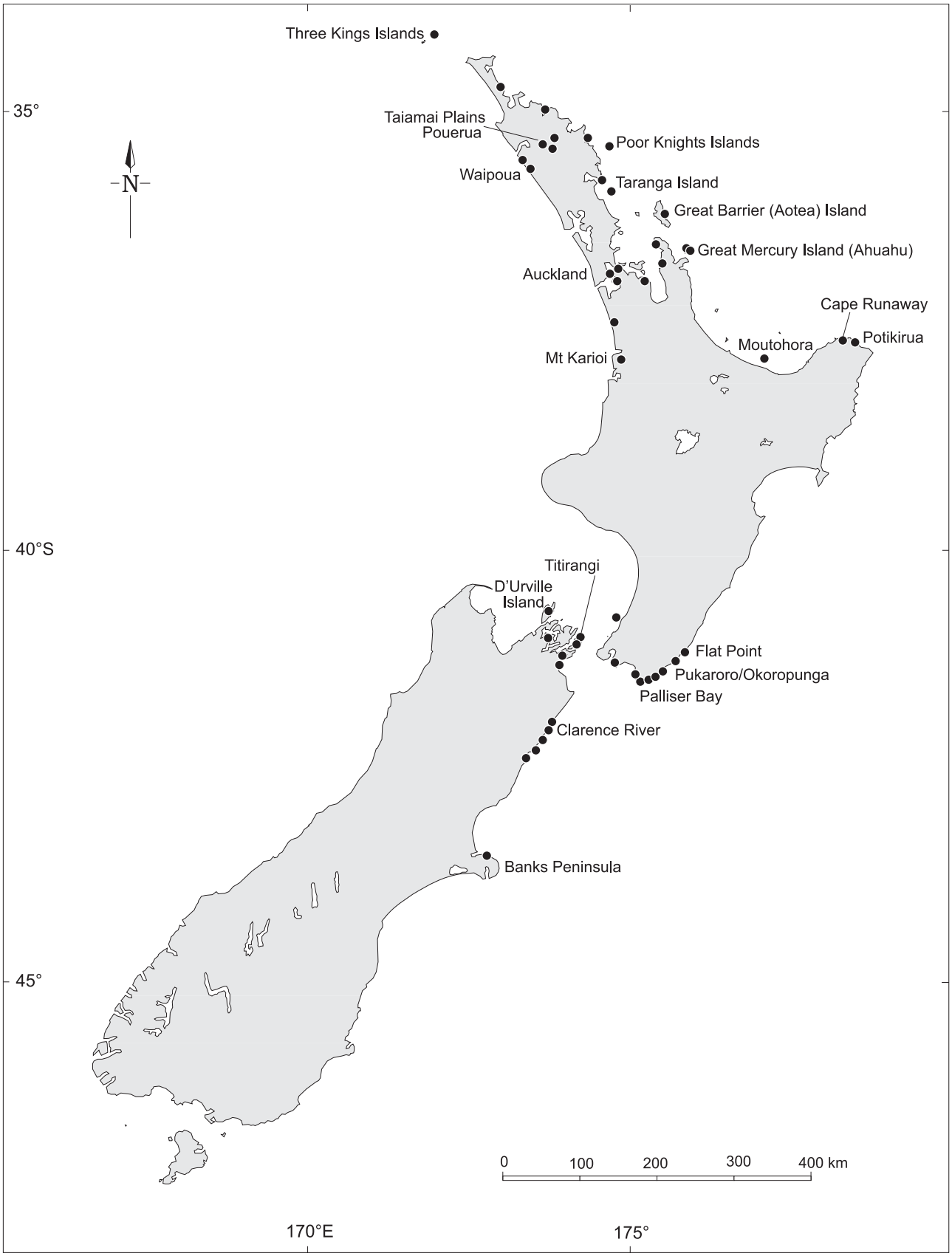

Figure 2. Distribution of recorded archaeological sites containing stone rows, stone mounds, heaps and stone alignments. Each locality represents one or more sites. *Map: C. Edkins, DOC.*

but they also represent the clearance of unwanted stone from gardens, and were possibly also used as wind shelters. These linear stone features (Fig. 3) are present on gravel fans, coastal terraces and platforms, riverine flats, and volcanic soils. They have been investigated in geographically diverse locations, from Clarence River on the northeast coast of the South Island to Pouerua in inland Bay of Islands, Northland.

