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PITS AND KUMARA AGRICULTURE IN THE SOUTH ISLAND

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Agriculture has long been a principal preoccupation of the prehistorians of Neolithic cultures as it is normally the economic base of such societies, and the distribution and expansion of many cultures is vitally dependent on the viability of this economic base. Currently fashionable theories for New Zealand attribute the replacement of the earliest Moa Hunter or Archaic period of New Zealand prehistory by the Classic elements, to the development of a new cultural dynamic in Northland based on an introduced cultigen, kumara *(Ipomoea batatas)* spreading mainly by migration and conquest by its carriers to the remainder of the North Island and New Zealand. As this replacement is the principal field of study for New Zealand archaeology, its economic base has attracted an almost equal amount of attention and some workers, at least, regard agriculture as the principal problem of New Zealand archaeology. Evidence of agriculture in the North Island can be found in a variety of sources. Numerous references to kumara occur in historical and traditional history literature, together with a massive amount of evidence for prehistoric fields. Wooden agricultural tools preserved in swamps and also evidence of cultivation, as are surface indications of storage structures excavated into the ground to store kumara tubers over the winter period where the plant would not survive in the ground. These structures are commonly called pits , and are often found in a wide variety of forms and sizes in field investigations and agricultural tools preserved in swamps are also evidence of cultivation, their lack of stratigraphic, or even site, association with any artefacts of the known sequence for New Zealand. Even the pits , although often found in demonstrable order on sites, and occasionally in datable contexts, present considerable difficulties.

Thus there is no simple or quick answer to defining the spread or viability of kumara agriculture .

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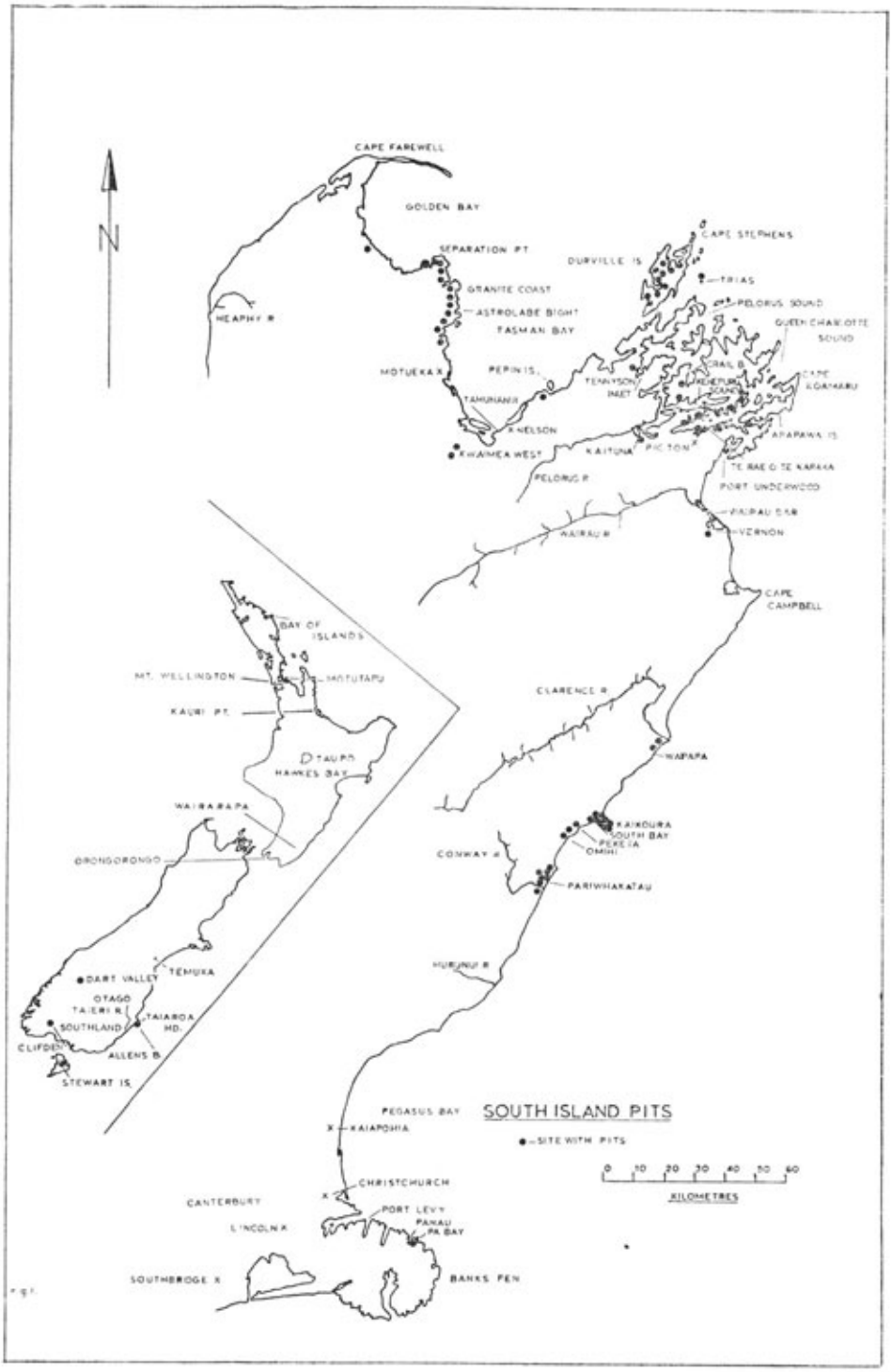

FIGURE 1.

FIGURE 1.

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The author was attracted to the South Island as a limited area for study, as it was marginal for agriculture , and the field evidence could produce a defined set of environmental limits to kumara cultivation.

Having found these climatic limits it is possible to discern more of the non-climatic limitations to kumara agriculture . In the narrower field of study of the pits themselves it appeared likely that the spacial differences in the South Island would give some hints on the separation of styles of pit building in the more complex North Island.

This study, then, sets out to order the relevant evidence of agriculture from the South Island to further these two aims.

One difficulty is that pits are not universally accepted as storage structures so that it is necessary to demonstrate the function of these structures before admitting them as evidence for agriculture .

Shawcross [1] and Ambrose [2] in recent discussions of excavated evidence for the Auckland Province, and Groube [3] in a wider consideration of archaeological and historical evidence, have concluded that even the larger pits , usually rectangular, discovered on many sites of northern New Zealand are not house pits as previously thought, [4] but were stores, presumably for kumara .

Final conclusions on the storage function of these structures must await full publication on more of these sites and a closer understanding of the environmental requirements of kumara both in growth and in storage. Similarly, any attempt at seriation either on metrical or other grounds is hampered by the lack of published data.

In the north of the South Island, however, most field workers have published at least some field evidence on pits , making possible the tentative summary presented in this article. The field workers in this area have with few exceptions interpreted the pits they have recorded, and in some cases excavated, exclusively as houses, rejecting the idea that they were for kumara storage. This surprising contrast with more recent North Island opinion deserves closer attention, particularly when one considers that most temporal differences commonly accepted as correct for New Zealand were generally first recognised in the South Island [5] where they were more readily recognised in site intrusion sites against an apparently more populous early settlement than in the North Island. Other sites had this potential to show temporal differences although this was not recognised at the time. [6]

FIELD EVIDENCE OF PITS

Otago Southland

Four sites in this area have undoubted pits . The first is a site near Clifden in Western Southland. The single pit is 8 ft by 4 ft by 3.5 ft deep and has a drain still visible in the floor. It is at the site of a known late

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village in which a clay pipe has been found. A site with terraces at Allens Beach on Otago Peninsula has two pits , approximately 9 ft by 4.5 ft by 0.7 ft deep; one of these pits has a raised rim.

The third site is remarkable, for as well as having very small raised rim pits it shows unequivocal evidence of houses on earth platforms with four-sided stone slab fireplaces and stone paving. Its position in the Dart Valley at the head of Lake Wakatipu, and a radio carbon determination showing a prehistoric date, make not only the site but especially these pits exceedingly anomalous. [7] Finally, a pit site occurs on Stewart Island at Paterson Inlet. [8] Its proximity to a known whaling station is probably significant. A dubious pit of unproved antiquity has been reported on the Taieri River in the Lammerlaw Ranges. This pit, which was under-ground with a timber-supported roof, has been described by Skinner. [9] It was cut in peat, and full of water at discovery, making its use for either habitation or storage unlikely. Rutland [10] mentions depressions on Taiaroa Head on the Otago Harbour which he had "little doubt were the remains of a dwelling"; however Knight [11] describes ovens for the preparation of edible extracts of cabbage tree roots *(Cordyline australis)* in this area. These take the form of circular raised rim pits .

