NEW OBSERVATIONS ON THE STRATIGRAPHY AND RADIOCARBON DATES AT THE CROSS CREEK SITE, OPITO, COROMANDEL PENINSULA

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Introduction

This paper re-examines stratigraphy and radiocarbon dates at Cross Creek in Sarah's Gully. Three new radiocarbon dates are presented for Layer 9, the earliest, and previously undated, occupation. This investigation is part of a programme of archaeological work being carried out on the Coromandel Peninsula. Although there are several individual research projects underway, they have a common theme related to the Polynesian settlement period on the Coromandel Peninsula. The two seasons of excavation at Tairua are being written up by Matthew Campbell of CFG Heritage on behalf of Roger Green. Louise Furey, also CFG Heritage, is researching a thematic study on early sites for the Department of Conservation. Archaeological research in the Opito area includes documenting a pollen sequence for Opito under a grant obtained from the Green Foundation for Polynesian Research: Pam Chester, Louise Furey and Brenda Sewell are participants. In addition, positively identifying the Kaharoa Ash in the Opito–Sarah's Gully area is a priority.

Settlement models

There are two opposing models – controversial long (~2000 yrs) or orthodox short (~600 yrs) – for the estimated date of first Polynesian settlement of New Zealand. Since radiocarbon dating was introduced, archaeologists have favoured a date somewhere between the tenth century (Davidson

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1984) to one that is several hundred years later (Anderson 1991). Scrutiny of suitability of samples for radiocarbon dating, along with rejection of individual dates on unidentified wood possibly subject to inbuilt age and materials now known to be unsuitable for dating, suggests that acceptable dates from both islands are no earlier than the early fourteenth century. This supports a model of colonisation by Polynesians no more than a few decades earlier than AD 1300 (Anderson 1991; Irwin and Walrond 2007). The dating of rat bones found in natural cave deposits in both islands, which suggested a much earlier arrival of people accompanied by rats, proved controversial (Anderson 2004; Holdaway1996). Subsequent research on dating of rat bones identified problems which have called into question the reliability of the original dates (Anderson 2004; Higham et al. 2004), and no further bones have been found to corroborate these finds. An archaeological site securely dated to the first millennium remains elusive and proxy indicators such as disturbances in localised pollen sequences, rat-gnawed seeds (Wilmshurst and Higham 2004) and rat-predated landsnails (Brook 2000) support a chronology model favouring the shorter rather than longer age for initial settlement.

However, the process of colonisation was not synchronous, but occurred over a period of time. Therefore the term colonisation period is by far the most appropriate designation as this definition may cover a broad temporal interval whose age span can only be determined through modelling. Refinement of the model using radiocarbon dating has its limitations – fluctuations in the calibration curve in the fourteenth century means results are not as precise as most researchers would like and have prevented resolution of this colonisation pattern. There is, however, a geological event, the Kaharoa volcanic eruption, which is now very tightly dated (Hogg et al. 2003) and, where present, serves as an important marker horizon (chronozone) for dating Polynesian settlement. The Kaharoa tephra, which erupted from the Okataina Volcanic Centre in the eastern central North Island, has a distribution from the Bay of Islands through Coromandel Peninsula, eastern Bay of Plenty and across to northern Hawke's Bay excluding the east coast area (Lowe et al. 1998). There were several eruptions within the Kaharoa eruptive event which is estimated to have lasted four to five years (Nairn et al. 2004: 267), but it is likely that only the last tephra shower was distributed over the Coromandel Peninsula as a thin, 30–40 mm thick, layer. Beneficially for us, this final Kaharoa tephra shower was deposited over a short duration of probably less than one year (Nairn et al. 2004: 267). Due to the thinness of the tephra on the Coromandel Peninsula, it is likely to only be recognised in undisturbed situations such as in dunes or swamps, and it has only been identified so far in the dunes at Port Jackson (Foster 1983), in the Cabana Lodge site at Whangamata (W. Gumbley pers comm.), and at Bowentown–Waihi Beach (Moore 2004). In each of these archaeological sites the cultural layers are above the tephra. It is also known from swamps at Harataonga and Awana on Great Barrier Island (Horrocks et al. 2001, 2002) and a swamp at Te Rerenga adjacent to Whangapoua Harbour (Wilmshurst and Higham 2004).[1]