There are some examples of isolated rows recorded in the NZAA site file, but stone rows are usually found as part of what is called a garden system or garden complex, consisting of multiple parallel stone rows, often covering a large area in association with stone alignments, stone heaps, mounds and occupation evidence, such as shell midden, ovens, terraces and pits. Modified soils or borrow pits may also be present, especially in the southern sites of Marlborough and in some sites in Palliser Bay and elsewhere in coastal Wairarapa. In the Auckland area and at Pouerua in the inland Bay of Islands, this combination of archaeological features can cover hundreds of hectares.

Stone rows and other evidence have been mapped at a number of sites in Palliser Bay (Leach, H.M. 1979a), the eastern Wairarapa coast at Okoropunga (McFadgen 1980b), Pukaroro Maori Reserve and Waikekino. In Marlborough, sites include those at D'Urville Island, Cattleyards Flat (Titirangi) in the Marlborough Sounds (Trotter 1977), Clarence River (Trotter & McCulloch 1979) and at several

Figure 3. Stone row at North Kawakawa, Palliser Bay (S28/79). These features are often low, grass covered, and more visible in low-angled light. *Photo: L. Furey.*

smaller garden sites on the Marlborough coast (Brailsford 1981). In Auckland, there has been extensive archaeological mapping of garden systems—primarily in the remnants of the Wiri-McLaughlin's volcanic field (Lawlor 1981b; Cramond et al. 1982; Veart et al. 1984; Veart 1986; Foster 1988), the East Tamaki stone field of Otara-Green Mount (Foster & Veart 1986; Albert 1987) and at Otuataua near Mangere (Foster & Veart 1985). However, the most comprehensively mapped volcanic garden system incorporates the majority of the volcanic area around Pouerua in Northland, including the pa and open-settlement (kainga) sites. This work provides a unique opportunity to investigate the social dimension of land subdivision hinted at from other volcanic areas in Auckland where only remnants of garden systems survive. The Pouerua map is as yet unpublished.

Stone rows generally appear in a regular pattern, in keeping with the orderliness of Maori gardens reported historically by the earliest European observers. They are parallel or roughly parallel, and may have rows at right angles, which define changes in slope or divisions into smaller plots. These remains of garden systems may be extensive. For example, some in Palliser Bay cover more than 9 ha. The parallel stone rows there are 2–3 m wide and between 400 mm and 600 mm high. The rows extend across the coastal platform from near the coast to the base of the hills. At the Black Rocks garden complex (S28/103) in Palliser Bay, rows are up to 212 m long. Sometimes, the main longitudinal rows are connected by transverse rows or cross-rows, dividing the land into plots, but the long rows were always oriented the same way, probably to allow all gardeners to have equal access to the range of conditions: 'Thus each rectangular strip in a group of apparently contemporary strips contains comparable soils, and no single land user could monopolise the deeper soils of the hollows, while another used only the dry stony ground of the beach ridge' (Leach, H.M. 1979a: 159–160). These boundaries were made up not only of rows, but also of alignments of stones (see section 5.1.2). In some cases, trenches have been found under, or next to, stone rows, or are visible on the surface. Natural topographic features, such as scarps, were also incorporated into the rows to form continuous garden plot boundaries. It is this kind of evidence that provides compelling proof that the stone rows were not merely the result of a convenient place to dispose of unwanted stones, but that they also had important functions in identifying and enclosing gardens.