Canterbury

At Temuka in South Canterbury, Yen [12] cites Lockerbie [13] on pits "construed to be for kumara storage" although reference to Lockerbie shows these to be gravel pits for lightening soil and not for storage. No such soils are mentioned, however, and this furtherest extent of kumara cultivation must be regarded as dubious.

On Banks Peninsula, Thacker [14] in describing an excavation on a pa site at Pa Bay reports one rectangular pit 8.5 ft by 5 ft, by 10 inches deep, apparently without postholes and with a drain leading from the centre of the pit which was associated with many "surface houses".

He dates the site to around 1820 by means of trade articles found on the site. In a site survey of Northern Banks Peninsula, Jones [15] reports 15 sites with circular pits alone, the majority of sites with only one pit. One other partially destroyed pa also has two pits .

Jones states that the pits are 5 to 10 ft in diameter and 18 ins deep with raised rims, and where the latter are broken, oven stones protrude.

This description together with their environmental location at the edge of the bush [16] is exactly paralleled by the *umu ti* described by Knight [17] on Otago Peninsula where distribution again parallels the distribution of

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the bush. Many other such sites certainly exist in Otago [18], but the two areas, Banks and Otago Peninsulas, were the principal coastal bush areas on all the Otago Canterbury coastline [19] in 1840 to 1860. Fomison [20] refers to a raised-rim pit in the Port Levy area, but as this is included in the area covered by Jones it is presumed to be of the same type.

A valuable summary of the pits on Banks Peninsula has been given by Harrowfield. Twenty-seven sites with pits are mentioned, eight of which have structures other than pits . At the remaining 19 sites a total of over 33 pits have been located although many of the sites have only one pit. Of 34 circular or oval pits , 33 were rimmed and of 13 rectangular pits , 9 were rimmed. It may be unwise to assign all the circular raised rim pits to the function of *umu ti* as at least one pa site on the Kaikoura Coast has this form of pit; however, the parallel between the evidence cited by Jones and that cited by Knight for Otago is too close to ignore. Unfortunately Harrowfield does not supply enough data to differentiate between sites with different sorts of pits or to localise them, but it is certain that more sites occur than one plotted on Figure 1 and that at a few sites pits are associated with fortifications or are constructed on terraces. [21]

A suspicion must remain as to whether any of these pits are earlier than the introduction of potato into the area.

Kaikoura Coast

The southern-most site with pits on the Kaikoura Coast, is one mentioned by Elvy [22] at the mouth of the Conway River. The site is called Tutae-putaputa and has large pits showing on the surface. Elvy ascribes the site to a "pit dwelling tribe". Pariwhakatau at Claverley is the next recorded site. This site, described and excavated by Duff [23], is a pa without earthwork defences, although a palisade has been discovered. [24] Inside the site are two groups of rectangular raised rim pits ; one group is aligned while the other is of random alignment. In size the 18 pits generally range from 11.5 to 22 ft long by 8 to 15.5 ft wide with one exceptional pit 36 ft long by 24.5 ft wide. The depth varies from 1.2 to 3.5 ft. [25] Three pits , two of the general size range and the largest, were excavated. Lines of interior postholes were discovered and extra posts were found around the wall. Short internal drains, buttresses, shallow scoops in the floor, and an extension of the side wall of one pit were noticed. One of the smaller pits had a section of a canoe set upright in the floor. Remains of the trunks of tree fern *(Cyathea sp.)* were found on the floors which, in contrast to the midden outside the pits , had no midden and very few artefacts. Tree fern trunks are the material traditionally used for lining storage pits . Artefactual material [26] outside the pits was of Classic

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form. [27] Duff regards these structures as house pits . The size range and the use of the canoe section seem to be the strongest arguments for this. The canoe section is a suitable surface for artistic expression [28] unlikely to be found inside a storehouse. Against this, however, is the surprising lack of a fireplace and the lack of trodden-in midden debris which is found on nearly all accepted house floors. [29] The site has traditional associations with the Ngati Mamoe, and its sacking and occupation by the Ngai Tahu can be dated by traditional means to A.D. 1650. [30] Radio carbon analysis has placed a sample, presumably from the burning of the large structure, at A.D. 1636 ± 60. [31]

Adjacent to Pariwhakatau, are two other undefended raised rim pit sites [32] of three and eight pits respectively. Four other sites with pits are mentioned [33] at Amuri Bluff near Okarahia, and another south of these at the site on the south side of the Conway Mouth; presumably the latter is that mentioned by Elvy. Again Duff regards these pits , which are "similar to those at Pariwhakatau" therefore presumably raised rim, as Ngati Mamoe. Elvy [34] refers to a single deep pit on a spur at Goose Bay, and at Peketa Pa refers to "a large excavation" [35] and again to "probably one hundred pits and terraces" [36] calling the site a Ngati Mamoe Pa.

This site and some of the pits have been investigated by the Canterbury Museum but unfortunately no results are as yet available.

A site near Peketa was investigated by Trotter. [37] The site consisted of oval rectangular and raised rim pits on a spur. Two of these were investigated, an oval and a rectangular pit. The oval pit contained a lens of charcoal and a

few graywacke stones in the fill, while the larger rectangular pit had two concentrations of charcoal in the fill. Some artefactual material, including greenstone, was found, but no postholes, drains or any of the normal features of pits . Trotter's first tentative conclusions were that they were neither for storage nor dwelling pits . [38]

On a rescue excavation at South Bay on the Kaikoura Peninsula, Wilkes [39] investigated one of a row of raised rim pits . It had a stepped floor, an irrational posthole pattern, including a wall posthole, a gutter outside the rim, and two deep floor depressions. Very little artefactual or midden material was found. The pit was stratigraphically earlier than the midden on the site. Wilkes offers no definite interpretation.

The Kaikoura Peninsula has been the scene of an extensive survey by Fomison. [40] Fomison records six pa with pits varying in number from

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one to eight, variously outside or inside the defences. Most of these are rectangular with a raised rim.

All these pa were either flat internally or had been terraced, while another three pa on the Peninsula had no pits . One undefended site consisted of six raised rim pits , end on end in two rows of three, associated with four terraces. The size range of these Kaikoura pits was 16 to 19 ft by 10 to 13 ft. Fomison considers the terraces to be house platforms but rejects food storage in the pits on the Pariwhakatau evidence. He regards pits as "secondary houses" associated with site expansion. All traditional associations of the pa sites on the peninsula are Ngai Tahu.

North of Kaikoura, Elvy [41] mentions a site near the Clarence River with "some large Maori pits ", and at the Clarence River mouth on the north bank, the Ngati Mamoe site, Matariki Pa [42] where "deep pits " exist dug by the "Moriori or older pit dwelling tribe". This site is also mentioned in a later publication by Elvy [43] as having pits . Rutland [44] also refers to this site.

Possibly this is the same site as a pa described by Trotter. His description of the interior of this pa is worth quoting. "There are 13 more or less circular level and raised rim pits in groups at either end, and they range in size from 6 to 14 ft in internal diameter. Where digging has taken place on a level section between the pits , remains of squared timber and a stone fireplace appear to indicate house sites." [45] Unfortunately this site with its provocative evidence was in the process of destruction when described.

Judging from published evidence, it can be said that the Kaikoura Coast is the most southerly extension of the proven prehistoric pits .

Wairau-Marlborough Sounds

As early as 1846, pits had been recorded on a site in this area. Angus visited an island pa in the Tory Channel which had been sacked by Te Rauparaha in 1828, and found overgrown pits . [46] Rutland [47] refers to pits at Vernon without any elucidation and also mentions depressions similar to some cup-shaped pits at Waimea arranged in a regular order. [48]

Johnstone [49] refers to a group of oval pits on the north bank of the Wairau River near the mouth. Further north, Rutland locates many sites of pits in the Sounds area, stating that they are of two types: single, varying from 5 to 21 ft long to 4 to 16 ft broad; and double, consisting of two pits end on end separated by 2-4 feet of baulk. [50] The two types are often found in association on terraces.

