Analysis of Sediments and Plant Remains from the Find-spot of a Cache of Polynesian Gardening Tools at Ruakaka, Northern New Zealand

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ABSTRACT

We outline a record of sedimentology and fossil plant remains of a prehistoric archaeological site in a small valley at Ruakaka, northern New Zealand. The evidence provides a *ca.* 850-year record of the sedimentation, hydrology and vegetation of the catchment, allowing the following deductions to be made: 1) the dramatically increased erosion rate of local hill slopes was a result of Polynesian deforestation by fire commencing at an estimated date of 700–550 ^{14}C yr BP, and 2) the subsequent stabilisation of these hill slope soils occurred as a result of the establishment of European pasture in the catchment after *ca.* AD 1800.

Keywords: POLLEN, SEDIMENTOLOGY, DEFORESTATION, EROSION, RUAKAKA.

INTRODUCTION

In the early 1980s, a cache of wooden Polynesian artefacts was found buried on a farm in inland Ruakaka, northern New Zealand. As the site was going to be inundated by a dam proposed by the local Whangarei City Council, archaeological surveys (Nevin 1986, 1988; Maingay 1988) and later an excavation (Best 2000) were carried out.

For Best's (2000) excavation, the presence of waterlogged sediments in the immediate vicinity of the find-spot presented the opportunity for a sedimentological and fossil plant study. We present here the results of analyses of sediments and plant remains in profiles from this site encompassing the last *ca.* 850 years. We provide a history of the hydrology, sedimentology and vegetation of the catchment showing the different effects on these of first Polynesian, then European, settlers.

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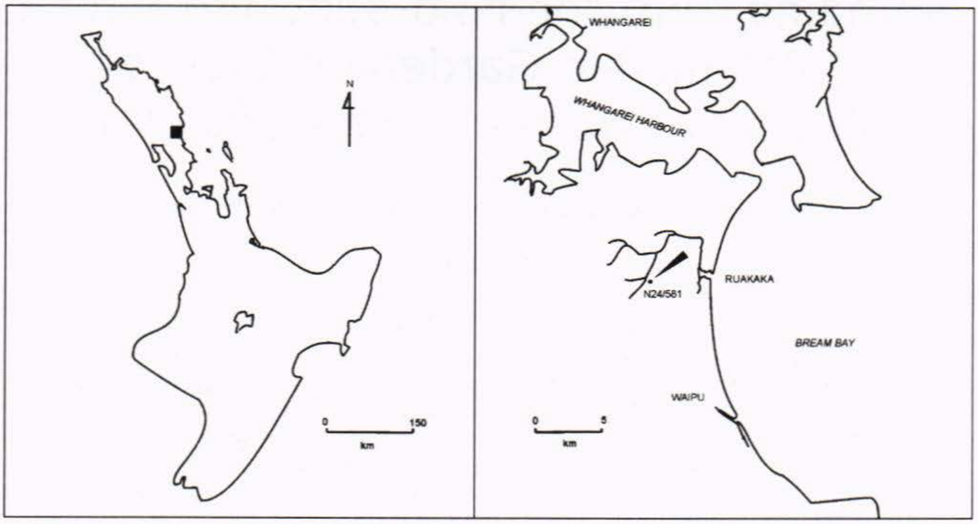

Figure 1: Location maps. Left, the North Island showing the location of Bream Bay; right, the Whangarei and Ruakaka areas showing the location of site N24/581 (from Best 2000).

THE STUDY AREA AND SITE

The Ruakaka area is located in Bream Bay in the north of the North Island (Fig. 1). Soils of this rolling and hilly area are primarily Rangiora clays, clay loams and silty clay loams, which are typically imperfectly to very poorly drained (Sutherland *et al.* 1981).

