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Bruce Bay Revisited: Archaic Māori Occupation and Haast's 'Palaeolithic'

Kevin L. Jones[1]
Ray Hooker[2]
Atholl Anderson[3]

ABSTRACT

Julius Haast (later von Haast), the founding father of New Zealand archaeology, based his initial view that there had been a 'Palaeolithic era' in New Zealand substantially upon evidence observed at Bruce Bay in 1868. From at least that time, the Bruce Bay coast, southern West Coast, has been eroding, exposing a series of middens. This paper describes recent archaeological and geomorphological investigations which set Haast's conclusions in modern context and restore credibility to his primary observations.

Keywords: NEW ZEALAND, HISTORY OF SCIENCE, WEST COAST, POUTINI NGĀI TAHU, ENVIRONMENTAL RECONSTRUCTION, EROSION, MOA-HUNTER, CLASSIC MĀORI, FISHING, SHELLFISH.

INTRODUCTION

Moa, the ratites endemic to New Zealand (genera *Dinornis*, *Anomalopteryx* and *Euryapteryx*), were hunted to extinction by about AD 1550. In the middle of the nineteenth century, the age and identity of the human society responsible for this extinction was controversial (Anderson 1989: 100–02). For Julius Haast, a key protagonist, a site at Bruce Bay was a key to his thinking on the antiquity of the New Zealand moa-hunters, which he considered to be similar to the European Palaeolithic (Haast 1870; Allen 1987; Anderson 1989: 100–02). Although a hemisphere distant, Haast was familiar with the literature of his time (Haast 1870; Duff 1956: 253–58; Allen 1987; Anderson 1989: 100–02; for the European background, see also Daniel 1975: 85–89). This historiographic reference to an archaeological site exposed by nineteenth century goldmining needs to be seen in the light of modern archaeological observations of its nature and geomorphological setting.

More recent archaeological and other literature on pre-European settlement in the Westland region provides little evidence for the use of marine foods (McCaskill 1954; Leach 1969: 67–68; Anderson 1982: 106–10) — more the result of lack of knowledge than of any empirical work.

In Bruce Bay during the early 1980s, two shell middens 80 m apart, G36/1 (Grid Reference 332282, S78/1) and G36/7 (S78/13) (possibly parts of a larger, or formerly

[1]Department of Conservation, P.O. Box 10 420, Wellington, New Zealand
[2]Arcsearch, P.O. Box 679, Cambridge, New Zealand
[3]Research School of Pacific and Asian Studies, Australian National University, Canberra ACT 0200, Australia

extensive, site), were being actively eroded by the sea. Aerial photographs (R.N. 933A, 1948) show timber-company buildings on the seaward side of a roadway in the vicinity, indicating the severity of coastal erosion. G36/1 showed a better exposed and more complex stratigraphy than G36/7 and, because of the presence of fishbone, offered an opportunity to further our understanding of marine subsistence in the region. This report describes the excavation of part of G36/1 and its environmental setting.

HAAST'S THEORIES AND HIS VISIT TO BRUCE BAY

In 1868, Bruce Bay was a small goldmining settlement. In the course of his visit, Julius Haast made observations on the vegetation, geology and also artefacts found by the miners (Haast 1870). These artefacts, a 'chisel' and a 'sharpening stone', were found close together at the base of a series of marine beach deposits and above a cemented argillaceous gravel (Haast 1870: 116; 1879: 409–10). The site was 14 feet (4.2 m) deep and 525 feet (160 m) from the high water mark at the time. Haast stated that the beds through which the miners had been working had not been disturbed and large trees up to 4 feet (1.2 m) in diameter had been growing on the claim.

Where was the exact location of Haast's 1868 section and what was the likely context and nature of the site in which his artefacts were found? An account related by S. Fiddian, the finder, to W. Wilson, a surveyor, clarifies Haast's description and pinpoints the exact location of Haast's published section:

> ...about three chains north of Bairds house on the back lead, in the sand under twelve feet of stripping he came upon a dark coloured patch of stuff that looked like the ashes of burnt bones and grease and also found an adze which he broke accidentally and a sharpening stone or file of very hard stone. Dr Von Haast got these off Sam and told him he would put them in the Canterbury Museum with his (Sam's) name attached. He sent Sam a moas leg in exchange. He told Sam that Dr Hectors theory was that the Maoris had only been on the coast 400 years but that the finding of these and the place would prove the time to be well on for a 1000 years. Big Birches was growing on the spot and the twelve feet of stripping consisted of hard cement, between this and the beach there were three or four other leads with a space between each and then tussock and foreshore. (W. Wilson ms)

Figure 1 prepared by Hooker shows the location of Haast's section drawing from the unpublished survey map by Wilson (S.O. 8634, 1885).