A site at Kenepuru had five terraces, all with pits cut into them amounting to three double pits and three single; [51] a site at Moetapu on Elephant

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Rock had four pits , one with remains of woodwork; [52] and at Kaituna Valley near Havelock there were "a few pits ". On the Trias in Cook Strait and Mabel Island in Picton Harbour, pits are reported, and a group of four pits is reported at Kenepuru, one of which was too small to lie down in. [53] At Crail Bay in Kenepuru Sound, Rutland [54] investigated and mapped a group of 12 pits . They varied in dimensions from 6.5 to 18 ft long by 4.5 to 11 ft broad. Other sites are mentioned at Whatamango Bay in Queen Charlotte Sound; [55] and at Horokaka Island in Port Underwood, four pits are mentioned, the largest of which was 5.5 by 4 ft and over 6 ft deep. Other pits also occur on the island. [56] Rutland excavated the floor of a pit in a "village" in Matai Bay, Tennyson Inlet, and found the floor burnt under a layer of charcoal. Rutland states that "Round Blind Bay, on Durville and Arapawa Islands and along

the shores of Queen Charlotte Sound and Port Underwood the remains of pit dwellings and villages are very numerous". [57] He twice stresses their absence from the Pelorus Valley, [58] although "throughout the Pelorus Sound the old pit villages are everywhere contiguous to land suitable for agriculture purposes". [59] Most of Rutland's evidence and argument can be found reproduced in Buick. [60]

The second major contributor to the evidence for pits in the Sounds area is Elvy. In Monkey Bay in Queen Charlotte Sound he describes a group of five pits varying from 4 to 5 feet in width and 9 to 13 feet in length. [61] Elvy cleared some of the pits , and although there were apparently no postholes, he found "a stone apparently placed to hold charcoal for heating purposes" and he found burnt clay and charcoal near this stone. Another site with at least nine pits adjoined this site.

These sites were interpreted by Elvy as groups of house pits . A pa site known traditionally as Te Rae O Te Karaka near Picton was illustrated by Elvy. [62] Inside the defences he illustrates ten pits , one double and one he calls a water reservoir apparently because of its small size. Some of the pits are on terraces and the two largest pits (the largest 16 feet by 24 feet) have remarkably deep drains surrounding them.

Elvy locates only one other site; this is at Bobbery Bay in Pelorus Sound [63] where there are about a dozen pits 10 to 14 feet long and 4 to 6 feet deep. He concedes that the "smaller may be store pits " but the remainder he regards as Ngati Mamoe dwellings. [64]

Speaking generally of the pits , he says, "It is no exaggeration to say that these pits exist in thousands throughout the Sounds District, Durville

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Island and Blind Bay", [65] but against this he only localised four such sites. The unlocalised sites were found up ridges, often at 1,000 feet above sea level, and frequently accompanied by shell midden.

More recent field work in Queen Charlotte Sound has located six further sites with pits . [66] Two of these sites were fortified, one with only one raised rim pit and another with two rows of pits , possibly with rims. Two other sites have pits on terraces, while the final two are a pair of raised rim pits , the largest of which is 13 ft by 30 ft, and a single raised rim pit without other earthwork evidence but associated with midden.

Durville Island was the scene of a survey by Keyes. [67] Eleven sites with pits were described. Four sites had rectangular pits only, one of them having four raised rim pits which were about 6 by 6 by 4 ft deep. One of the other three sites was described as being similar to this, while another had six pits , the largest being 20 by 10 by 8 ft deep. Two sites had circular depressions, one associated with terraces, and another four sites had pits associated with terraces. One of these groups had two pits , the largest of which was 14 by 6 by 5 ft deep.

Keyes regarded the association of double and single rectangular pits as early, and exclusively Ngati Mamoe in origin. He claims the Ngati Mamoe had no fortifications when they resided in the Sounds. A ridge end pa on the island, with internal double and single pits , he considered to be a composite of an early pit site and a later pa. After this was justly criticised by Golson, [68] Keyes [69] defended this assertion by saying the fosse occurred at only one pit site; yet in the same paper he admitted Elvy's site of Te Rae O Te Karaka as a fortified site but with Ngati Mamoe pits . [70] He claims "material evidence shows that at a later period these sites were resettled", and quoting Elvy states "its later resettlement history is known". Elvy in fact calls this site a Ngati Mamoe pa and states that it "was never occupied after the attack . . ." (by the Ngai Tahu). At least four other fortified sites with pits occur in the Sounds area apart from these two. Keyes states that the Ngati Mamoe only acquired fortifications under pressure on the Kaikoura Coast [71] yet, in another paper, credits them with the introduction of fortifications into New Zealand. [72] The present writer does not doubt the association of pits and fortifications in the Sounds area.

With the exception of the site in question, Keyes regards the pits on Durville Island as late and for kumara storage. Wellman [73] mentions pits on the island.

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A pa near Pepin Island is reported as having terraces and pits inside the defences. [74]

There is extensive evidence of pits in the Sounds area associated with many other forms of prehistoric evidence and it would appear to be the strongest centre of pit-building in the South Island.

Nelson, Golden Bay

At Waimea West, Rutland [75] besides his recurrent description of "Maori holes" in the area, describes cup-shaped depressions "arranged like a street", implying that these were different from the Maori holes which must be the borrow pits described by Rigg and Bruce. [76]

Again Rutland states that at Waimea West, near a pa, there are "lines of pit-like artificial depressions" [77] adding they were like those he had described in the Sounds area; they are therefore presumably rectangular.

On the Granite Coast between Golden Bay and Tasman Bay, Wilkes [78] locates twelve sites with pits ; one of these sites is fortified with the pits on the terraces. Of the other sites, terraces are mentioned at only one, while the number of pits varies from one to "many". The pits are rectangular, one only having a possible raised rim. The sizes vary from 6 to 11 ft wide and 6 to 17 ft long. In addition, on each of three sites known to have been occupied in 1840, Wilkes found a single pit; all were dug in sand. These sites are not included in the twelve sites with pits , and in view of their aberrant nature and their dating will not be considered further.

In Golden Bay, Wilkes describes the pa site of Pariwhakaoho as having two flat areas, one with five pits varying from 5 to 8 ft wide by 7 to 15 ft long, while the other area had 23 pits in one acre. This pa was occupied in Te Rauparaha's time. Wilkes regards the pits in this area as houses, claiming that no pits too small to be houses had been found in the area.

On the evidence presented in this article, the following basic pit types can be suggested.

Type I Rectangular without a raised rim.

Type II Double rectangular.

Type III Raised rim rectangular.

Type IV Circular without a rim.

A fifth type of circular pit with a raised rim possibly occurs as well, but this type is not as yet well defined. These types are obviously simplistic and with so few excavated it would be surprising if they do not require revision in the near future. Sizes can be associated only with types I and III. Type I varies from 21 by 16 ft to 5 by 4 ft and is up to 6 ft deep while type III varies from 36 by 24.5 ft down to 11.5 by 8 ft on the Kaikoura Coast but down to 6 by 6 ft in the Sounds area and is up to 3.5 ft deep. The only justification for suggesting these types is that they appear to have some spacial significance. Type I predominates in Nelson although it occurs in all areas, while type II is confined to the Sounds area. Type III

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predominates in Kaikoura but is found in the Sounds and possibly in Nelson. Type IV also occurs in all areas but nowhere predominates. This latter type does not correspond with any excavated pit in the North Island unless it is the surface evidence of a collapsed underground store pit. Complete examples of these have not been identified in the South Island. Type II, although localised to the Sounds area in the South Island, may be related to Parker's archaic B pits in Auckland. [79] Type I is universal in the North Island although type III predominates in Hawke's Bay and the Wairarapa. [80] It should be noted that these types are inadequate to describe all North Island pits .