The Kaharoa lithozone provides a relative dating mechanism for evaluating major biological events (biozones), which are subject to regional and temporal variability, and for cultural events which cannot be precisely dated from the archaeological evidence available, particularly when they occur in different places at different times (Figure 1). Relevant biozones include human-induced vegetation disturbance apparent in pollen cores (McGlone and Jones 2004), the presence of rat-gnawed seed cases, the extinction of moa (Anderson 2000; Holdaway and Jacomb 2000; Wilkes 2000), the localized extirpation of the large limpet *Cellana denticulata* on the Coromandel Peninsula (Rowland 1976), and the presence of dog as indicated by coprolites on surfaces underlying the tephra at Port Jackson (Foster 1983). Re-evaluation of all these lines of evidence is necessary for us to begin the process of modelling this colonization process.

Proxy indicators of Polynesian settlement

In the absence of a full archaeological record, proxy indicators suggest a chronology model of Polynesian settlement more short than long. Reviews of a number of pollen sequences in the North and South Islands (McGlone and Jones 2004; McGlone and Wilmshurst 1999) concluded that evidence of vegetation disturbance occurred at or just prior to deposition of the Kaharoa Ash in those areas where ash was present, or between AD 1200–1400 where the chronozone was absent. Although there are blips of vegetation disturbance going back thousands of years in pollen sequences taken from swamp deposits, the majority of these have been attributed to either volcanic activity or to localised natural spontaneous fires. Forest clearance and ongoing environmental impacts associated with Polynesian settlement are considered to be indicated by an increase in the amount of charcoal in a core sample associated with a decline of forest tree pollens and an increase in bracken (*Pteridium aquilinum* var. *esculentum*) and grasses.

[1] Loisels Pumice, believed to have been derived from an eruption of the Healy submerged caldera northeast of New Zealand (McFadgen 2007: 15), is also a chronozone, that occurs in a number of coastal sites. Although the eruptive event itself is not dated, and there is the possibility of re-deposition and mixing of sources, it could nevertheless not have been deposited prior to the Kaharoa tephra and is most likely to have been deposited in its primary state between AD 1305–1345 (McFadgen 2007: 69).

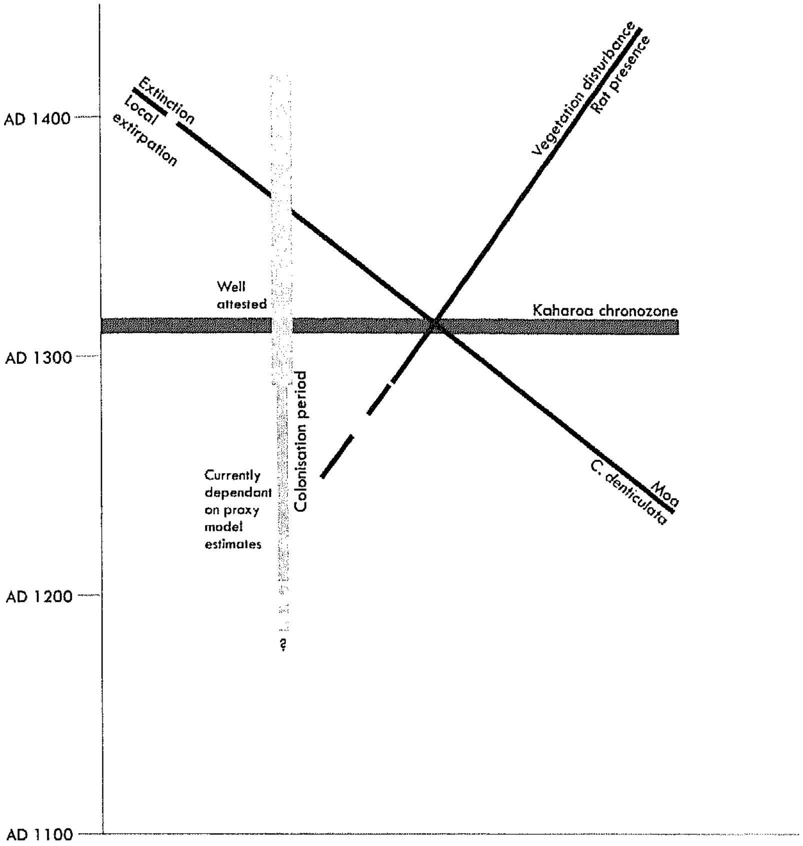

Figure 1. Schematic diagram (after Wagner 1998) of the relationship of the Kaharoa lithozone with biozones referred to in the text. The biozones are diachronous and occur in different places at different times. In contrast, the Kaharoa chronozone is synchronous and of very limited time span.