The vegetation of much of the Ruakaka area comprises improved pasture with patches of conifer-hardwood forest and scrub (Newsome 1987). The forest and scrub is mostly secondary growth induced by human disturbance. Common canopy and emergent trees are pokaka (*Elaeocarpus hookerianus*), towai (*Weinmania silvicola*), *Nestegis* spp., matai (*Prumnopitys taxifolia*), miro (*P. ferruginea*), rewarewa (*Knightia excelsa*), rimu (*Dacrydium cupressinum*), tawa (*Beilschmiedia tawa*), totara (*Podocarpus totara*) and kauri (*Agathis australis*). Sub-canopy and understorey shrubs and trees include species of *Coprosma, Pittosporum* and *Pseudopanax,* mahoe (*Melicytus ramiflorus*) and ground ferns. Manuka (*Leptospermum scoparium*) may be present on poorer soils.

The study area is a small valley about 4 km inland, west of the mouth of the Ruakaka River (Fig. 2). The valley is about 200 m long and 250 m wide, and branches off the much larger Waiwarawara Stream system (the Waiwarawara Stream joins the Ruakaka River). The sampling site, an artefact find-spot (N24/581, Best 2000; New Zealand Map Series 260 E263825 N658715), is in the small stream, a side arm of the Waiwarawara, that runs through the valley (Fig. 3). Much of the valley is in pasture. The tops and sides of the low hills on either side of the valley have some secondary forest and scrub, with abundant kanuka (*Kunzea ericoides*), manuka and totara.

Archaeologically, the Ruakaka area is under-researched. The few studies include a geological survey that recorded some inland *pā* (Ferrar and Cropp 1934), a coastal archaeological survey (Best 1996), and the aforementioned archaeological surveys (Nevin 1986, 1988; Maingay 1988) and excavation (Best 2000). Apart from the artefact find-spot

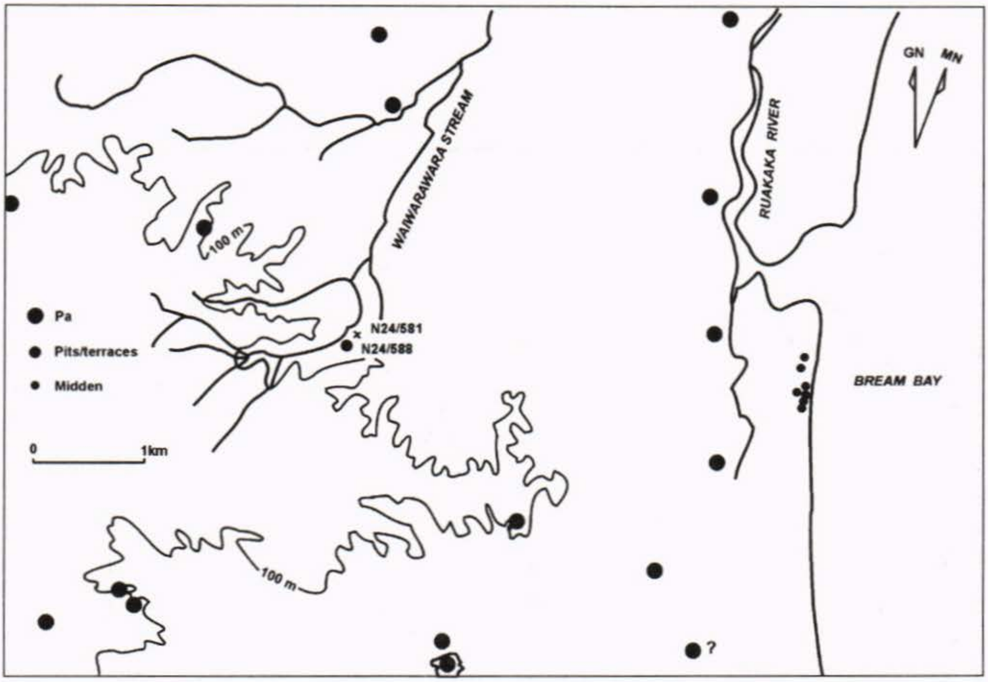

Figure 2: Map of Ruakaka area showing waterways, the 100 m contour and locations of recorded archaeological sites (from Best 2000, based on Ferrar and Cropp 1934 and New Zealand Historic Places Trust).