Figure 2 shows the sizes of the rectangular pits of types I and III on some sites and areas already mentioned. Those for Kaikoura and Pari-whakatau are exclusively type III, Crail Bay and the Granite Coast are exclusively type I, while the Durville Island and Queen Charlotte Sounds plots are aggregates of types I and III. The larger lower size limit and

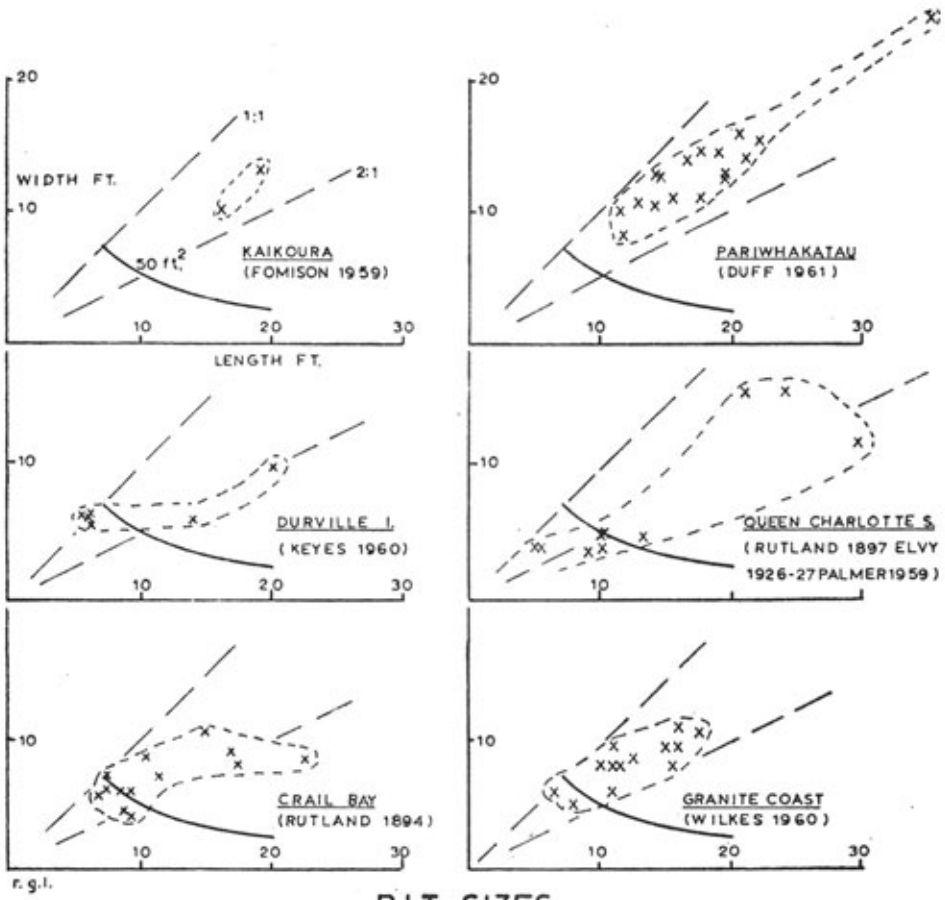

FIGURE 2.

FIGURE 2

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TABLE 1: SITE ASSOCIATIONS OF LOCALISED PITS

Feature – Area	Granite Coast Nelson				Sounds, Wairau										Kaikoura					Canterbury Otago Southland		
Pit Type 1	X		X	X	X			X	X	X	X	X			X					X	X	
Pit Type 2						X		X		X		X										
Pit Type 3							X						X		X	X	X	X	X			X
Pit Type 4		X						X						X		X						
Fortifications				X							X	X	X					X	X			
Terracing or Hut Sites			X	X					X	X	X	X		X			X		X		X	X
Association Totals	11	1	1	2	12	1	3	2	1	4	1	2	1	2	2	6	1	1	3	4	1	1	2
Area Totals			15							32								21				5
TOTAL – Localised Pits										73												

A cross signifies presence on a site while a blank shows absence.

TABLE 1: SITE ASSOCIATIONS OF LOCALISED PITS , A cross signifies presence on a site while a blank shows absence.

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the tendency for pits to be closer to square in plan at Kaikoura and Pariwhakatau, are noticeable. Table I shows the site associations of pits . The widest variety of sites is seen to be found in the Sounds where the largest number of sites with pits occur and all the four types of pits are present. All pit types appear with terracing in at least one area in the South Island, but type IV pits , unlike types I to III, do not occur with fortifications anywhere.

The total of 73 sites with pits in this table is inadequate to draw many conclusions because of the strong possibility that one, as yet unrecorded, site may disturb these conclusions. All sites with pits are plotted in Figure 1. The obvious tendency for the sites to group on the North-East Coast of the South Island is too marked to be a sampling error. Within this district there are regional variations in intensity and some gaps. This is due in part to some areas such as the Kaikoura Coast receiving more attention and others such as Golden Bay, which must have more sites than have been recorded, receiving scant attention.

Before pits can be treated as evidence of agriculture and the consequences of this distribution studied, it is necessary to resolve the controversy on their function. While some of the necessary evidence is in the nature of the pits themselves and has already been presented, areal correlation with the known areas of cultivation provides corroborating evidence. It is also necessary to consider the evidence on the nature of houses in New Zealand, to suggest other housing for the prehistoric inhabitants of the area. For the first reason it is necessary to discuss the definite agricultural evidence before drawing conclusions on the function of pits .

KUMARA AGRICULTURE

As already mentioned for the North Island, the evidence takes a variety of forms. Traditional and historical evidence can be combined with field evidence of garden areas and swamp buried finds of wooden implements.

The distribution of this evidence can be confirmed by comparison with the climate of the area and the known climatic limitations to the growth of kumara . This evidence will be treated in turn for the South Island.

Traditional and Historical Evidence

Unlike the North Island, there is not a strong body of traditional history recorded for the South. The causes of this are various. The repeated raids of the Ngati Toa from the North Island in the early nineteenth century decimated much of the population in the north of the South Island and because of this and an already lower population, the interest of the first European settlers in the previous inhabitants was not stimulated as it was in the North. The commercial interests of the first long-term European visitors to the area precluded any systematic recording of information until the 1840s by which time the New Zealand-wide change of Maori Culture under European influence was far advanced; and in the South Island a complete change of economy to potato cultivation had taken place at least thirty years previously.

In consequence, most of the traditional information for the South

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Island was recorded fairly late and is subject to errors arising from this as well as the usual failings of oral transmission. Consequently, the author places little credence in traditional associations of sites with tribal groups or kumara cultivation to certain areas and bases no conclusions on them.

Stack gives traditional evidence of kumara cultivation by the Ngati Mamoe at Waipapa, south of the Clarence [81] and also by the Ngai Tahu branch at Waimea. [82] Accounts recorded from people living at the time of the Ngati Toa raid are more reliable; these show that Ngai Tahu had kumara at Omihi [83] and cultivated it at Kaiapohia. [84] The latter information is confirmed by the other evidence.

Shortland was told by an informant in 1844 [85] that kumara cultivation was never attempted south of Taumuta, a little south of Banks Peninsula, and that cultivation at this place was long since abandoned.

Historical accounts of kumara cultivation are few.

Many whaling accounts refer without elucidation to potatoes traded from the Maoris [86] but it is generally assumed these are introduced potatoes. Gaimord, who sailed with D'Urville on the *Astrolabe,* said of Astrolabe Bight in 1827, “their commonest food is the root of the tree fern, to which must be added fish and sweet potatoes”. [87] Dieffenbach [88] refers to cultivation of potatoes and sweet potatoes, wheat, and taro in Queen Charlotte Sound, saying of potato and sweet potato cultivation that they prefer the sides of ravines after burning the bush rather than the bays. Wooden implements were still in use in the Sounds in 1839 when he made these observations. Neither Cook nor Banks nor Spaarman mention any kumara cultivation in the Sounds and in fact deny it. [89] The area appears at this stage to have been in political upheaval with warfare and cannibalism much more in evidence than in the North. This, or soil exhaustion which Dieffenbach implies existed in the limited areas of the bays, may have been the cause of

this remarkable absence of kumara cultivation at the time of Cook's visit. By 1820 potato cultivation had been established in the Sounds but kumara was still absent. [90] It seems almost inconceivable that kumara should not have been grown in the area before Cook's first visit. At Motueka kumara was included in the list of Maori foodstuffs observed by a Mr Morley around 1844. [91]

Field Evidence for Kumara Agriculture

Maori agriculture has left quite a wide variety of field evidence. In the North Island, drains are frequently observed while the practice of adding gravel and sand to soils has left large areas easily recognisable; the excavations for the added gravel or sand are also frequently recognisable. During clearing of stony ground the large stones were often piled into

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heaps or rows. Sites showing all these features, including one site with drains, have been recognised in the South Island.