Rat activity has also been used as a proxy indicator of Polynesian settlement. A study of damage caused by rats to shells of large land snails (*Placostylus (Maoristylus) ambagiosus)* from several places at the northern end of the Aupouri Peninsula indicated rat presence around AD 1200 (Brook 2000), consistent with archaeological evidence of permanent Polynesian arrival in Northland (Allen 2005; Furey 2002). The region prior to that time is likely to have been a rat-free, unmodified natural environment.

Of more relevance in relation to the Kaharoa chronozone is the dating and position of rat-gnawed berries in the swamp column sample at Te Rerenga, Whangapoua Harbour, only 25 km in a straight line from Opito (Wilmshurst and Higham 2004). Gnawed berries of the genus *Elaeocarpus* (including hinau and pokaka) and *Prumnopitys* (matai and miro) were found above, within and immediately below the Kaharoa tephra (email Janet Wilmshurst to Jack Golson 21/12/05) The oldest rat-gnawed seed case gives a calibrated age of AD 1290–1320 and 1350–1385 at 1 σ (OxA-11915) (Wilmshurst and Higham 2004: 804). This date, together with the position of the gnawed seeds relative to the tephra deposit, indicates that rats, and people, were present on the Coromandel Peninsula before the Kaharoa ashfall, but significantly the time interval for human presence prior to the tephra was not a thousand, or even several hundreds of years.

Archaeological evidence at Opito, Coromandel Peninsula

Although no archaeological sites have been found under the Kaharoa Ash, it has not been for want of looking. The Coromandel has a lengthy coastline subject to geomorphological change and the possibility of buried evidence, in clichéd terms like looking for a needle in a haystack.

Stepping back from the mass of data of environmental origin, archaeologically-focused questions must concentrate on where the most likely place for evidence of early settlement will be. All known early sites on the east coast of the North Island, as far south as Tokitoki on the Ohiwa Harbour in the eastern Bay of Plenty, have quantities of Mayor Island obsidian and Tahanga basalt from Opito on the Coromandel Peninsula (Turner and Bonica 1994). Mayor Island and Opito would have endured repeat visits to obtain high quality stone essential for adzes and other cutting and manufacturing tools, yet a pollen sequence from Mayor Island (Empson et al. 2002) did not reflect that level of repeated visitation and activity prior to AD 1500, i.e., several hundred years after known Polynesian settlement regardless of which settlement chronology model is favoured. The Kaharoa tephra was present in the Mayor Island sediment core but, although there is a small and temporary increase in charcoal at around the same level, it was not accompanied by a significant and sustained increase in the presence of bracken fern or other indicators. The interpretation of this small charcoal increase as a natural fire event may or may not be correct, but a highly visible and ongoing alteration to the vegetation is only evident approximately 200 years after the Kaharoa tephra was deposited. The result may be due to the location of the pollen core – a lake in the emergent caldera away from the accessible coastal deposits of high quality obsidian – but it may simply be a fact that small scale settlement is not highly visible in the larger scale environmental record.

The Opito area on the Coromandel Peninsula has a high density of archaeological sites which fit the characteristics of an early site within the colonisation period (Sewell 1990). They contain artefacts of the New Zealand East Polynesian Culture defined by Golson (1959a), in particular adzes made from local Tahanga basalt, the presence of moa and sea mammal remains, and a location adjacent to the coast in dunes. Several of these sites have been excavated and radiocarbon dated and they are typical of sites of similar content and age on every beach and bay on the east coast of the Coromandel Peninsula (Davidson 1979). It seems logical to us that the basalt at Opito would act as a magnet for Polynesian explorers of the region: it is present on the foreshore as boulders and as flow deposit, and the main source on Tahanga hill immediately behind the beach is easily accessible. The presence of Tahanga adzes (Turner 2000) in all excavated early sites (without exception) throughout the northern North Island demonstrates both the importance of Tahanga as a primary basalt source and that the source was discovered prior to the settlement of each of those sites. A parallel model can be constructed for Mayor Island obsidian (Leach and de Souza 1979).