(N24/581, Best 2000), there is only one other recorded archaeological site in the immediate vicinity of the study catchment. This is a pit/terrace/midden complex (N24/588, Nevin 1986) on the end of a small spur about 75 m upslope to the south-west of the find-spot.

THE ARTEFACTS

The artefacts found buried in the stream sediments in the early 1980s are five well preserved wooden Polynesian gardening tools (Fig. 4). They were found during a clean out of the watercourse by mechanical digger. They are pointed and paddle-shaped, 50–100 cm in length and can be classified as *ketu*, also known as *pinaki*, *wauwau* or *kāheru* (Best 1925). These are for light and delicate gardening work, as indicated by their small size and pointed shape. The two tasks ascribed to this type of tool by Best (1925) are weeding and lifting crops such as kumara.

METHODS

The excavation, mapping, stratigraphy and sedimentology were carried out by S.B.B., and the palynology by M.B. and M.H. Rod Wallace (University of Auckland) identified wood

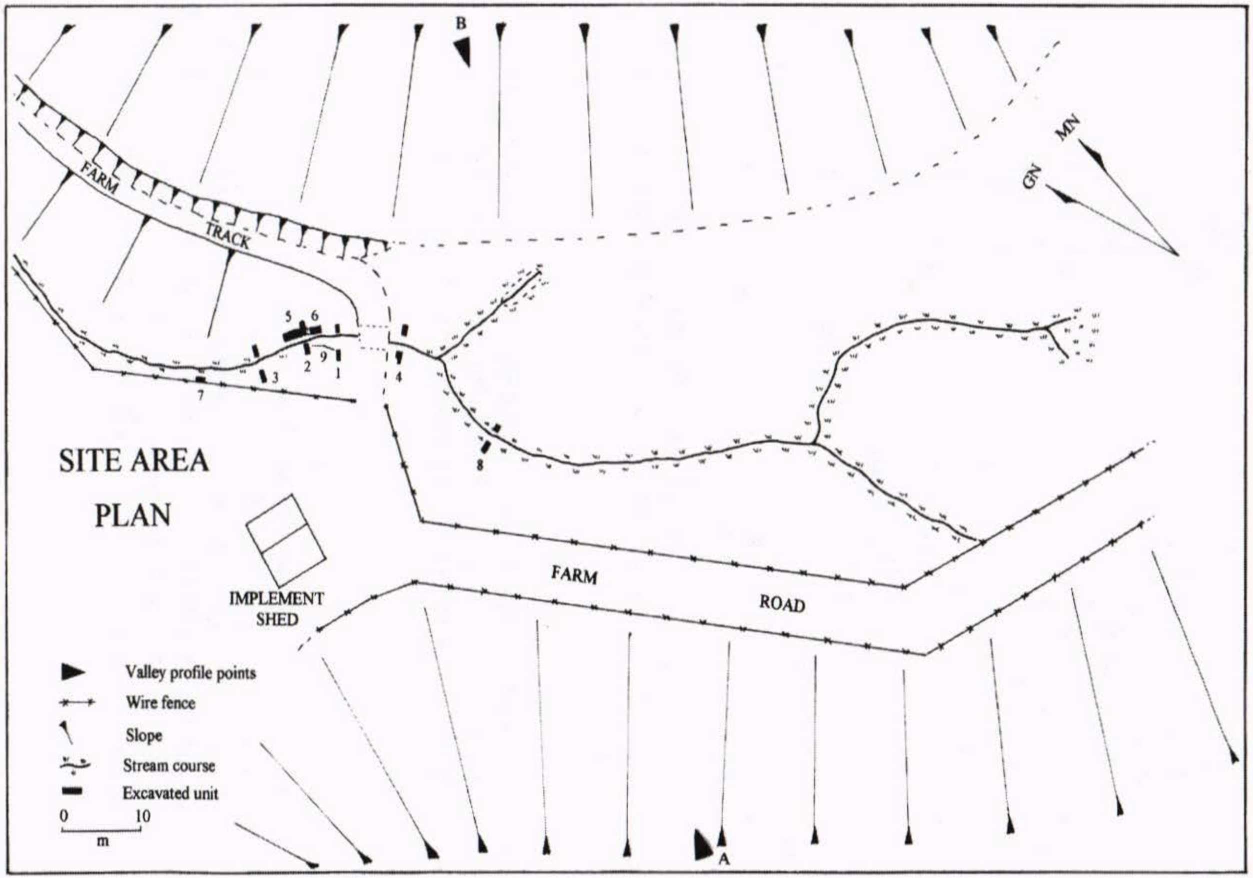

Figure 3: Site plan of the valley (from Best 2000).