Borrow pits have been recognised at Temuka [92] (though this identification is suspect) Kaiapohia [93] and at Waimea West. [94] Evidence of gravel addition to soils has been observed at Kaiapohia, [95] at South Bay, [96] in the Sounds at Endeavour Inlet, [97] on Durville Island in a large number of localities, [98] an area of 1,000 acres at Waimea West [99] and at Motueka. [100] Stone rows and heaps presumably occur at Panau, Little Akaroa on Banks Peninsula, [101] which Duff dates to 1820-30, and certainly at the Conway, [102] and on a three mile strip north of the Clarence River, [103] at Matai Bay in Tennyson Inlet in the Sounds, and "elsewhere in the cleared bays". [104] At least four other sites with stone rows occur on Banks Peninsula, but in the absence of published plans it is difficult to assign these definitely to agricultural clearing. The sole record of drains is from Paua Bay in Banks Peninsula where a series of parallel drains run directly down a slope. [105] This style of drainage is well known from Northland sites.

Two agricultural areas, interpreted as such by long mounds, were noted on Durville Island by Keyes. [106]

Duff, speaking generally of the South Island, states that "field evidence is at present restricted to the Ngai Tahu". [107]

One further piece of evidence is the discovery of small stone figures or " kumara gods" set up in fields, at Waimea. [108] Again caution is necessary as some of the field evidence, particularly that of stone rows, may be of potato cultivation.

Wooden Implements

The Maori used three basic types of earth-moving tools although there is considerable variation in form and size within these types. They are long pointed digging sticks, or *ko,* often with a detachable footrest or tread; spades, similar to a modern banjo shovel; and short pointed weeders. Only the latter can be positively associated with agriculture as the first two can be used for other earth-moving tasks. However, the commonest other task in the North Island, at least after fernroot digging and agriculture , was store pit excavation. *Ko* were still used in the early historic period for potatoes, which adds an additional uncertainty.

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Unfortunately no weeders are reported in the literature from the South Island and in their absence spades and *ko* can be regarded as indications of the presence of agriculture .

Two finds of wooden tools from swamps are known from Canterbury: one of a spade from the swamp adjoining Kaiapohia, and a second of a *ko* from a swamp at Southbridge, Little Rakaia, a little south of Banks Peninsula. Other spot finds of these implements are on Durville Island [109], in Nelson [110], and on the Granite Coast at Awaroa Beach [111]. Knapp [112] describes and illustrates what he interprets as a *ko* tread, stating he has found several others, on the agricultural area at Waimea. In the South, five *ko* are known from Otago, only two of these from swamps, and only one of all the *ko* is plausibly prehistoric as the others show signs of late workmanship. Two *ko* are known from Southland [113]. The majority of *ko* from Otago and Southland must be regarded as late and associated with potato cultivation, as must a single *ko* from Westland.

The archaeological, historical and traditional information is plotted on Figure 3. Again the distribution clearly favours the north-east coast, but the number of points is not sufficient to show concentrations or gaps within this area.

Kumara Physiology

Kumara is basically a tropical crop which, in its natural state, grows continuously through the year. It can be propagated either by transplanting shoots from the plant or tuber, or planting part of the tuber itself. It is, however, sensitive to cold, and will only winter over (even then with low success) in favourable areas north of Auckland [114]. Normally, for New Zealand, the tubers have to be stored throughout the winter. Although it yields well in slow warming heavy soils where low temperatures are not encountered, fast warming dry soils are necessary in areas where the season between the frosts is short, to make the most of the season [115]. In parts of the New Guinea Highlands where the climate is warmer than in most of New Zealand and the rainfall is up to 100 inches per annum, it will give heavy yields. [116] The plant responds well to watering during growth although it does not like wet soils, particularly in cold areas. [117]

A New Zealand Agriculture Department publication states that in Christchurch the plant will only yield in some seasons, [118] while modern commercial growing is not practised south of Nelson, and then only for local markets. [119]

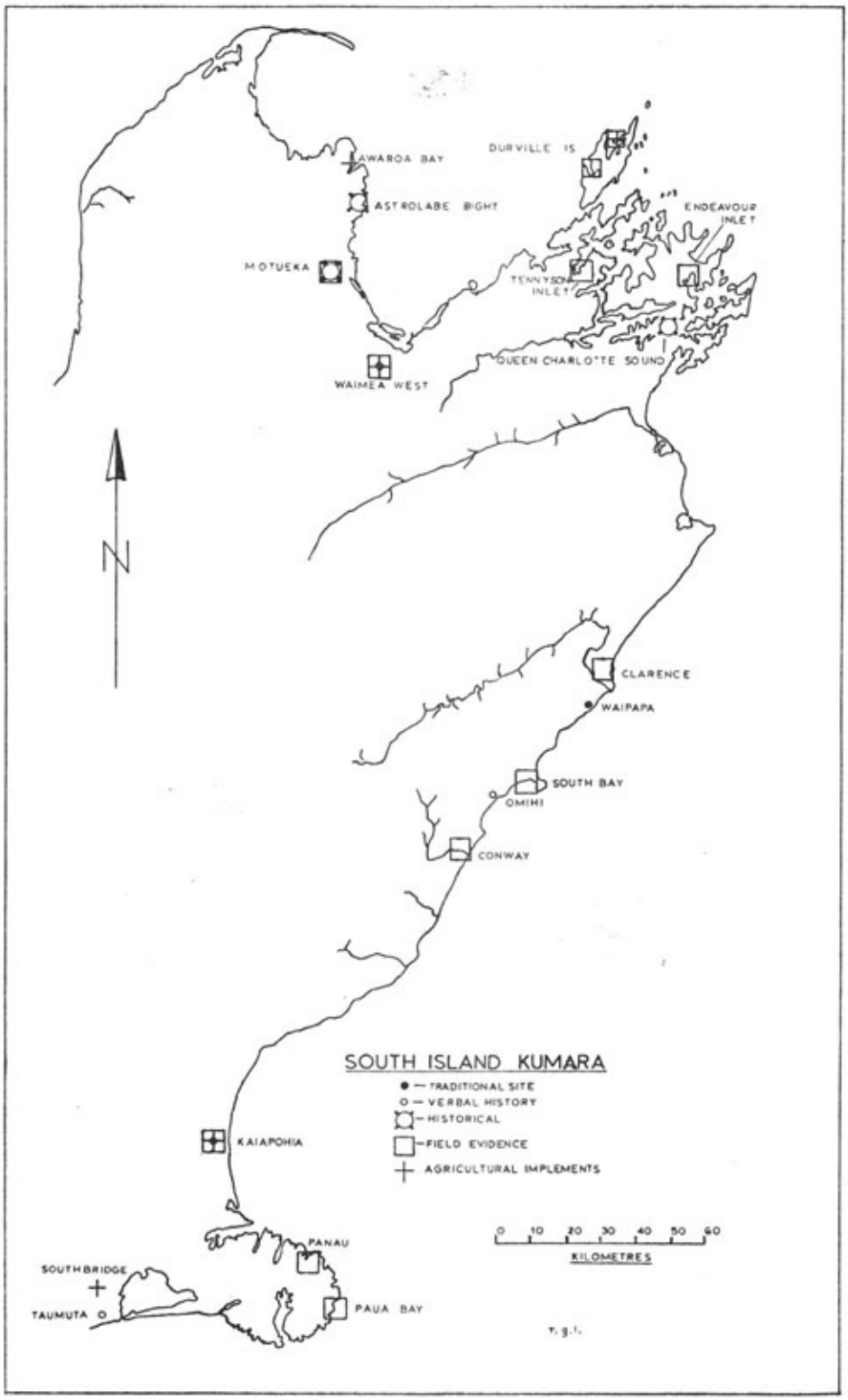

FIGURE 3.

FIGURE 3.

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Yen, [120] has conducted experimental cultivation of kumara at Lincoln, south of Christchurch, over three seasons. In the one good season of the three, yields per plant for the two Maori varieties were comparable with similar crops at Otahuhu near Auckland. But the yields were minimal in the following year because of lower minimum ground

temperatures in March when tuber formation is in progress. In the third season, a late December planting associated with even lower minimum March ground temperatures, gave no yields at all. Clearly these late summer minimum temperatures must be one of the most critical climatic factors affecting kumara distribution. The propagation method used by Yen gave his experiment an advantage over Maori propagation. Possibly kumara could not be grown at Lincoln using Maori methods. American data [121] have shown a marked tendency for the starch content of sweet potato to vary inversely with latitude and for the starch content (and acreage yields) to decrease in seasons of drought. Canterbury therefore, apart from its lower rainfall and presumably higher drought risk, probably produces nutritionally inferior tubers even in a good year.