On the Auckland volcanic fields of East Tamaki and the Wiri-McLaughlin field in South Auckland, the rows commenced not on the coast or older fans (as at Palliser Bay), but on the lower slopes of the volcanic cones. Rows at Wiri radiated out into the surrounding lava field, creating strips or wedges between 25 m and 60 m wide and between 80 m and 300 m long. These strips were sub-divided by rows at right angles to the main rows, forming plots of 250 m^2 or more (Sullivan 1974). While the general intention may have been one of straight lines, in reality the rows and alignments followed natural topographic features, incorporating natural rock scarps and outcrops into the line (Fig. 4). Where there were no impeding natural features, the tendency was to form rectangular plots (as at Palliser Bay). The boundaries became more irregular with increasing distance from the cone, reinforcing the suggestion that they originated from the very regular zone around the base of the cone itself (ibid). Green Mount in East Tamaki displays a similar pattern of rows radiating out from the cone, becoming more haphazard with distance from the cone. Veart (1986: 231) attributes this

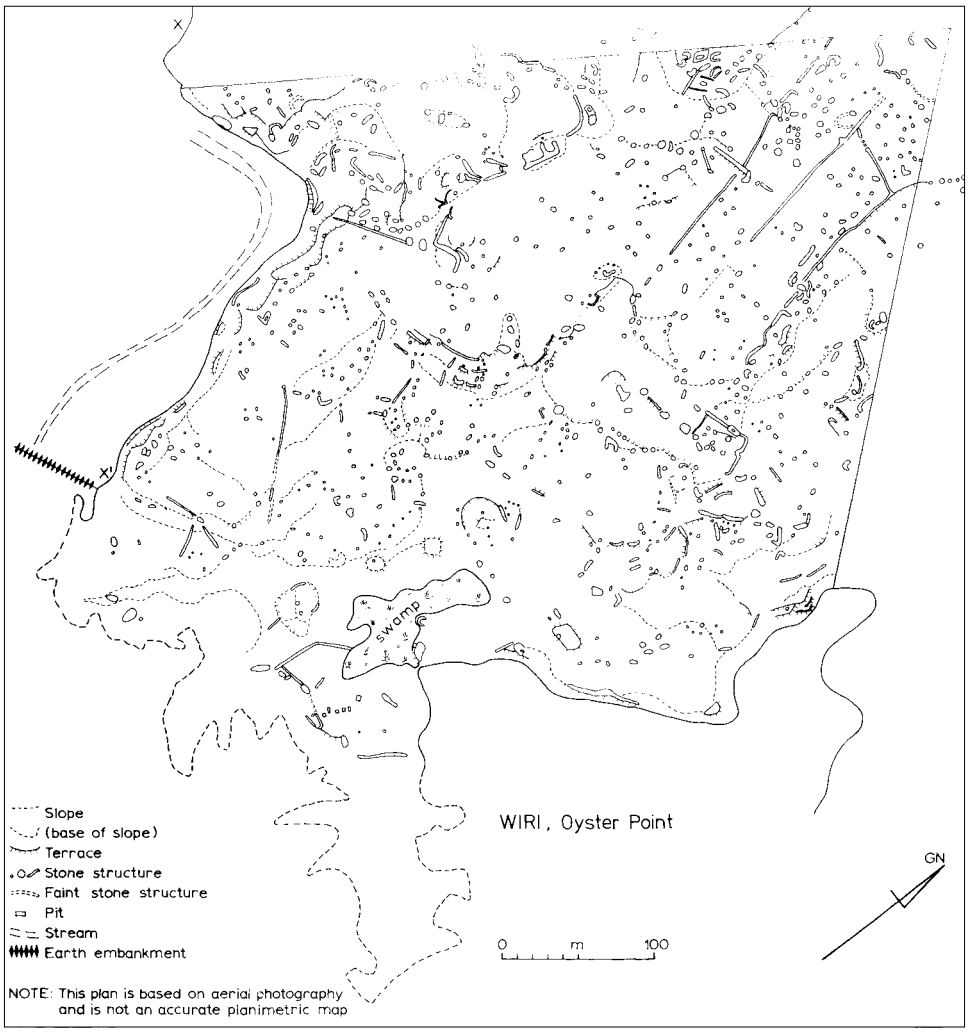

Figure 4. Part of the stonefield garden area at Oyster Point, Puhinui (R11/25), South Auckland, associated with the McLaughlan Mt/Matukureia Paa area. The Puhinui Creek, which flows into the Manukau Harbour, forms the boundary to the west and south. Archaeological excavations were carried out at this site by Ian Lawlor in 1981. *Anthropology Department, University of Auckland; mapping by A. Sullivan.*

to the unevenness of the terrain on the lava fields creating difficulties for Maori gardeners attempting to continue straight lines unimpeded by barriers. At both Wiri and Green Mount, aerial photographs show that there was an overall radiating division based on rows, but within these units there were longitudinal row divisions of parallel rather than divergent orientation. It is now difficult to resolve what the original shape of these land units may have been, since only remnants of the Auckland complexes exist.