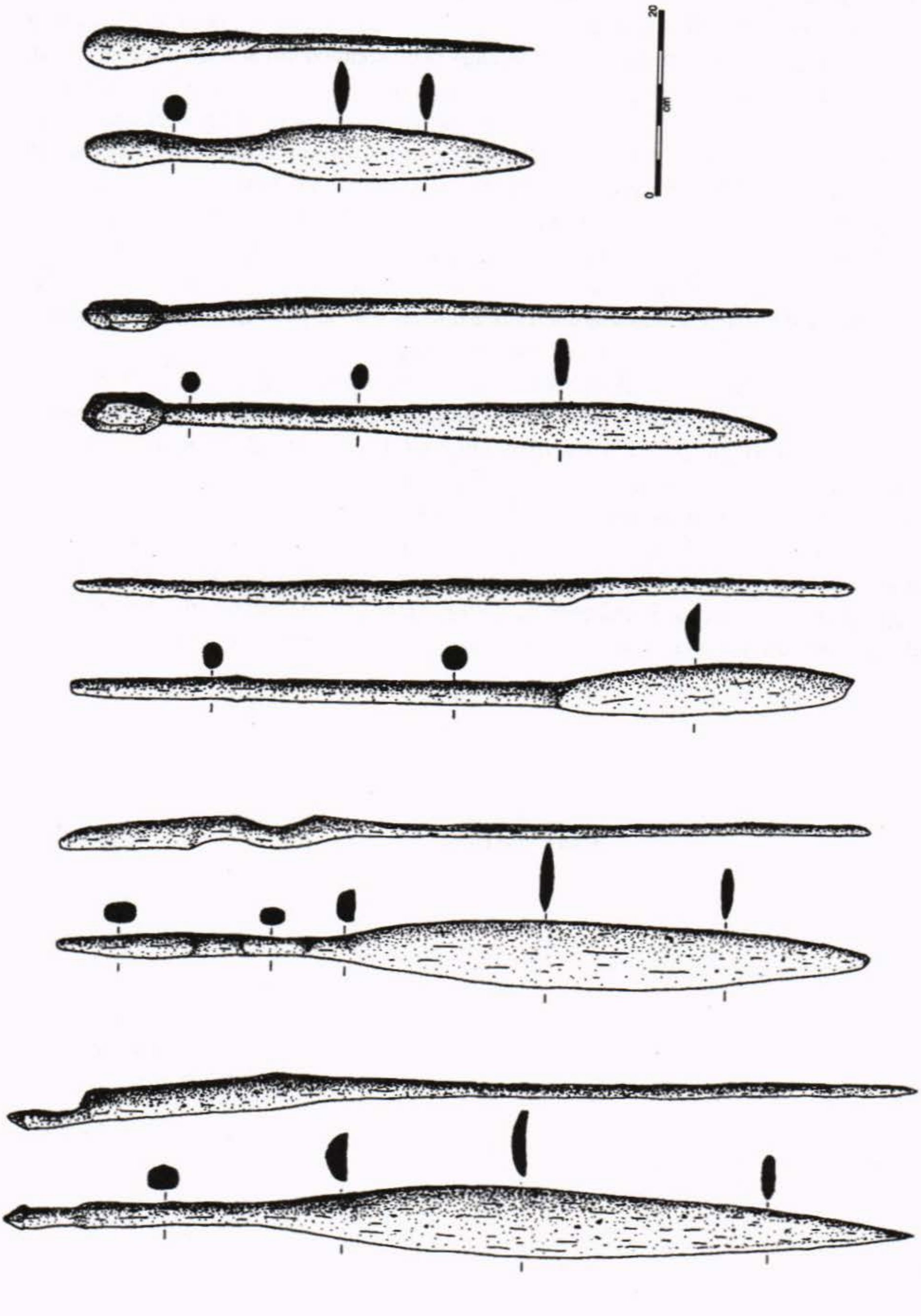

Figure 4: Gardening tools found in the stream bed in the early 1980s (from Best 2000).

samples (Wallace 2000) and Rhys Gardiner (Auckland War Memorial Museum) identified samples of seeds and leaves.