Sarah's Gully, a small bay to the northwest of Opito on the Coromandel Peninsula, was a focus of archaeological attention from 1956–59 when Jack Golson carried out a major fieldwork programme on the Sarah's Gully Settlement site (Golson 1959b, Green 1963), and again in 1983 when Brenda Sewell investigated the Cross Creek site. The Sarah's Gully Settlement site is accepted as being occupied towards the early end of the orthodox accepted settlement sequence on the basis of material culture and the presence of moa bone. Radiocarbon dates for the site were, however, on unidentified charcoal, and subject to limitations on several grounds, including provenance and stratigraphy.

The Cross Creek site (T10/399) is, as the name suggests, on the other side of the creek and within 30 m of Area D of Sarah's Gully Settlement. It is located partly on an old dune with more recent sand overlying and partly on an elevated weathered clay surface which forms a barrier across the mouth of the valley. The stream drains a catchment area enclosed by two steep-sided north trending ridges. In 1983 a large area of the site was exposed by dune deflation (Figure 2). Photographs show sand was also mobile in this area during Golson's excavations, and at the time Ron Scarlett made a surface collection of faunal material and artefacts from a deflated surface. Excavations in 1983 revealed six occupation layers, with the intact lower layers separated by sand.

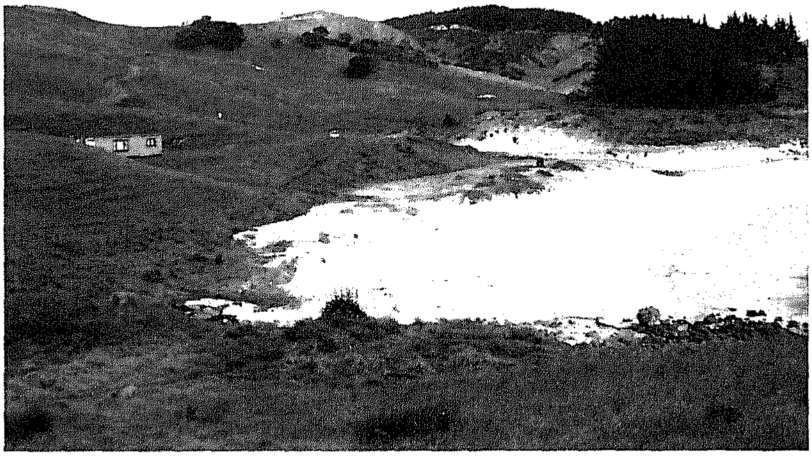

Figure 2. Sarah's Gully 2006 from the north showing Cross Creek as a deflating north facing dune slope, and Sarah's Gully Settlement site to the centre left, substantially altered by coastal erosion and by recontouring.

Layers 1 and 2 were deflated at the time of excavation. These were mapped and a surface collection made. Only intact Layer 2 material was excavated. Activity areas were apparent in both layers, while cooking areas, stone working areas and shell heaps were identified in Layer 2.

Layer 3 was up to 500 mm thick and extended over all of the excavation area. Layer 3A was a dense concentrated shell midden, limited to about 5.25m^2, containing stone flakes, shell fishhooks and worked shell. Layer 3B was a grey sand and oven rakeout into which over 30 firescoops had been dug in addition to aligned postholes suggestive of a structure. There was also a stone flaking area at the western end, while cooking evidence was confined to the eastern end.

Layer 5 varied in depth from 100–400 mm. Features included 16 firescoops dug into grey black sand, 14 postholes, a bin pit and possibly another pit. Stone flaking activity was concentrated at the western end of the occupation layer.

Layer 7 was up to 200 mm thick. Cooking features were less abundant with only six firescoops recorded, but like earlier occupations these were all at the eastern end of the site. Stone flaking and adze making evidence was present at the western end.