These observations are of general interest because (in part) this particular geomorphological setting led Haast to propose that New Zealand had a race of autochthonous peoples who hunted megafauna. Drawing on similarities with the cultures of the European Palaeolithic, such as the use of chipped stone, Haast had to prove that his moa-hunters were coeval with moa, and that both preceded a 'Neolithic' Māori race. In the paper *Moas and moa hunters*, he distinguishes the moa hunters who possessed "only rudely chipped stone implements" from the Māori, later arrivals in Haast's view, who had "reached a high state of civilization in manufacturing fine polished stone implements' (Haast 1872: 91, 104–07). James Hector (1872) was the chief protagonist for the view that the 'Neolithic' Māori occupied New Zealand at the same time as the moa.

One of the main empirical factors in Haast's thinking was Bruce Bay where he had found polished, i.e., Neolithic, implements "in such positions that their great antiquity cannot be doubted, and which is an additional proof of the long extinction of the moa" (Haast 1872: 107). Haast thought the 'Neolithic artefacts' from Bruce Bay to be ancient, but later in date than the chipped stone tools associated with moa on the east coast of the South Island. The Bruce Bay materials, which were of ground stone and thus 'Neolithic' in time, fitted into a chain of reasoning which placed the moa-hunter materials as equivalent in age to the European Palaeolithic. That interpretation was not unreasonable in an age when there were no methods of absolute dating that could be converted to calendar years. It now illustrates the extent to which theory can influence what are perceived to be facts.

Our opinion on the nature and age of the Bruce Bay site reported by Haast is given in a following section.

PHYSICAL SETTING

Bruce Bay is 150 km south-west of Hokitika on the South Island's West Coast, at the western end of a crescentic-shaped bay some 7 km long. To the west, Heretaniwha Point projects nearly 2 km north into the Tasman Sea (Fig. 1). Approximately 100 m high, the point protects Bruce Bay from southerly and westerly storms, giving the north-facing Bruce Bay a favourable micro-climate. The Bruce Bay beach is some 3 km long and terminates at the Mahitahi River. River courses and coastlines in the region are generally unstable and the Bruce Bay beach front has retreated some 30–40 m since the 1930s, destroying middens seen at that time by J. Bannister (pers. comm. 1983). Several factors contribute to the instability: glacially over-steepened mountain slopes, rapid mountain uplift rate and rainfall of up to 12,000 mm per annum, and a northerly longshore drift carrying gravel and sand. A consequence of aggradation is that the rivers frequently change course and swamps or lagoons at the rear of beach dunes commonly interlock with the old river paths.

The Bruce Bay lowland is of Quaternary origin and comprises the following zones: a narrow (width uncertain) band of older dunes; a mixture of swamp deposits surrounded and probably underlain by river gravels deposited less than 6000 years BP (these gravels where surface-exposed generally support a podocarp forest); and, adjacent to the Mahitahi River, younger gravels deposited less than 150 years BP (Fig. 1, based on Mortimer *et al.* 1984: 28–29).

The forest adjacent to G36/1 is rimu (*Dacrydium cupressinum*) dominant with a sub-canopy of mountain toatoa (*Phyllocladus alpinus*), kāmahi (*Weinmannia racemosa*), southern rata (*Metrosideros umbellata*), silver pine (*D. colensoi*), Hall's tōtara (*Podocarpus hallii*) and miro (*P. ferrugineus*) (Woolmore, pers. comm. 1984). It extends inland some 200–300 m from the present shoreline. South of the forest lies a swamp with two arms reaching the shoreline east and west of G36/1. The termination of the eastern arm is generally obscured by recent sand deposits but the western arm shows in profile at the wave-cut shoreline as a buried, gravel-filled, former course of the Mahitahi River.

HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

Māori occupation at Bruce Bay includes the sites already mentioned as well as shell midden traces exposed in the wave-cut bank further to the west and an artefact findspot (G36/2) by

the Heretaniwha Stream, source of a broken nephrite adze, a broken grey argillite drillpoint and two grindstones. The general environmental context of these sites, on the surface of dunes or wedged in peaty swales, is consistent along the length of the Bruce Bay and similar to that of G36/1 (Fig. 1).