One source states that the tubers will not germinate well after the plant has been subjected to less than 40° Fahrenheit for several days during tuber formation. [122] Such a temperature is experienced quite regularly in March throughout the north of the South Island.

The climatic maps (Figure 4) show that frost and temperature deterioration inland would make cultivation in these areas impossible. In storage, the tubers are particularly susceptible to fungus diseases, which enter the tuber through bruises, cuts, or the broken-off join to the roots. This can be prevented by curing at high temperatures and humidity to form a cork over the wound. But this process would be technologically impossible for the Maori and no such processes have been recorded. After this curing, storage at a temperature above 50° F. and a humidity over 80% is obligatory for good results. [123] It has been suggested that the frequent pit reconstruction on sites in the North Island was to avoid fungus diseases, while the scoop hearths found in some pits may have had the same function by drying the pit and its lining or by keeping the temperatures above 50° F. [124] Pits were formerly used for storage in North America where losses to fungus were often of the order of 30% [125]

Clearly kumara cultivation is marginal for the South Island and its cultivation must have been on the warmer northern coastal areas. The evidence from archaeology can be used to suggest the climatic limits of kumara agriculture as practised by the Maori, and this is discussed below. However, it is clear that in several places Maori agriculture went very close to the absolute limit where the frequency of failure becomes impossibly high.

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FIGURE 4,

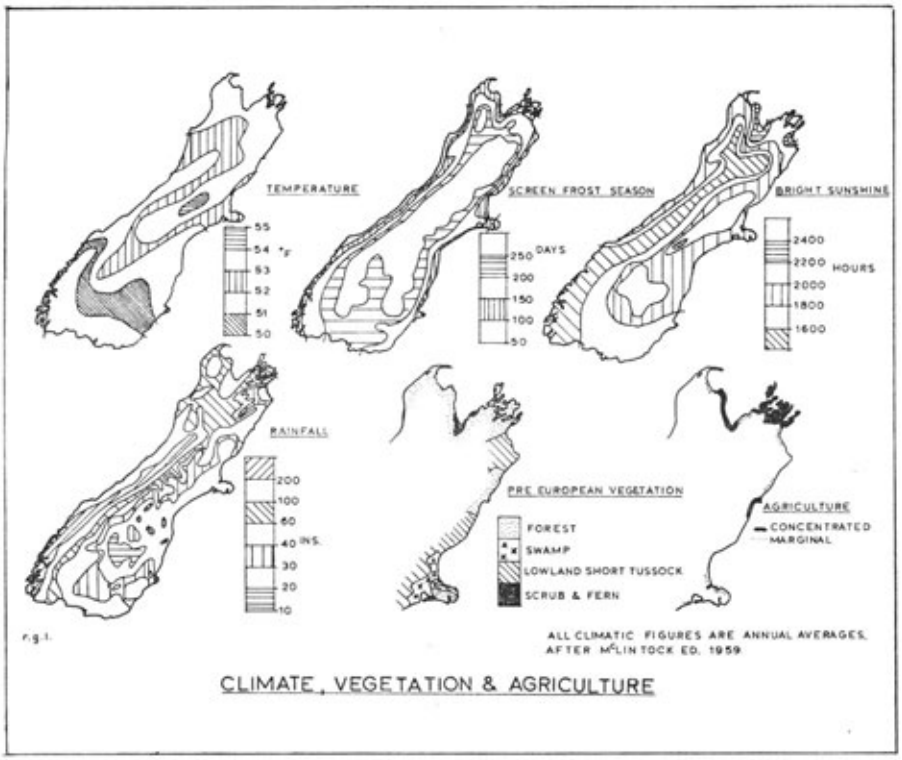

FIGURE 4.

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THE FUNCTION OF PITS

We have now accumulated sufficient data on pits and kumara cultivation to resolve the controversy on whether they were for storage or houses. The criteria for the identification of houses in New Zealand are perhaps too exclusive in demanding that they should have a four-stone fireplace and a scatter of occupation material on the floor, but a reasonable proportion of the examples should show these features.

Groube [126], using these criteria, has adequately summarised the evidence for surface houses recovered archaeologically in the south of the South Island. There can be little doubt that this was the only form of house found in Murihiku at any stage of its prehistory. For the north of the South Island, however, there is no such unequivocal evidence, though the pavements at Heaphy River, [127] a late moa-hunter site, can be interpreted as belonging to surface houses. The irregular pattern of postholes discovered in recent excavations at Wairau Bar [128] also invite this interpretation, as might surface fireplaces at Durville Island [129] and the fireplace at the pa at the mouth of the Clarence [130]. At the other end of the time scale, patently surface houses were reported by Bank [131], illustrated and reported by D'Urville, [132] and no doubt many other reports could be found. There is a single historical record of a house sunken into the ground near Kaikoura. [133] Like similar records in the North Island, it is typically late. [134] The occurrence of surface houses at the beginning and end of the short time scale for the area should be a warning against postulating any different mode of housing for an intermediate period.

Figure 2 summarises the metrical data collected in this article for rectangular pits . A hyperbolic line representing a pit of 50 square feet area is superimposed on these plots. This area is regarded by the author as a reasonable minimum size for a permanent house. There is no reason why kumara should not be stored in pits smaller than this. There are records of smaller shelters being used temporarily for habitation, but if pits are houses they are certainly not temporary shelters. As can be seen on this figure, 17 or 28% of the 60 points plotted fall below this line, some being well below. The use of pits as houses, excepting Kaikoura where the pits are larger, is impossible unless pits are given a dual role with only the larger pits being houses. This is an uneconomic explanation. A comparison of Figures 1 and 3 shows that with the exception of the four sites with pits in Otago and Southland, the distribution of the pits is consistent with the distribution of kumara agriculture . Of the four southern sites, one is associated with undoubted houses and the pits are too small for houses, a second is late and undoubtedly for potato storage

as has been recorded for the Chatham Islands where no kumara grew [135], while the third has terraces suitable for houses adjoining the pits .

All these sites are beyond the possible limit of kumara for the modern climate of New Zealand. The first site mentioned, that in the Dart Valley, is unlikely to be a potato using village so the pits there must be for storage of some other unspecified or perishable item. All other pit sites falling north of Banks Peninsula are consistent with the known climatic limits of kumara , although some here may be for potato storage as at Dart Valley.

The usual explanation for the construction of pit houses is that they were sunk into the ground for warmth. If so, their absence from the colder south is remarkable. A more reasonable hypothesis is the climatic restriction to agriculture and the consequent presence of storage pits . Similarly, their absence in the Pelorus Valley away from the sea can be explained by the short frost-free season there. Agriculture was practised a short distance away from the sea and its resources, at least at Waimea, for here the evidence of agriculture extends 4.2 miles inland. In the North Island the archaeological determinants of agriculture are storage pits , evidence of fields, and wooden implements from swamps. All three are found in the South Island in a rational distribution, yet only the latter two are usually admitted as South Island culture traits. As this agriculture is undoubtedly a derivative from the North Island, a change in function for the pits in shifting again is an uneconomic explanation. Of the larger number of pits excavated in the North Island, only two have revealed a four-sided stone fireplace. One near Taupo [136] is beyond the climatic limits of kumara cultivation, although the other—a raised rim pit at Orongorongo [137]—is within it, and both had artefactual material showing them to be post European. The rest of the excavated pits , now numbering in the hundreds, are all possible store pits . No four-sided stone fireplaces have been encountered in the few pits excavated in the South Island, while the hearths reported for the Sounds area are not inconsistent with the scoop hearths which have been found in Auckland in pits too small for occupation. [138]

The raised rim type III pit is the dominant pit observed on the surface in Hawke's Bay and the Wairarapa, the traditional area of emigration of both the Ngati Mamoe and Ngai Tahu, who traditionally, in turn, occupied the Sounds. This pit type occurs in the Sounds unassociated with types I and II, as well as on the Kaikoura Coast where it predominates, although it is here associated with types I and IV. In the above North Island areas the raised rim pit is certainly for kumara storage. It is possible there is a functional explanation of this parallel in the similarly dry climates of the areas. [139]

Although no writers on the South Island deny the existence of kumara agriculture they almost universally fail to allow for any storage mode. If pits were houses, what were kumara stored in? Many of the sites

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with pits have associated terraces which are eminently suitable for surface houses, even though these, through lack of attention, have yet to be recognised for this area.