The excavation, carried out in October 1999, consisted of five trenches sited across the watercourse (Trenches 1, 2, 3, 4 and 8) and another three on the banks parallel to the stream (Trenches 5, 6 and 7) (Figs 5–10). The central part of each of the cross trenches, where the stream was running, was left to contain the water. It was considered unlikely that this area was archaeologically important since it had already been cleaned out at least once. A length of the south bank, in the vicinity of the artefact find-spot, was also cleared and examined (Unit 9). The excavations were spaced along an approximately 40 m length of the stream (Fig. 3). All stratigraphy was recorded and sampled, and sediments were described using the Munsell Chart. Plans of the excavation and the catchment were made, and a profile was taken across the valley at the eastern end of the site. After completion of the above, a mechanical digger was used to take out the stream bed over a 14 m long stretch immediately downstream of the culvert, the area tested by Trenches 1, 2, 3, 5 and 6, and to spread the spoil along the banks where it was searched for artefacts. The upper 5 m of a small side arm immediately upstream of the culvert was similarly tested.

A 1.5 m sediment column was taken from Trench 3 for pollen analysis using a metal box section 4.5 x 5 cm in size. Starting from 10 cm depth, the column was sub-sampled every 10 cm. Samples were prepared for pollen analysis by the standard acetylation and hydrofluoric acid method (Moore *et al.* 1991). The samples from 60, 140 and 150 cm depth contained insufficient pollen for analysis. The pollen sum in New Zealand palynological studies is usually at least 250 grains, excluding swamp plants and ferns (except bracken [*Pteridium*], which may form a dominant vegetation cover [McGlone 1982, 1983, 1989]). Swamp plants and ferns are excluded because their generally local pollen and spore dispersal can blur regional pollen signals. However, as we are primarily interested in local signals for

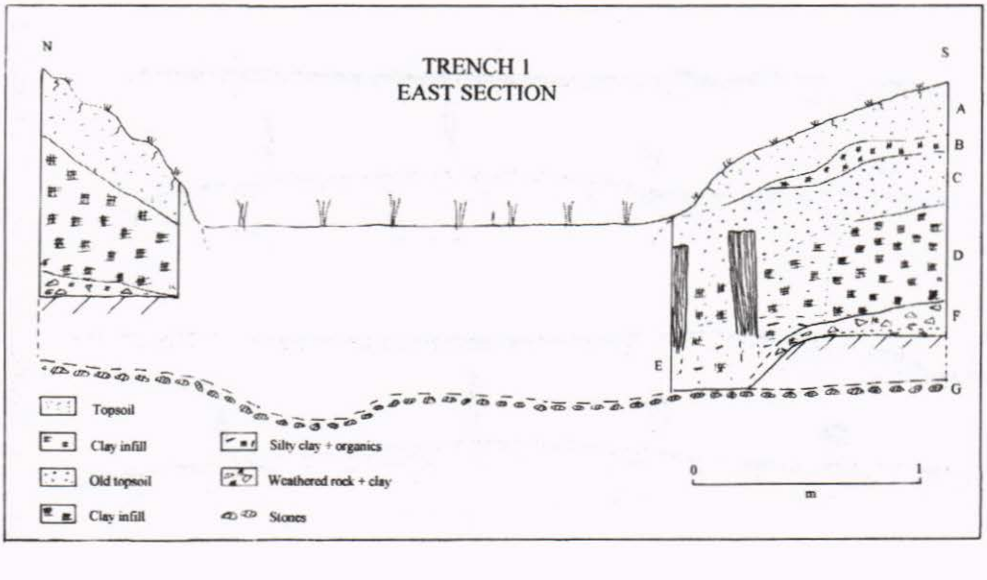

Figure 5: The east section of Trench 1 (from Best 2000).