In 1897, G.J. Roberts recorded a traditional account of Bruce Bay as a construction centre for double-hulled canoes, utilising the abundant and large tōtara trees available (Skinner 1912: 145). Possible canoe-making tools from Bruce Bay include a grey argillite adze (Duff type 1A) from the Makawhio area in the Museum of New Zealand Te Papa Tongarewa (ME006204), a trapezoidal cross-sectioned, hammer dressed and polished adze in the Canterbury Museum (E145-147), and a nephrite adze (Duff type 1B or C) in the Otago Museum (D43.1).

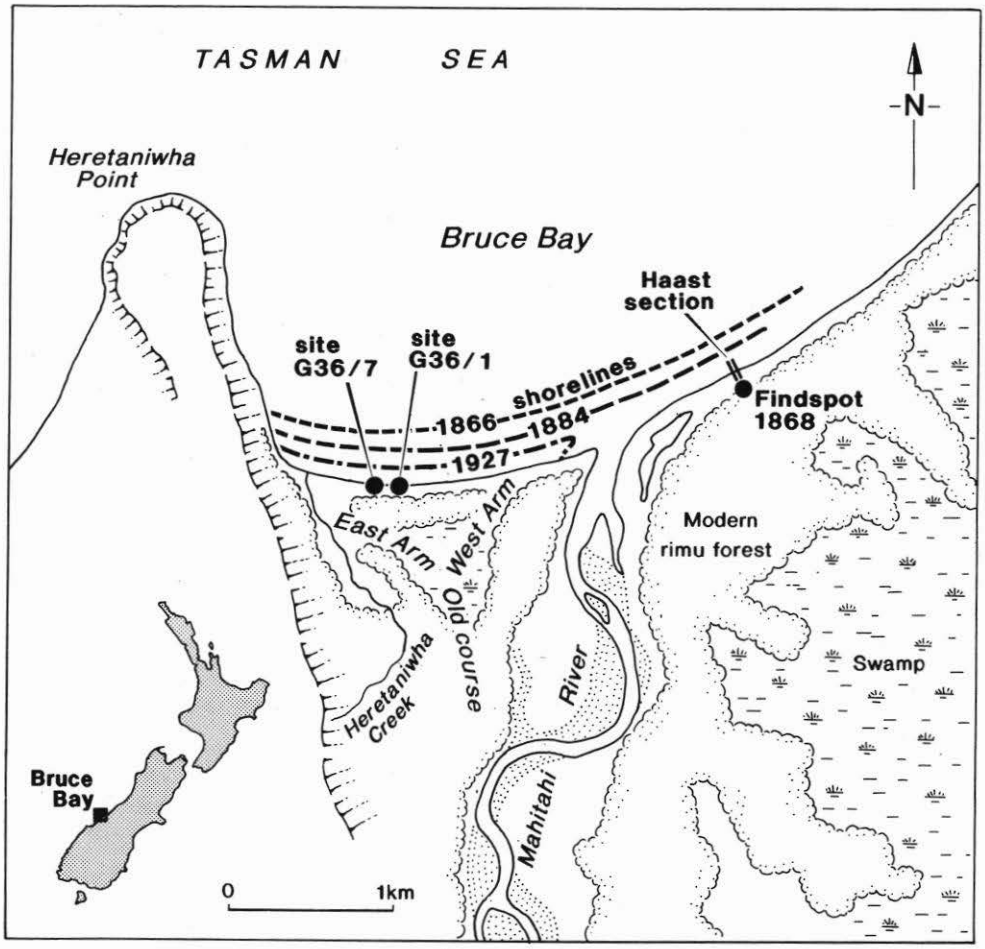

Figure 1: Physical setting of the Bruce Bay site, based on air photograph 1933A, 1948. Former shorelines based on Department of Lands and Survey maps S.O. 8623, 2670.

From 1847, there are numerous contemporary references to a small Māori population and gardens in Bruce Bay (Brunner 1959: 291; Mantell in Mackay 1873: 274–80; Mackay 1860; Mueller 1958: 53, 61; *West Coast Times*, 11 November 1865). Late in 1865, gold was discovered 10 km north of the Mahitahi River mouth. A township called Bruce Bay sprang up, in the lee of Heretaniwha Point, as a supply centre for the diggings. The gold rush was largely a 'duffer' and most miners soon moved away to other goldfields.

EXCAVATION

G36/1 is exposed as a discrete lens of tuatua shell in a 1–1.5 m high eroded section. Excavation was carried out by Jones and Hooker in October 1984. The exposed face of the midden was lightly cleaned and material at the foot of the bank (midden talus deposits) was collected. Samples dug from the exposed face of the two concentrated shell lenses (A and B on the west and east side of the section respectively) indicated that the site extended some distance back into the section.