Layer 9 was thin and due to its depth below the surface was only excavated at the eastern and western ends of the site. A firescoop was excavated and a small quantity of bird, fish, seal, dog and rat bones recovered. No stone flakes were present in the small area excavated.

Cultural layers 2, 3, 5, 7 and 9 were separated by sterile deposits: white sand in the case of Layers 4 and 6 (0–400 mm and 200–400 mm depth respectively), and a yellow sand-like material 40–100 mm depth in Layer 8. The underlying Layer 10 was a white sand, or orange clay. Layers 2 and 3 were separated by a light brown sandy silt up to 800 mm in depth, and deposition of Layer 2 was preceded by a truncation of the edge of Layer 3 at the western (seaward) end of the site, and up to 3 m above current beach level. The truncation of Layer 3 and the subsequent deposition of silty sand (not numbered in the layering system) are undoubtedly associated, but the cause of the events is not clear. Four radiocarbon dates were obtained during the initial excavation on shell from Layers 3, 5 and 7 (Sewell 1986) (see Table 3).

Changes in some types of faunal material occur between the lower and upper layers. Although moa remains are not numerous in the site, fragments of moa bone are present in Layers 7 and 5, and an articulated moa skeleton was partly uncovered in Layer 9 (the bone has not been identified to genus or element). Sea mammal remains are also not present in the layers above Layer 5. The absence or scarcity of moa at Cross Creek is confirmed by changes in the material fishhooks are made from (Table 1): from Layer 5 there is an increase in the number of shell one- and two-piece fishhooks made from *Cookia sulcata* and worked shell for manufacturing fishhooks. This coincides with

	Layer 1	Layer 2	Layer 3	Layer 5	Layer 7
Shell worked	2	1	26	4	1
Shell fishhook		3	18	6	
Moa bone fishhook			2		5
Moa bone core					9
Sea mammal/cetacean fishhook			1	3	1
Sea mammal/cetacean core					1
Sea mammal/cetacean tab				1	

Table 1. Fishhook material from Cross Creek by layer. Sea mammal and cetacean fishhooks include those made from ivory.

	Layers							
	1	2	3A	3	5	7	9	Total
Open Sandy Shore								
Paphies subtriangulata	490	235	499	205	47	4	P	1480
Pecten novaezelandiae	32	8	68	6	3	P	-	117
Tucetona laticostata	31	6	4	8	2	1	-	52
Dosinia sp.	32	52	6	4	2	32	P	128
subtotal	585	301	577	223	54	37		
Sheltered Sandy Shore								
Paphies australis	21	12	24	39	26	1	-	123
Austrovenus stutchburyi	3	1	9	2	-	1	-	16
Amphibola crenata	9	-	2	-	-	-	-	11
subtotal	33	13	35	41	26	2		
Rocky Shore Species								
Turbo smaragdus	91	33	204	59	22	184	1	594
Cookia sulcata	63	17	837	7	2	3	-	929
Cellana radians	649	277	2530	932	73	98	P	4609
Cellana ornata	31	35	27	4	1	2	-	100
Cellana denticulata	1	-	P	5	6	199	9	220
Perna canaliculus	453	86	393	584	97	272	4	1889
Dicathais orbita	212	40	41	43	6	9	P	351
Haustrum haustorium	172	31	78	60	6	22	P	369
Melagraphia aethiops	315	238	1180	293	39	25	-	2090
Nerita atramentosa	663	172	269	295	13	30	-	1442
Haliotis iris	7	12	91	28	8	20	P	166
subtotal	2657	941	5650	2310	273	765	14	

Table 2. Minimum numbers of selected shellfish species by layer at Cross Creek. The methodology used in analysis is given in Sewell (1984).

a decrease in the number of moa bone hooks and moa bone manufacturing debris (Sewell 1984, 1988).

The shellfish collected also exhibit change through the succession of layers (Table 2). Significantly, *Cellana denticulata* is present in large numbers in Layer 7, reducing sharply in Layers 3 and 5, even though the continued collecting of rocky shore species is confirmed by the presence of large numbers of *C. radians* and other rocky shore species.