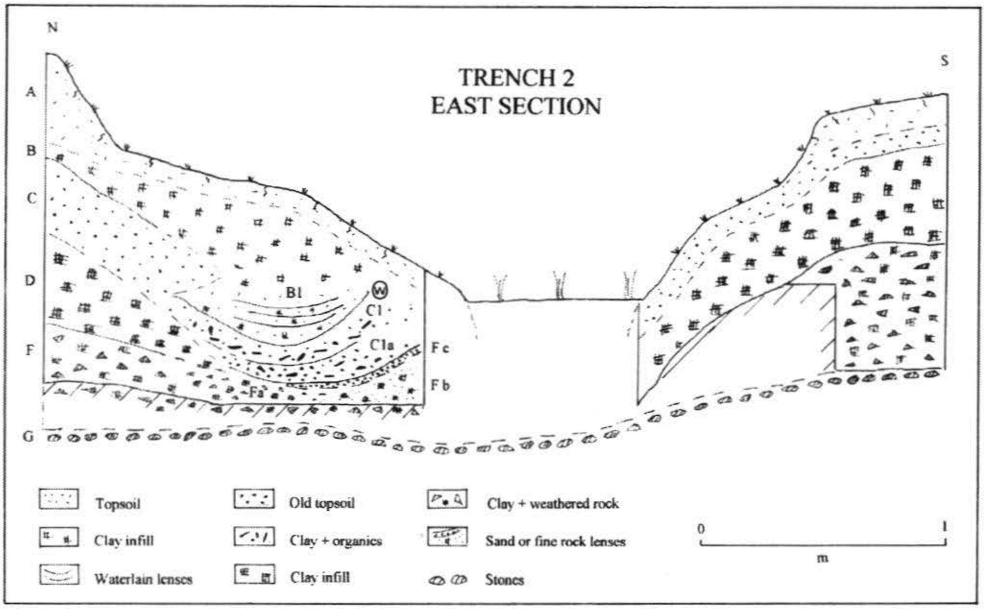

Figure 6: The east section of Trench 2, w = wood (from Best 2000).

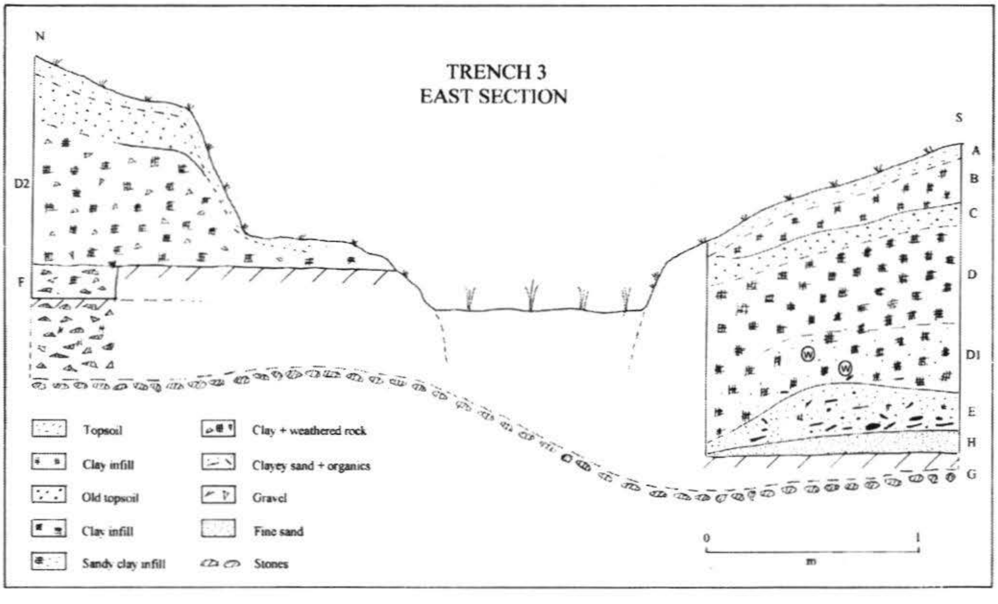

Figure 7: The east section of Trench 3, w = wood (from Best 2000).