The section was then stratigraphically excavated by trowel, opening up a plan area of about 75 cm into the eroding bank and 3.2 m along the bank. The deposits were wet and did not sieve. Wet sieving was not possible in the sea conditions prevailing. Bone, shell and worked stone or other artefacts were recovered by feeling through fairly full clogged sieves. The midden itself was enclosed as a lens in a soft, slightly sandy, decomposed peat. It consisted of a large lens some 2.5 m long in section and up to 40 cm thick. The lens was stratified and included an upper cap of whole tuatua (*Paphies subtriangulata*) 5 cm thick. Because there was not time to investigate in detail, it was taken out in two spits, an upper and a lower. A bulk sample (4 litres) was taken from each of the midden units A and B for landsnail analysis. A baulk was left between the east and west sides of the midden.

STRATIGRAPHY (Fig. 2)

From the datum (2.25 m above H.W.M.) down, the layering was as follows:

(0–10 cm) moss and fine roots, wet, forming a peat (modern vegetative cover on the old Bruce Bay road surface);

Layer 1 (10–25 cm) grey, rounded gravelly sand with many rounded stones and small boulders, very firm and compacted (old Bruce Bay dray track/road);

Layer 1A (25–45 cm) mottled grey, iron-stained silty clay, wet (silt blown from an exposed inland riverbed on to dunes) (James pers. comm. 1984);

Layer 2 (45–75 cm) shell and bone midden, with a base of flattish stones (midden thrown on to a lagoon/swamp edge, with stone paving);

Layer 3 (75–90 cm) slightly sandy, dark brown/black, decomposed peat, wet, enclosing and underlying the midden; some fish bone and shell immediately adjacent to the midden and stones, and lumps of charcoal; many kākahi (*Hyridella menziesii*) periostracum in compacted layers;

Layer 4 (90–190 cm and sloping down to swamp) grey sand with ironstains, and some distinct brown, peaty bands up to 2 cm thick with charcoal lumps; some horizontal logs and small stumps; beach or river stones at base, wet.

FAUNAL REMAINS

Shell

Nearly all of the shells in the midden are tuatua (*Paphies subtriangulata*) and green mussel (*Perna canaliculus*). The normal habitats of these species are open sandy beaches (lower inter-tidal) and rock platforms or logs (inter-tidal) respectively. Small numbers of the following shells were also found: *Austrofusus glans* (mud-dwelling, sea floor species, probably thrown up by storm action), *Paratrophon patens* (rocky intertidal), *Paphies donacina*, *Dosinia anus* (sandy lower intertidal), *Spisula aequilateralis*. Closely packed lenses of the periostracum of the freshwater mussel (*Hyridella menziesii*) occurred only in the decomposed peat (layer 3) rather than in the midden, and were also common in other