The only evidence which can be presented in favour of the house theory is the canoe section in the house at Pariwhakatau, and the historical records of a house with a shallow sunken floor at Kaikoura. While tempting viewed in isolation, viewed with the rest of the evidence these must be rejected.

It should, however, still be noted that pits can be used for potato storage and the pits at Dart Valley cannot have been used for storage of either potatoes or kumara because of the climate at this locality and the prehistoric date of the site. But the pits here are certainly not houses as they are too small and they are associated with incontestable surface houses. The evidence for the vast majority of pits being houses is therefore unconvincing, yet the general belief to the contrary by most workers remains to be explained. Undue faith in dubious traditional sources, and earlier interpretations of field evidence based on them (particularly those of Elvy and Rutland) seem to be the major cause of much of the error, while attempts at interpretation on purely local evidence with the understandable temptation to seek social rather than economic interpretations, may explain the rest.

THE PLACE OF KUMARA IN SOUTH ISLAND ECONOMICS

From Figures 1 and 3 a clear idea can be gained of the spacial extent of kumara agriculture in the South Island. Figure 4 shows agriculture to have been at its most intensive on the Granite Coast extending to Waimea, in the Sounds and on the Kaikoura Coast and apparently more spasmodic in Golden Bay, on the east shore of Tasman Bay, and near Banks Peninsula. The gaps between Vernon and the mouth of the Clarence River and between the mouth of the Conway and Kaiapohia might be more apparent than real, but the gaps are consistent in each of the sources used in compiling Figures 1 and 3.

This proven extent of pit building and agriculture represents the survival of such evidence from the whole of the prehistory of the area. It does not prove that agriculture was contemporary in any two areas.

We have not yet considered variation through time of the types of pits or their concentration or the arguments against the early presence of agriculture .

The normal time control used for the area is traditional associations for all sites younger than those of the Moa-Hunters. For Kaikoura, Canterbury and Otago there was a two-phase settlement first by the Ngati Mamoe and then by the Ngai Tahu who displaced them. The traditional history of the Sounds and Nelson is more complicated. Even using traditional evidence for dating the simple change at Kaikoura leads us into difficulties.

Kumara was grown traditionally by the Ngati Mamoe at Waipapa yet Duff can only associate the field evidence with the Ngai Tahu. Pits with raised rims are regarded by Duff as Ngati Mamoe houses, yet these are

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found on sites with Ngai Tahu associations on Kaikoura Peninsula. Since no culture traits pertaining to agriculture can definitely be associated with the Ngati Mamoe, there is doubt as to whether they really had cultivations. The author believes there are sufficient field and analytic techniques available to archaeologists and prehistorians to write the details of the movement of Classic Maori traits into this area without recourse to the difficulties of traditional dating. Application of these techniques has only just started in the field, and application of the analytic technique will follow when sufficient data has been accumulated. It has been suggested that a change of climate which made New Zealand less favourable for kumara agriculture took place within New Zealand's prehistory [140] but the way this evidence for change has been used can be seriously challenged and it must be regarded as dubious at present. [141] The four sites with pits beyond the present limit of kumara agriculture are all almost certainly later

than the dating of the supposed change, and three of these are probably for potato storage. Significant climatic change is not necessary to explain the distribution evidence in its present state.

The age of kumara agriculture in the South Island is difficult to establish. The claim generally made that the Moa-Hunters did not have kumara [142] has not been adequately tested. In the South Island, river bars are unlikely places for cultivation because of poor soil development and exposure. The usual assertion is made on evidence from sites on river bars and thus is based on negative evidence. On Durville Island Wellman [143] found a gravel soil overlaid by a Moa-Hunter layer which must raise the question of the age of the pit sites on the island. Certainly the more recent radio carbon determinations for Moa-Hunter sites in the north of the South Island [144] closely approach dates from sites such as Mt Wellington and Kauri Point, [145] both of which are pa with pits inside the defences. The inhabitants of these sites must have grown kumara and must have been close to Classic Maori in their economic and political organisation. Sites excavated recently on Motutapu Island near Auckland, have produced pits and artefacts "which would not be out of place in a Moa-Hunter camp", [146], while other sites such as Kaupokonui, Sarahs Gully, Skippers Ridge, and Moturua Island, have produced evidence supporting a widespread use of agriculture by A.D. 1300 The postulation of agriculture in the Moa-Hunter period of the South Island, demands that we reassess the nature of this period already studied. Adzes such as the small Duff type 2a (rectangular ungripped) are very little different from the thousands of 2b adzes in the North Island, and yet this adze type forms 30% of the adzes from the midden at

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Wairau [147] while it did not have even half this importance in Otago and Southland at the same time. [148] Wairau and other similar sites in the area, at a later stage after the initial settlement and the development of the new kumara agricultural techniques, could have been occasional shell fishing and moa hunting [149] settlements for the cultivators of the Sounds. This hypothesis requires more proof, but the usual association of agriculture only with Classic culture in the South Island is open to question. The bulk of the agricultural evidence for the area must, however, be associated with the Classic Culture.

Agriculture makes demands on a group which practises it, as it requires the presence of the group at least at planting and harvest, while at least some of the group must weed the crop in growth. Competition for land will demand the continuous presence of the group to defend the garden or the stored crop. Such a limitation will inhibit the wider use of the environment by the group. For agriculture to be viable it must either produce a staple, or if it is only practised to produce a minor food source, the limitation placed on economic exploitation by hunting and gathering must be negligible. It is apparent that because of the high probability of crop failure, particularly at Banks Peninsula, the latter alternative is probably the case for the South Island. A corollary of this argument is that poorer environment with lower potentials for hunting and gathering may not have had agriculture , even though it was climatically possible. There are thus two limitations to kumara agriculture : the climatic limits and the more rigorous economic limits, culturally applied. The separation of these two is a difficult task.

The mean climates of the points at which pits and other evidence of agriculture are encountered are shown plotted in Figure 5. This allows the definition of a reasonable set of absolute climatic limits to kumara agriculture beyond which crop failures became too frequent. These limits are shown as dashed lines on the figure and in geographical terms are clearly coastal. It appears from the figure that the two gaps with no evidence of agriculture above and below Kaikoura are climatically possible for agriculture and a further area extending a short way down the West Coast is also possible. The latter area, however, is very inaccessible which may well explain the absence of recorded agricultural sites. And the gaps above and below Kaikoura can be seen from the vegetation map in Figure 4 to have supported only tussock while most other areas are in beech or podocarp forest. In addition there is a remarkable parallel in the distribution of exposed coast over the same area. Access to deep water is an important economic asset in littoral exploitation. The coasts of Banks Peninsula, the Kaikoura Coast and the area through the Sounds and Nelson have quite frequent sheltered landing places. But these appear to be less common over the very areas in which agriculture should, but does not, appear.

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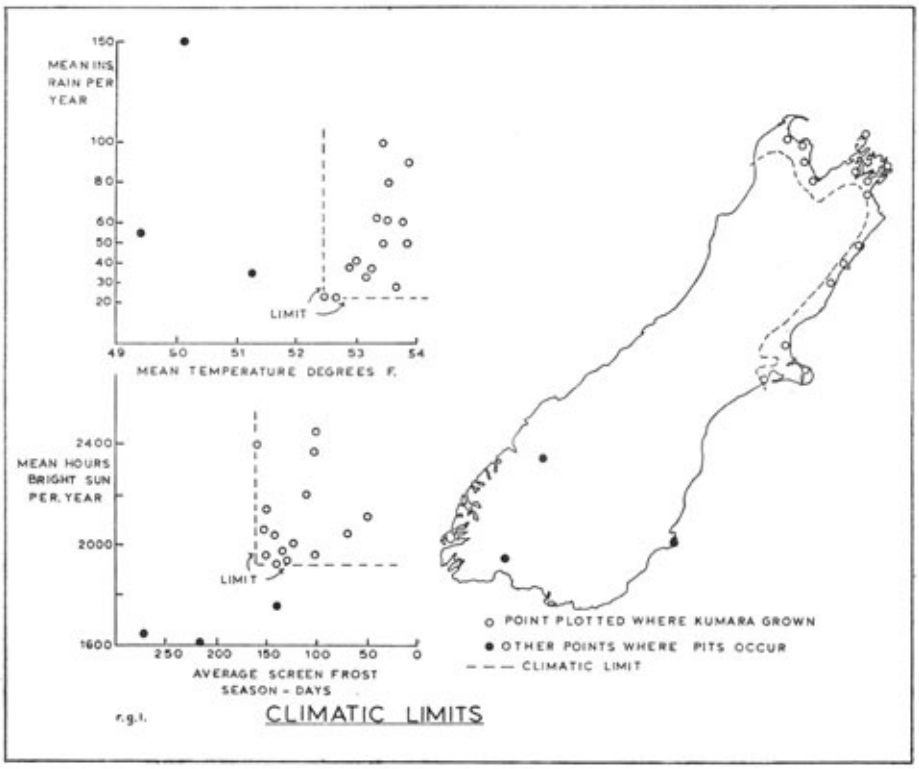

FIGURE 5.