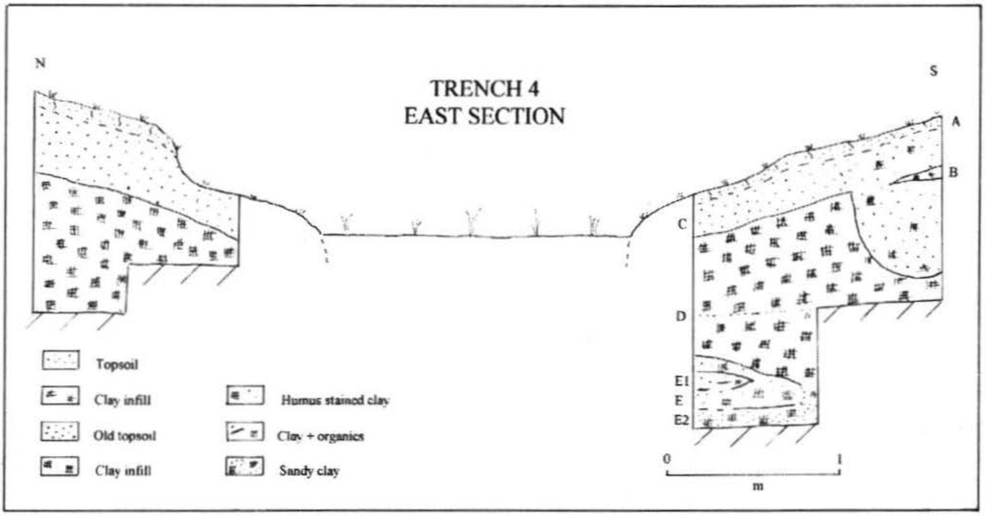

Figure 8: The east section of Trench 4 (from Best 2000).