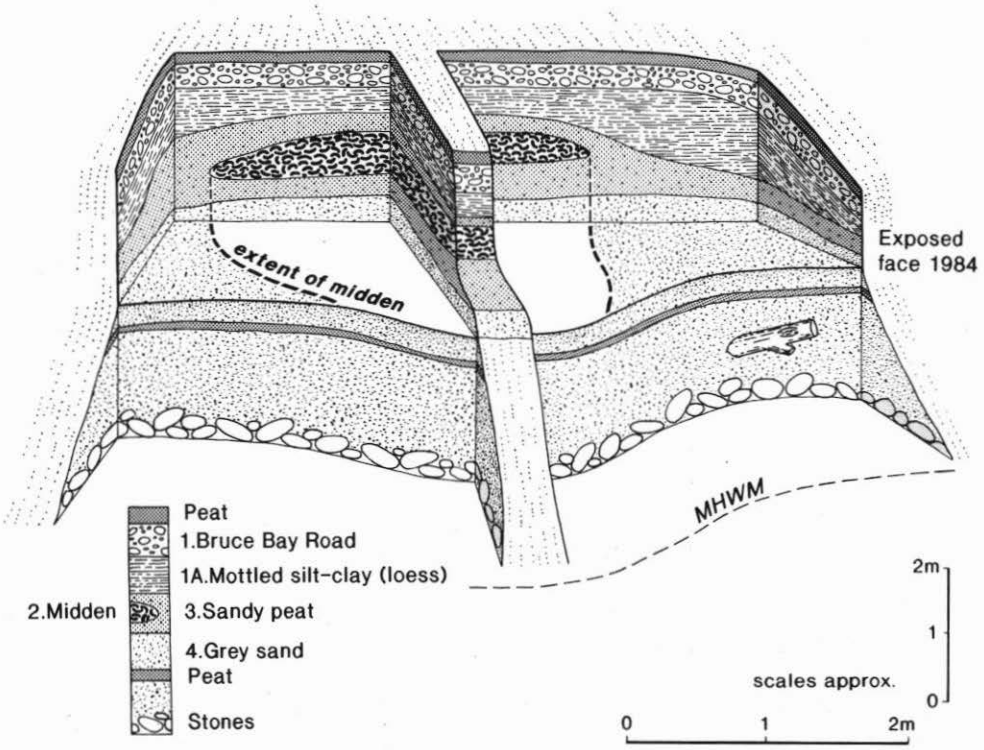

Figure 2: Isometric view of excavation of G36/1.

parts of the eroded section where there was no evidence of midden. Its occurrence is therefore natural, and the lenses are due to compaction of the peat around natural beds of the mussel. This provides the strongest evidence that the site was adjacent to a former river bed or lagoon, in which conditions the freshwater mussel thrives. For land snail analysis, bulk samples of midden were dried in the laboratory, sieved through 2 mm mesh, and the residue floated in water. From this, Dr Frank Climo (pers. comm. 1984) identified 20 individuals of '*Charopa*' cf. *montivaga* (Suter). These suggest that, at least for the duration of the occupation, the site area was above water.

Bone

Anderson identified the fish bone (Table 1) using the comparative collection in the Anthropology Department, University of Otago. A total minimum number of 50 individuals of all species is a small sample on which to base conclusions but some general observations are warranted. The red cod is, next to the barracouta, the most common fish represented in pre-European Māori sites in southern New Zealand (Anderson 1985). It is often regarded as an inhabitant of open sand or mud bottoms but it can be found in most habitats and, in water less than 50 m deep, it seems to prefer rocky reefs (Graham 1956: 169; Ayling and Cox 1982: 143). It is normally caught on a baited hook at or near the bottom. Tarakihi are also found in different habitats but prefer areas over a gravel bottom. They are 'good heavy biters' (Graham 1956: 250) of a baited hook suspended near the bottom. Tarakihi are almost absent from sites along the east coast of southern New Zealand but occur at frequencies of 3–18% in sites along the outer coast of Fiordland (Anderson 1985). Their representation at Bruce Bay is the highest yet recorded. Wrasses, including *Pseudolabrus* sp., are typically rocky shore and reef fish, though they are not confined to such areas. Most *Pseudolabrus* species are largely confined to shallow waters and are seldom found below 30–50 m (Ayling and Cox 1982: 255–56). Of the remaining species, the barracouta is interesting mainly for its scarcity in the midden. It is less abundant here than in other West Coast (Fiordland) sites where it generally forms 10–12% of the catch, and much lower than in east coast sites (Anderson 1985). The ling quadrate is from a very large individual. Fish of such size are normally associated with catches representing offshore fishing.

Overall, however, the scarcity of ling and the absence of hapuku (*Polyprion oxygeneios*), the scarcity of fish caught by trolling such as barracouta and kāhawai, and the preponderance of red cod, tarakihi and *Pseudolabrus* sp., indicate fishing with baited hook in comparatively shallow water, over a soft bottom, but close to rocky reefs or shore. This doubtless reflects fishing opportunities in the vicinity of the site. There is very little to indicate seasonality in the assemblage except to note that barracouta tend to be caught in large numbers off shore in summer and autumn while tarakihi move into shallower water during the winter (Ayling and Cox 1982: 243). The near-shore environment of the site at the time of occupation and its subsequent changes are discussed later in the paper.

Other than fish, one individual each of dog (*Canis familiaris*) and pigeon (*Hemiphaga novaeseelandiae*) was identified. The dog bone is a metatarsal from a small, probably immature, individual. Both proximal and distal epiphyses on the intact metatarsal and the phalanx are closed, indicating an individual older than eight months (Silver 1969: 285). Only the distal part of the phalanx is burnt, which might suggest that a hind-leg was cooked with the paw attached. The pigeon, represented by a coracoid, is burnt as well but this is more likely to have resulted from discard into a fire after consumption.