Stone rows covering an area of 2.5 ha at Cattleyards Flat (P26/217) in the Marlborough Sounds give the impression of enclosures rather than strips of land, and right-angled rows may form the front edges of terraces or changes in slope (Trotter 1977; Brailsford 1981). These are unusual, and a similar configuration of rows has not been recorded elsewhere on the Marlborough coast. At Clarence River, the longitudinal rows, over c. 5 ha, are definitely parallel in orientation, with only a few rows sub-dividing the longitudinal space. Rows at three sites in Wairau Bay in Marlborough, including Robin Hood Bay and Rough Paddock, are also parallel (Brailsford 1981).

On the northern offshore islands, the stone row systems are smaller than at the mainland sites described above, and many have short rows that may also be interpreted as elongated heaps. Some larger garden complexes exist on islands such as Great Barrier (Aotea) and Great Mercury (Ahuahu).

The majority view of archaeologists, based on the evidence, is that the rows and other stone features were the result of the need to clear stones from the garden soils. However, Helen Leach (1979a) contends that stone rows and stone alignments were constructed primarily to define garden plots and land ownership, a view supported by the use of trenches and single stone alignments as boundaries. Natural boundaries were also used, where appropriate, for garden divisions, and stones were only gathered up where they hindered land use.

Since the rows are in a regular pattern, enclosing land in rectangular plots, it has long been assumed that the soils inside the rectangles or between the rows were gardened. Stone heaps enclosed within the rows were the result of stone clearance. McFadgen (1980b, 2003) suggests an alternative interpretation for stone rows, based on his research at Okoropunga in eastern Wairarapa. He argues that the stones used in row construction were taken from borrow pits on the crest of beach ridges rather than from the area between the rows. An excavated section through a row showed that the soil profile within the feature was thicker and darker than the surrounding ground, leading to speculation that the rows themselves were gardens rather than the intervening space. A second line of argument—that the soils between the rows had not been modified by the addition of gravel and sand, were not uneven like nearby modified soils, and did not have thickened topsoil depth—was used to support the view that the space between the rows had not been cultivated. However, given that rows tend to be regularly spaced, are oriented in a particular direction in relation to the sea and the hills, and, in some excavated examples, have earlier and less permanent trench boundaries underneath, are continuous with stone alignments and incorporate not only stones but charred wood and branches, twigs and occupation debris, strongly suggests that their primary function was that of delineating garden space, as appears to have been the case in garden systems in other regions. In addition, if the rows themselves were gardens, they should be more closely spaced to maximise the area of garden in production. The rows may, however, have served the secondary purpose of windbreaks and shelters for plants. Windbreaks were, from historic accounts, important features of Maori gardens. The notion of delicate wind-sensitive plants being grown on rows in the most exposed situation is counter to all known literature on Maori garden practices.

Most of the stone incorporated into rows was present on the surface or within the depth of the garden soil, but this is not always the case. For instance, the Black Rocks garden complex in Palliser Bay has rows on old fans and on sand-mantled, earthquake-uplifted beach ridges. Towards the lower end of the rows, some of the stones are beach cobbles derived from the beach rather than the fan (Leach, H.M. 1979a). At Okoropunga, the stone rows are on sand-mantled beach ridges where there is little or no stone present on the surface, yet beach cobbles have been dug out from beneath the surface to form the rows (McFadgen 1980b). These two examples strongly support the case that rows are not merely the result of clearing stones from the soil.

Few long profiles through gardens and across rows have been published or, indeed, investigated (Fig. 5). It is, therefore, difficult, in the absence of section drawings showing the depth of soil horizons, relative density of stone in different parts of the garden, and distribution of materials added to the soil, to dismiss one or other of the opposing interpretations. To progress the debate further, it would be useful to examine both stone rows and soil in the open space between rows for distinctive microfossils to indicate where crops were grown.