New research

Layer 8, a thin sterile yellow sand-like layer was noted by Roger Green to have different characteristics to natural sand layers below Layer 9 or those sandwiched between higher cultural layers. This combined with the radiocarbon date from layer 7 (NZ6800), which was within the date range for the Kaharoa tephra, provided the impetus to re-examine the date of Cross Creek.[2] Unfortunately, although a sample of Layer 8 was retained during excavation, it cannot now be located. The undated and ephemeral Layer 9 underneath this provided the opportunity to investigate the antiquity of occupation in relation to the now tightly dated Kaharoa eruption event. We were able to obtain two samples of fish (*Pagrus auratus*) and one bird (*Nestor meridionalis septentrionalis*) for radiocarbon dating from this layer. These are also reported in Table 3.

In order to demonstrate the relationship between the Kaharoa and early deposits at Cross Creek we used the OxCal program (Bronk Ramsey 1995, 2001, 2005). This program employs Bayesian statistical methodologies to analyze radiocarbon determinations in association with prior information such as stratigraphic sequence and archaeological provenance (see also Buck and Millard 2004) thereby giving more precise results in historical years.[3] Our model for the sequence of events is shown in Table 3. The calendar age of AD 1314±12 for the Layer 8 yellow sand-like material is derived from the wiggle match age for the Kaharoa Tephra (Hogg et al. 2003).

The results of this model are shown in Figure 3. The Bayesian computation results for Model 1 give an overall agreement index of 134.7%, shown at the top of the figure, which is well above the lower limit of 60%.[4] In this analysis only Wk-21355 falls just below this limit with an individual agreement of 57.9%. Typically a low agreement index indicates a problem (e.g., reworked

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[2] Loisel's Pumice was not present in the Cross Creek site although the occupation deposits were laid down within the time range for its occurrence on other Coromandel sites. This may be due to its elevated position in the dunes.

[3] The OxCal "Sequence" command is used when a group of successive phases, with no possibility of overlap in time due to stratigraphic succession, is arranged in order. The use of the "Boundary" command places limits in the model, according to the stratigraphy and other relevant information, in order to signal to the program that they all belong to one period or are separated in time (Bronk Ramsey 2005).

[4] An assessment of the combined data is given an individal agreement index, which indicates the extent to which the final (posterior) distribution overlaps the original (prior) distribution. This is displayed on the plot alongside the name of the sample. This can be further tested by calculating an overall agreement that is calculated as a function of all the constraints applied within the model. In both cases the agreement index should not fall below 60% (A'c).