Coastline instability has an important bearing on the interpretation of the prehistoric subsistence pattern revealed here. Sandy shore shellfish species do not appear to have been available in the historic period in South Westland. In the late 1860s, following the initial gold rush, the survey crew and remaining miners often ran out of provisions between the infrequent ship calls. Only mussels, eels and fern tree tops are mentioned as the staple diet, sometimes for several weeks (Mueller 1958: 68–85; *West Coast Times* 17 July 1866). If other shellfish had been available, it is likely that they would have been utilised, since Mueller had Māori with local knowledge in his party. As earlier indicated, this is likely to be the result of storm-induced failures of the tuatua populations on this beach. The increased storminess has in turn led to increased erosion which implies destruction of the shellfish habitat.

Changes in the frequency of shellfish species utilisation over time were recorded in archaeological investigations at Martins Bay (Wellman and Wilson 1964: 717; Coutts 1971: 194). At Bruce Bay today, although mussels are common along the rocky shore, sandy shore shellfish are uncommon along the beach. At 550 yrs BP, however, the sandy shore species, tuatua, was important in the middens G36/1 and 7, confirming a dramatic change in coastal conditions since that time. The midden contents point to the relative rawness of the site setting. The high frequency of tarakihi indicates a gravelly inshore bottom derived from a river delta and longshore drift. In the immediate vicinity of the site, the lack of forest is indicated by the paucity of bird bone in the midden, although to some extent the presence of bird spears counts against this.

ARTEFACTS

The bird spear (Fig. 3) is worked from the bone of the albatross (*Diomedea* sp.)(Michael Trotter pers. comm. 1984). During the excavation, several possible schist abraders, flakes of quartz, a very small flake of pale nephrite of South Westland origin (Neville Ritchie pers. comm.) and fragments of the point of a further bird spear were also recovered.

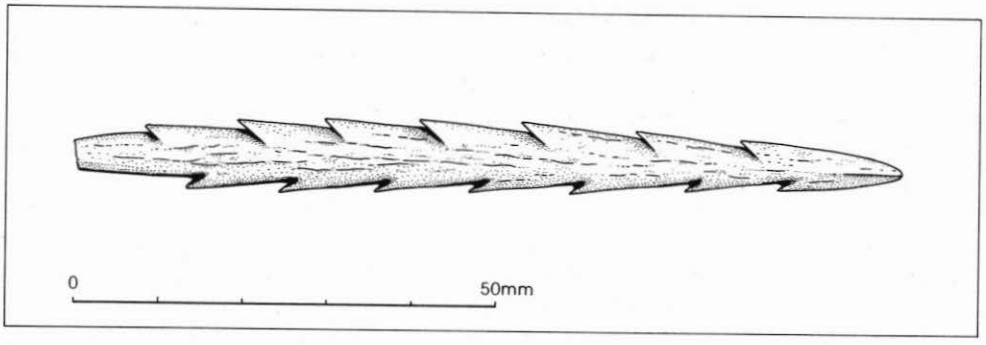

Figure 3: Birdspear point in *Diomedea* bone.

TABLE 1
Fish remains from G36/1, Bruce Bay.

	A		B		C		D		E		F		G	H	
	L	R	L	R	L	R	L	R	L	R	L	R	-	N	%
1. LAYER 2 LOWER PART															
Red cod[1]	9	9	6	8	5	7	1	3	3	5	-	-	-	9	56
Tarakihi[2]	-	3	3	4	2	1	1	1	1	1	-	-	-	4	25
Pseudolabrus sp.	1	-	2	1	-	-	-	-	-	-	1	-	3	3	19
2. LAYER 2 UPPER PART															
Red cod	5	6	12	9	3	2	7	7	2	2	-	-	-	12	36
Tarakihi	3	1	11	8	5	9	8	6	12	11	-	-	-	12	36
Pseudolabrus sp.	6	2	6	7	3	2	1	2	-	-	4	2	7	7	21
Ling[3]	-	-	-	-	-	-	-	-	1	-	-	-	-	1	3
Barracouta[4]	-	1	1	-	-	-	-	-	-	-	-	-	-	1	3
3. LENSES A and B															
Red cod	1	2	4	5	1	5	1	2	-	-	-	-	-	5	50
Tarakihi	1	-	2	2	3	2	2	-	2	2	-	-	-	3	30
Pseudolabrus sp.	1	-	2	-	-	-	-	-	-	-	-	-	-	2	20
TOTAL 1, 2, 3															
Red cod	15	17	22	22	9	14	9	12	5	7	-	-	-	22	44
Tarakihi	4	4	16	14	10	12	11	7	15	14	-	-	-	16	32
Pseudolabrus sp.	8	2	10	8	-	3	2	1	2	1	5	2	10	10	20
Ling	-	-	-	-	-	-	1	-	-	-	-	-	-	1	2
Barracouta	-	1	1	-	-	-	-	-	-	-	-	-	-	1	2
TALUS															
Red cod	-	-	-	2	-	-	-	-	-	-	-	-	-	2	50
Tarakihi	1	-	-	2	-	-	-	-	-	-	-	-	-	2	50

Nomenclature after Ayling and Cox (1982). A = Dentary, B = Premaxilla, C = Maxilla, D = Quadrate E = Articular, F = Superior Pharyngeal G = Inferior Pharyngeal, L/R = left/right, H = Maximum Minimum Number and Percentage.