FIGURE 5.

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The place of kumara agriculture in New Zealand has been called to question recently by K. Shawcross who assembled a convincing mass of historical evidence, principally for the Bay of Islands, showing that *Pteridium esculentum* fern root was more important than kumara . She suggested that the extensive evidence of agriculture at Waimea might be due to the large area of scrub and fernland there, [150] the only such area in the South Island, as shown on Figure 4. Research by the present writer suggests that in the early nineteenth century some smaller but not insignificant areas of fernland could be found on the forest margins wherever agriculture occurred in the South Island. This need not support Shawcross's suggestion as some fernland being fire-induced from forest may be an effect rather than a cause of agriculture . This is not to say, however, that the fernland was not exploited, and as Shawcross has shown, fern exploitation coupled with agriculture is a powerful economic combination. As fernland is closely associated with forest margins, this resource is only rarely available in tussock grassland.

Previously it was suggested there were two limits to agriculture , absolute and economic. It would appear that in the South Island, kumara agriculture only went to the absolute limits in areas that were richer in other resources. In this case the resources seem to have been forest, flora and fauna, rather than grassland, flora and fauna, access to deepwater fishing and possibly available fernland. Where these did not occur the economic limit was in operation rather than the absolute limit.

It is hoped that this article, in clearing some misinterpretations of the evidence and establishing a reasonable basis for the study of the economics of agriculture in the region in relation to other resources, has laid part of a new foundation in the study of Classic Culture in the region.

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1 Shawcross 1968:25.

2 Ambrose 1967.

3 Groube 1964:45.

4 Golson 1961a:21; Green 1963a:151.

5 Hjarno 1967:3; Duff 1956.

6 Simmons 1967.

7 Information on these sites was supplied by D. Simmons Personal Communication 1968.

8 O. Wilkes Personal Communication 1969.

9 Skinner 1934:293.

[10] Rutland 1897:83.

[11] Knight 1966:332.

[12] Yen 1961:343.

[13] Lockerbie 1950:82.

[14] Thacker 1960:10.

[15] Jones 1962:112.

[16] Johnston 1961:6.

[17] Knight 1966:336.

[18] R. Law and D. Simmons Personal Communications 1968 and Trotter 1961:32.

[19] Johnston 1961:6 and Forrest 1963:51.

[20] Fomison 1962.

[21] Harrowfield 1969:99-100.

[22] Elvy 1949:91.

[23] Duff 1961:269.

[24] Fomison 1962.

[25] Duff 1961:275.

[26] *ibid:* 284.

[27] Golson 1959:47.

[28] Hamilton 1896:16.

[29] Groube 1964:45.

[30] Duff 1961:270.

[31] *ibid*:270.

[32] *ibid*:274.

[33] *ibid*:274.

[34] Elvy 1949:78.

[35] *ibid*:74.

[36] Elvy 1957:22.

[37] Trotter 1968.

[38] *ibid.*

[39] Wilkes 1964:129.

[40] Fomison 1964:4.

[41] Elvy 1949:50.

[42] *ibid:* 47.

[43] Elvy 1957:22.

[44] Rutland 1897:83.

[45] Trotter 1966:124.

[46] Angus 1847:278.

[47] Rutland 1897:83.

[48] Rutland 1894:232.

[49] Johnstone 1964a:232.

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51 Rutland 1894:222.

52 *ibid*:222.

53 *ibid*:223.

54 *ibid*:222 and Rutland 1897:78.

55 *ibid*:78.

56 *ibid*:79.

57 *ibid*:83.

58 *ibid*:80 and Rutland 1894:223.

59 Rutland 1897:81.

60 Buick 1900:43.

61 Elvy 1926:329.

62 Elvy 1927:368.

63 Elvy 1957:23.

64 *ibid:* 23.

65 *ibid:* 20.

66 Palmer 1959:13.

67 Keyes 1960:239.

68 Golson 1960:392.

69 Keyes 1962:1.

70 *ibid*:10.

71 *ibid:*10.

72 Keyes 1967:56.

73 Wellman 1962:65.

74 Johnston 1964b reporting a site survey by C. Northcroft and B. Bennet.

75 Rutland 1894:292.

76 Rigg and Bruce 1923:85.

77 Rutland 1895:29.

78 Wilkes 1960:24.

79 Parker 1962:226.

80 L. M. Groube Personal Communication 1968.

81 Stack 1898:52.

82 *ibid*:31.

83 Turumeke and Harden 1894:107.

84 Stack 1893:24.

85 Shortland 1844.

86 McNab 1931:11 *et sequ.*

87 Durville 1950:210.

88 Dieffenbach 1943:120.

89 Cook 1955:247 and 1961:168; Banks 1962:457; Spaarman 1953:38, 104.

90 Bellingshausen in McNab 1909:252.

91 Broad 1892:60.

92 Lockerbie 1950:78.

93 Stack 1895:26.

94 Rutland 1894:221 and 1896:111; Rigg and Bruce 1923:85.

95 Stack 1893:185.

96 K. Fletcher Personal Communication 1968.

97 Rutland 1894:231.

98 Wellman 1962:70.

99 Rutland 1896:221 and Rigg and Bruce 1923:85.

100 Chittenden, *et al.* 1966—map in end papers.

101 Jones 1962:114 and Duff 1967:124.

102 Duff 1961:124.

103 Trotter 1968.

104 Elvy 1957:22.

105 Harrowfield 1969:99.

106 Keyes 1960:262, 263.

107 Duff 1962:209.

108 Best 1926:62.

109 Keyes 1960:258.

110 Duff Personal Communication 1965.

111 Wilkes 1960:27.

112 Knapp 1929:27.

113 D. Simmons Personal Communication 1968.

114 Coleman 1968.

115 Kennelly 1963:158.

116 Brookfield and Brown 1963:19.

117 Coleman 1968.

118 Kennelly 1963:159.

119 Coleman 1968.

120 Yen 1961:340.

121 Boswell *et al* 1944.

122 Kennelly 1963:159.

123 *ibid*:161.

124 Ambrose 1967.

125 Conway 1958:46.

126 Groube 1964.

127 Wilkes and Scarlett 1967:194.

128 Wilkes Personal Communication 1964.

129 Keyes 1960, Plate I.

130 Trotter 1966:124.

131 Banks 1962:17.

132 Durville 1950:81 and facing:65.

133 Bedford 1885:13.

134 Groube 1965:87-91 gives a thorough treatment to this material.

135 Simmons 1966:31.

136 Hosking 1968.

137 Pit excavated by B. McFadgen; J. Daniels Personal Communication 1968.

138 Ambrose 1967.

139 Groube 1965:96.

140 Green 1963b.

141 Gorbey 1967:176 and Pullar 1966:41.

142 Duff 1956:17.

143 Wellman 1963:71.

144 Wairau Bar 1015 ± 110 A.D. and 1100 ± 50 A.D. Duff 1956:XII. Rotokura (Nelson) lowest layer of three. Moa-Hunter layers 1325 ± 71 A.D. Tahunanui (Nelson) lowest level 1361 ± 70 A.D. Millar 1966. Heaphy River 1518 ± 70 A.D. Wilkes and Scarlett 1967:210.

145 Mt Wellington 1430 ± 40 A.D. Golson 1961b:51. Kauri Point pa 1455 ± 100 A.D. Ambrose 1967.

146 Davidson 1968:5.

147 Duff 1956:381.

148 Simmons 1967:40.

149 The order here is intended to be significant. Midden analysis, as yet unpublished by C. Northcroft, showed shellfish predominated over moa in the diet of the people who built at least one area of the midden.

150 K. Shawcross 1967:341.