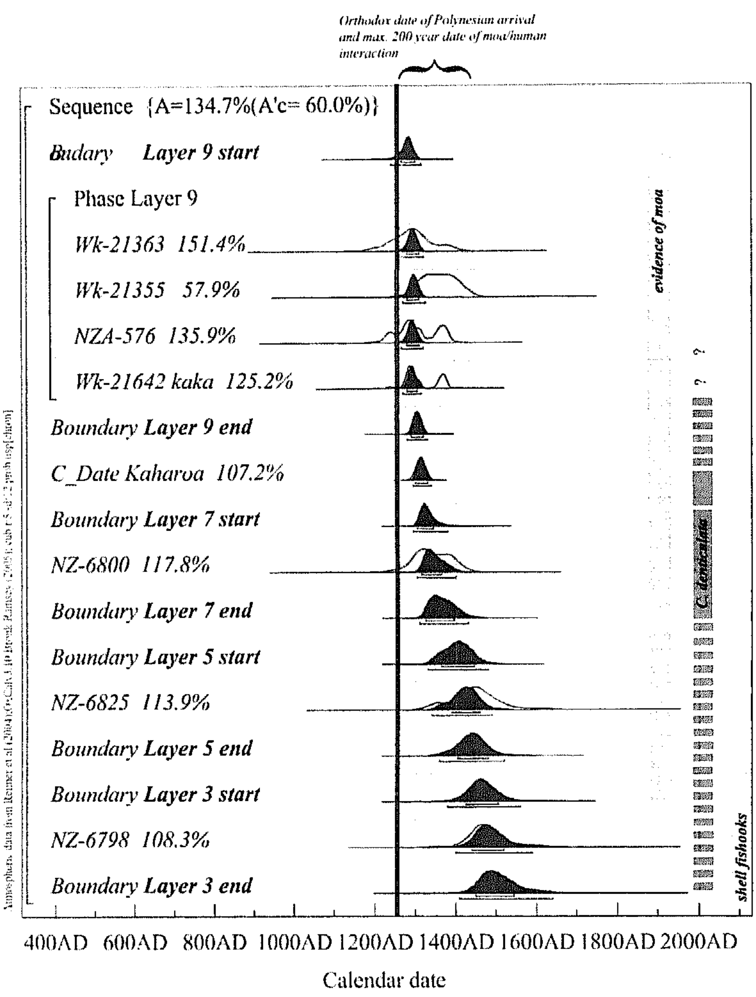

Figure 3. Modelled sequence at Cross Creek (Model 1) showing the 1σ and 2σ calibrated age ranges. The outline date distributions show the calibrated ages for each individual sample. The solid black distributions show the calculated ranges when applying the Bayesian model outlined in the text (quoted probabilities vary slightly by run). To calibrate terrestrial samples we have used SHCAL04 (McCormac et al. 2004). Both the shell and fish results were calibrated using the marine curve of Hughen et al. (2004) with ΔR for New Zealand set at -7 ± 45 ^{14}C yrs (Reimer and Reimer 2008).

material, contamination, erroneous stratigraphic interpretation, incorrect reservoir correction, etc.). We therefore decided to further test the robustness of the results obtained for Model 1. Because there is no unequivocal proof that the yellow sand is the Kaharoa tephra we have "questioned" the assumption that the wiggle match Kaharoa date occupies a position between Layers 7 and 9 (Model 2). The OxCal "question" command removes the constraints imposed by the position of this sample in the sequence and gives the probability that this determination occupies that position. In this model, the results for the overall agreement index decreased slightly for the remaining samples in the sequence (A = 128.4%) and Wk-21355 is no longer an outlier (A=73.8%), but the calculated probability that the Kaharoa Tephra falls between Layers 7 and 9 is low (A= 31.4%). Bronk Ramsey (2005) warns that this is to be expected when the constraints placed on the sample are very stringent. We argue, therefore, that the tight wiggle match date and short interval between layers 7 and 9 (<35yrs at 1σ) (Figure 4), in combination with the uncertainty added by the comparison of marine and terrestrial samples, is responsible for this low agreement. To further test our assumption about the placement of the Kaharoa tephra we moved the wiggle match date to before human occupation at the site (i.e., before Layer 9 in the sequence) (Model 3). This produced a zero distribution (i.e., an order which obeys all the constraints was not found by the OxCal program).

Discussion

Radiocarbon data supports deposition of the Layer 9 occupation sequence at Cross Creek immediately prior to the Kaharoa eruption event. Even without a positive identification of the Kaharoa tephra, rats (and people) were

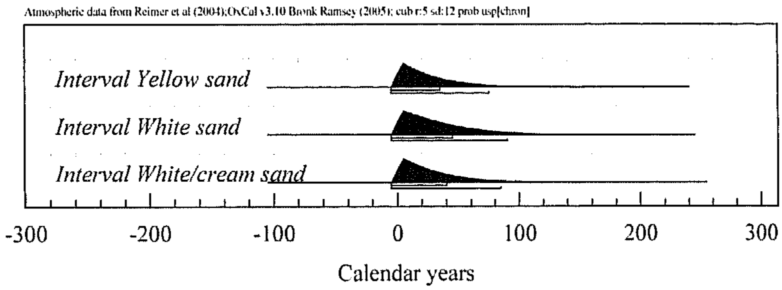

Figure 4. Total elapsed occupation time for the white sand (Layer 6), white / cream sand (Layer 4) and yellow sand-like (Kaharoa tephra ?) layers according to the stratigraphic model outlined in the text and shown in Table 3.

present at Te Rerenga on the east coast of the Coromandel Peninsula prior to deposition of the tephra, and were without doubt in Opito at the same time. This research is one step forward in proving that contention.