1. *Pseudophycis bachus*. 2. *Nemadactylus macropterus*. 3. *Genypterus blacodes*. 4. *Thyrsites atun*.

RADIOCARBON DATE

The former Institute of Nuclear Sciences (now the Nuclear Sciences Group of the Institute of Geological and Nuclear Sciences) supplied the following date (NZ6797) on washed and air-dried tuatua (*Paphies subtriangulata*) from the midden. The CRA (conventional radiocarbon age) is 872 ± 28 yrs BP ($\delta^{13}C$ 0.98 ± 0.04) with a marine calibration of Cal. 541 to 466 (95%) or 522 to 486 (68%) years BP. This has been recalculated from the original data by McFadgen (pers. comm. 1993) using the McFadgen and Manning (1990) marine correction method (ΔR -30 ± 15); the confidence intervals follow the method of Stuiver and Polach (1977).

COASTAL REGRESSION AND ORIGINAL SITE ENVIRONMENT

Following the excavation, further investigations were undertaken to check the chronological relationship between the site and the adjacent rimu forest, estimated to be 400–500 years old. The key to this lay in tracing the extent of the layer 1A, mottled grey, iron-stained silty clay, which is a wind-blown deposit (James pers. comm. 1984; see also earlier description of stratigraphy). This deposit can be seen at other exposures along the beach; at the midden G36/7, 80 m to the west, it seals a lens of cultural deposit extending over 4.2 m. A Dutch soil auger was used to investigate stratigraphy on the south side of the roadway at G36/1. The silty clay (layer 1A) was not found directly south of the site. However, a little to the east the silty clay lies 60 cm below humic soil underlying rimu forest. Rimu therefore covers layer 1A which in turn seals both G36/1 and G36/7 and gives them a minimum age equivalent to that of the trees (*c.* 400–500 years).

The dune ridge on which G36/1 and G36/7 are located was, after occupation, colonised by podocarp forest and, like Haast's site to the east of the Mahitahi River, was clothed with tall forest in the nineteenth century. Although now exposed to wind and salt damage, this tall forest must have grown to its present size with protection from a seaward forest zone that has now been destroyed by coastal erosion. The estimated age of the rimu forest is consistent with an age of Cal. 541 to 466 years BP estimated from the radiocarbon date (NZ6797) for G36/1.

Haast (1870: 116; 1879: 409–10) shows a minimum distance of 150 m from the H.W.M. to the rimu forest (see Figs 1, 4). He also reported the location of the sub-surface find of the artefacts as 37 feet (12 m) within the tall forest. Since then the coastline has retreated considerably. Mueller's surveys of 1865–1866, when compared with the modern survey, indicate some 200 m of erosion during the subsequent 120 years (see Fig. 1, based in part on S.O. 8623, 2670). This is important for understanding the likely setting of Haast's original discoveries.

The general setting of the site at the time of occupation is interpreted in Figure 4a and b. Figure 4a shows the midden deposited at the rear (landward side) of a dune and spilling into a freshwater peat swamp or slow moving stream at the edge of a river flood plain. Inland of the site, there was a source of fine sediments, probably an actively aggrading river in an unstable course. The area of old river bed (now swamp) immediately south of G36/1 is the obvious candidate as a source. The extent of erosion and forest cover at the time of Haast's visit is indicated in Figure 4b, while the 1985 situation is depicted in Figure 4c.

CONCLUSIONS

A site similar to G37/1, reported by Julius Haast in 1868, because of its depth and the apparent age of its forest cover, supported his belief that Māori occupation was of great antiquity and that the antecedent moa-hunter sites were older still, equivalent in age to the European Palaeolithic. In the modern perspective, the finding of deeply buried midden some 200 m from an ancient shoreline confirms that Haast's original findspot was accurately recorded. From the deep location of his finds he could reasonably conclude that they had great antiquity, but he failed to take into account the sheer amplitude of coastal change and sedimentation that applies on the West Coast compared with the eastern coast of New Zealand with which he was more familiar.