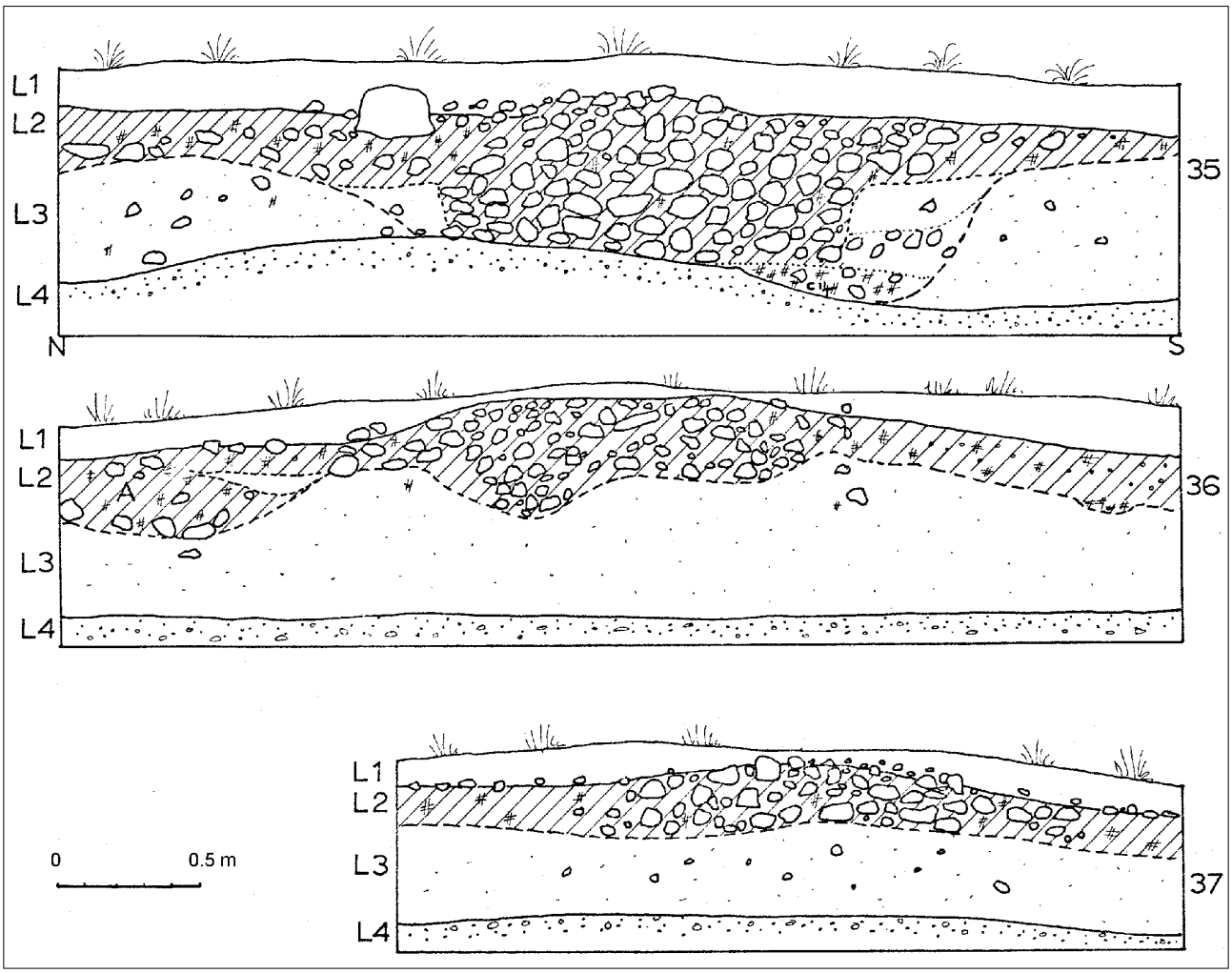

Figure 5. Sections through stone walls, North Kawakawa, Palliser Bay (S28/79). In the upper section a trench was dug into the natural 'C' horizon, filled in, and redug with straight sides into which the stone row was constructed. In the middle figure, the topsoil has been artificially deepened on either side of the row. The lower section shows the concentration of stones within the cultivated L2 soil. *After Leach, H.M. 1976: figs 35–37.*