The revised radiocarbon chronology at Cross Creek has also enabled a more indepth evaluation of a couple of key biozones at this locality (Figure 3). Rowland (1976) identified *Cellana denticulata* as a marker for early sites. Several excavated Coromandel coast sites, in addition to Cross Creek, demonstrate a similar change in relative numbers in *C. denticulata* to *C. radians* (e.g., Tairua (Rowland 1975) and Hot Water Beach (Leahy 1974)). *C. denticulata* was, therefore most likely locally extinct by the early to mid 15th century. At Cross Creek, moa were no longer present by about AD 1400, supported by the radiocarbon dates for Layers 5 and 7, and a corresponding increase in shell fishhooks. This evidence fits with the contention that moa were more than likely extinct 50–200 years after a generally accepted orthodox AD1250 date of Polynesian arrival (Anderson 2000; Holdaway and Jacomb 2000). However, it is likely that the date for moa extinction varies also. Additional research into these key biozone markers at sites across the region has the potential to provide a clearer picture of the pattern of colonisation than is currently available.

Other sites in the immediate area also hint at an antiquity currently not fully realised. The Skipper's Ridge (T10/165) site produced a charcoal date (NZ1740) from the base of pit fill that was on short-lived *Pseudopanax* sp. wood (Davidson 1974). At one standard deviation the upper limit of the date range predates the Kaharoa tephra event (AD 1180–1300). This single date was dismissed as unreliable by Anderson (1991), although Davidson (1975: 36) considered it acceptable based on site context. The earliest layer from the Opito Beach Midden (T10/159) predates the Loisel's Pumice (Boileau 1980) and is possibly contemporary with the nearby Skippers Ridge site. These two sites are considered to be components of a contemporary settlement with storage on the ridge and shell midden, cooking and activity areas on the dunes below (Green 1963, Davidson 1976: 39). Unfortunately, while a charcoal date from the lower layer (Layer 4C) deposits of the Opito Beach Midden is similar in age to Layer 7 at Cross Creek, the charcoal was not identified to species and there is an unknown amount of inbuilt age. Further work on correlating the stratigraphy and dating of these Opito sites and Sarah's Gully Settlement site are underway and will be reported at a later time.

Layer	Event	Shellfish main species	Moa/sea mammal	Fishhooks	Lithic	Radiocarbon data (calibrated ranges shown at 68.2% probability)
1	Occupation	*Paphies subtriangulata, Cellana radians, Perna canaliculus, Nerita, Melagraphia, Haustrum, Dicathais*				
2	Occupation	*P. subtriangulata, Nerita, P. canaliculus, C. radians, Melagraphia*				
	Slip/weather event					
	Storm/truncation of Layer 3 at western end of site					
3A	Occupation	*P. subtriangulata, C. radians, Turbo smaragdus, P. canaliculus, Nerita, Melagraphia, Cookia sulcata*	Sea mammal	Shell	Basalt/ obsidian	NZ6798 AD 1430–1520 (*P. subtriangulata*)
3B		*P. subtriangulata, Nerita, Melagraphia, P. canaliculus, C. radians*				

Table 3. Layers, events, chronology and summary of information on Cross Creek site. (NZ radiocarbon determinations from the Radiocarbon Database. The three Wk dates for Layer 9 are new and have not previously been published).

Layer	Event	Shellfish main species	Moa/sea mammal	Fishhooks	Lithic	Radiocarbon data (calibrated ranges shown at 68.2% probability)
4	Sand deposition	White sand				
5	Occupation	*C. radians, P. canaliculus*	Sea mammal/ cetacean	Moa/shell	Basalt/ obsidian	NZ6825 AD 1390–1510 (*P. subtriangulata*)
6	Sand deposition	White sand				
7	Occupation	*C. denticulata, T. smaragdus, P. canaliculus*	Sea mammal/ cetacean/ moa	Moa	Basalt/ obsidian	NZ6800 AD 1295–1390 (*P. subtriangulata*)
8	Sand deposition	Yellow sand-like layer				
9	Occupation		Moa skeleton (natural death?)/ sea mammal			Wk21355 AD 1320–1405 (*Pagrus auratus*) Wk21363 AD 1230–1340 (*Pagrus auratus*) Wk21642 AD 1270–1310 and (*Nestor* AD 1360–1380 *meridionalis septentrionalis*) NZA576 AD 1230–1250, (moa sp.) AD 1260–1320 and AD 1350–1400
10	Sand					

Table 3. continued.

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