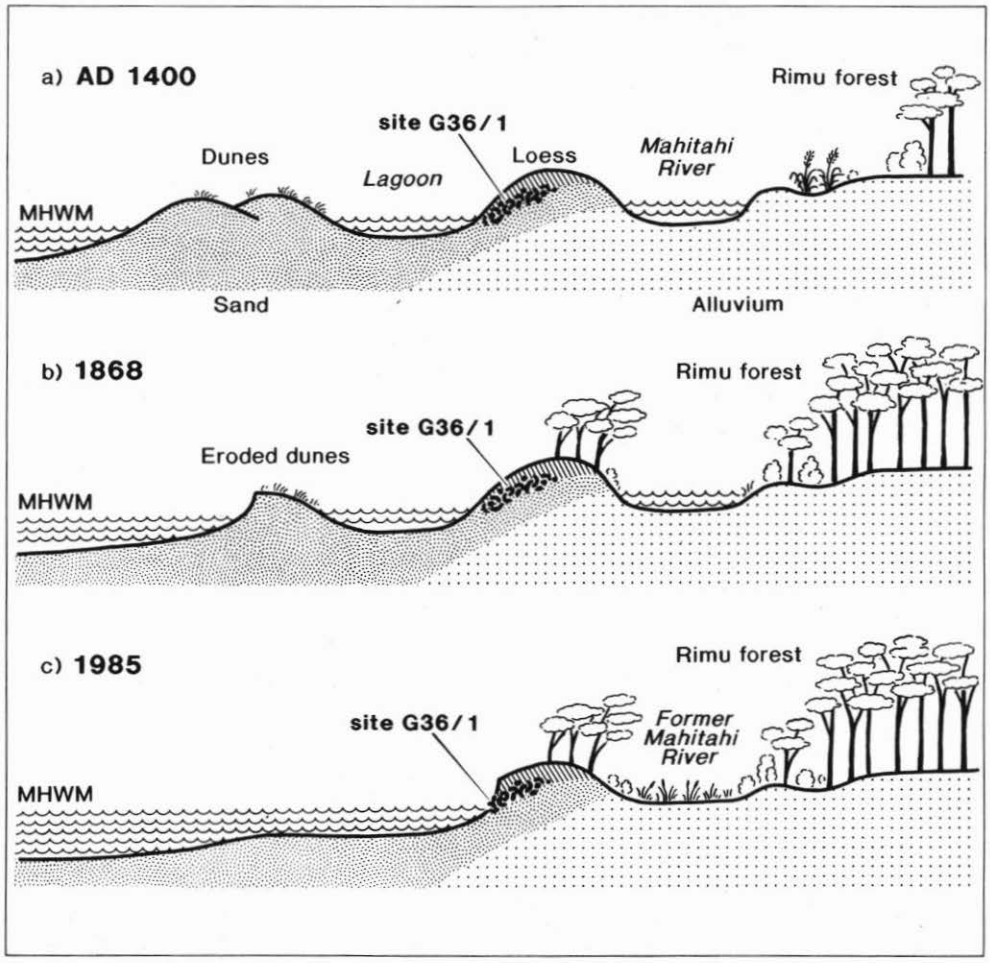

Figure 4: Schematic interpretations of site setting at various times: a, *c.* AD 1400, the period of occupation; b, 1868, the time of Haast's visit; c, 1985.

In general terms the material from G36/1 confirms Archaic occupation of South Westland and indicates that the marine resource was then a significant component of the diet. Shellfish gathering and inshore fishing for bottom dwelling species were important, but trolling and offshore fishing cannot be ruled out. Marine subsistence depended on shellfish species requiring a sand habitat and now locally extinct, and fish species that prefer a gravelly ground.

At the time of occupation Cal. 550 years BP (AD 1400), people lived on dunes on the edge of a swamp or lagoon 150–200 m from the sea. Further inland some 200 m was an active course of the Mahitahi River, a source of loess dust which periodically fell on the site. Vegetation cover was relatively immature both on the dunes and on the alluvium. Following abandonment of the site, the alluvial flats of the river expanded, and loess was blown on to the dunes. The coastline prograded further. The Mahitahi River changed to its present eastern course, and the inland dunes and alluvium were colonised by podocarps while the deeper bed of the former river became swamp. From at least the mid-nineteenth century, the coastline began to erode, and is now some 150–200 m inland of its extent in 1865, exposing the occupation layer (G36/1).

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