Some rows in Palliser Bay may have been constructed as early as the mid-14th century. It is believed that environmental deterioration and cooler climatic conditions may have led to the abandonment of gardens on the coastal platform in Palliser Bay by the 15th century (Leach, H.M. & Leach, B.F. 1979; McFadgen 2003). This part of the Wairarapa coast is extremely exposed, receiving both north-west and southerly winds; thus, vegetation regrowth necessary to replenish the soil during the fallow period would have been slow and patchy. Rows at Clarence River have been dated to between the 15th and 17th centuries, while those at Cattleyards Flat at Titirangi, Marlborough Sounds, were constructed in the 16th to early 17th centuries (Challis 1991). Similarly, the dates from the Auckland volcanic fields indicate row building and garden division from the 15th century (Lawlor 1981b,c), but the majority of field evidence from the Wiri-McLaughlin's complexes is slightly later (Bulmer 1987). There is no direct evidence for when row construction began at Pouerua, but forest clearance, assumed to be related to agricultural development, began in the 15th century, and repeated occupation of the Pouerua cone and the smaller sites within the volcanic field suggests that gardening was an ongoing activity over several hundred years (Sutton et al. 2003).

Garden systems based on stone rows are highly visible and can be mapped and interpreted at a general level, but are only a variant of gardening. The use of stone was not a technique especially developed for marginal areas, although there may have been advantages derived from using stony soils, perhaps leading to higher yields and more reliable and consistent harvest results.

5.1.2 Stone alignments

Stone alignments are lines marked out on the ground by stones, generally not more than one course high. These are likely to be boundaries or plot delimiters in the same way that rows and trenches are. However, at the South Pararaki complex in Palliser Bay, an alignment ran parallel to a row and followed its orientation exactly, to the extent of turning a right-angled corner. Excavation revealed a posthole and paving in the space between the alignment and the row, and it was interpreted as marking out a footpath around the edge of the garden (Leach, H.M. 1979a: 148). A similar feature is described from the Cattleyards Flat site in the Marlborough Sounds (Brailsford 1981). After rows, alignments were the second most common feature of the garden systems at Palliser Bay, and feature prominently at the Washpool garden site. In several instances, single stone alignments were a continuation of stone rows. This was attributed to the absence of stone in silty soils compared with the more stony soils where rows were present (Leach, H.M. 1979a).

5.1.3 Stone heaps

Stone heaps are piles of stones of various sizes that may be faced with carefully placed larger stones. Walton (1999: 60) identified heaps associated with Maori gardens as having small stones, being regular in shape and having had some care taken in their construction. They contain no soil. In addition, the heaps are often located on waste ground. In contrast, heaps made during European land-clearance practices tend to comprise larger stones and be constructed in an irregular fashion.

5.1.4 Stone mounds

Stone mounds are interpreted as being more structured than heaps and often have soil incorporated into them. Mounds may have a stone curbing around the base and have smaller stones in the core. In the archaeological literature, the terms ‘stone heaps’ and ‘stone mounds’ have been used interchangeably, but work focusing specifically on these features during the 1980s’ investigations of the garden systems of South Auckland has indicated that there are differences between them (Coates 1992). Mounds have a distinctive rock and soil core covered with, or surrounded by, small rocks (Fig. 6). Challis & Walton (1993) defined heaps at Pouerua as being structured piles using larger stones on the outside and smaller stones in the core. In contrast, mounds were defined as low piles with larger stones forming a perimeter and often containing a large quantity of earth. They suggested that heaps, which contain more stones, may represent the first attempt at stone clearance, and mounds may have been the result of a second level of clearance or may have functioned as gardens. A classification of mounds has been attempted based on plan, cross-section and composition (Rickard et al. 1983), but it is the internal composition that is important (Coates 1992), and this cannot always be ascertained from surface features. Mounds may also be fragmentary or dilapidated rows (Sullivan 1974).

Continue to next file: Part 2