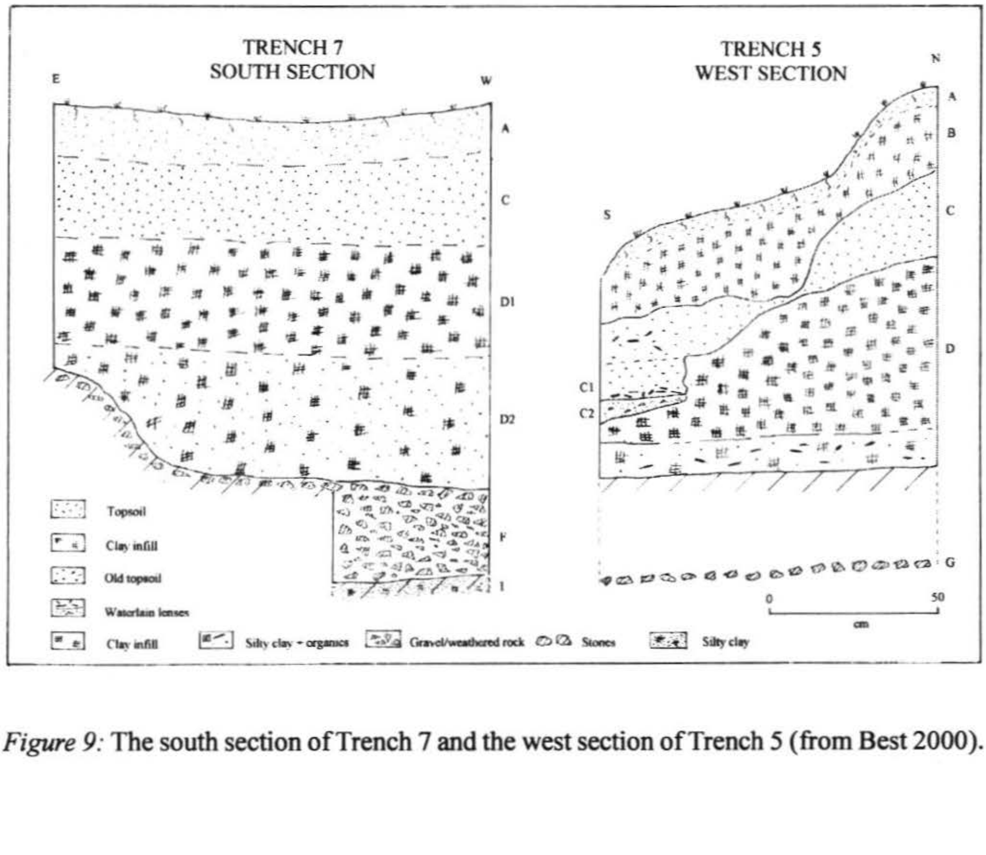

Figure 9: The south section of Trench 7 and the west section of Trench 5 (from Best 2000).

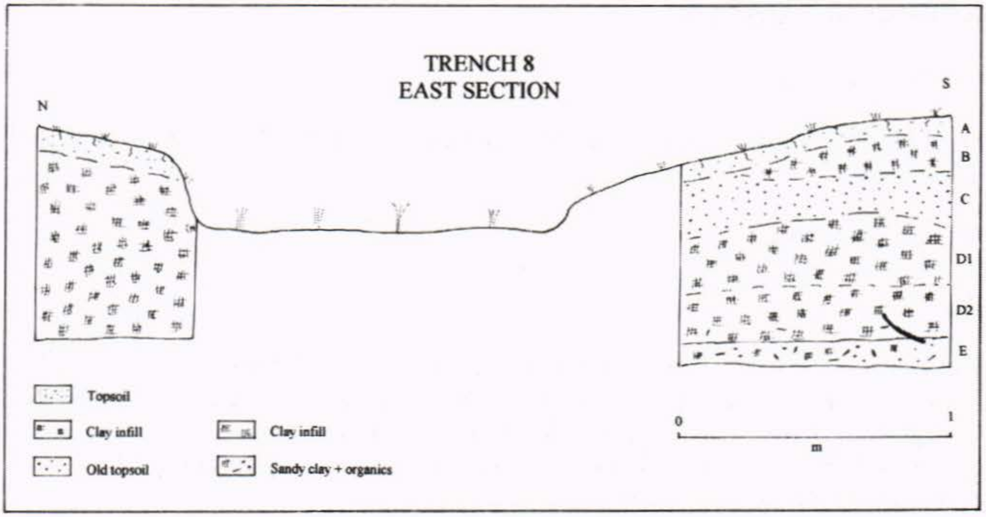

Figure 10: The east section of Trench 8 (from Best 2000).

this study, we included all taxa in the pollen sum. This is at least 270 pollen and spores except the sample from 50 cm depth (216 pollen and spores) which contained relatively little pollen. After the initial count, slides were scanned and taxa not encountered during the count were noted.

Abundance of charcoal was estimated microscopically using the pollen slides. Graticule points were used to record 'hits' of charcoal fragments (Clark 1982), and estimates are expressed as a percentage of the pollen sum. As sediment samples were sieved with a 130 μm sieve prior to analysis, larger fragments of charcoal were not included. The software packages TILIA.2 and TILIAGRAPH.2 were used to construct the pollen diagram (E. Grimm, Illinois State Museum, Springfield, Illinois). Three radiocarbon age determinations were carried out by the University of Waikato, Hamilton (Table 1).

TABLE 1

Radiocarbon dates from Ruakaka

Laboratory Sample No.	**Sample Type**	**^{14}C yr BP**	**1 sigma cal. range AD**	**2 sigma cal. range AD**	**δ^{13}C**
Wk-8270	cockle shell	560 ± 50	1670–1810 [1]	1640–1870 [1]	0.9 ± 0.2
Wk-8316	leaves/twigs	790 ± 50	1215–1281 [2]	1161–1295 [2]	-27.7 ± 0.2
Wk-8317	bark	1560 ± 60	425–596 [2]	386–639 [2]	-26.5 ± 0.2

[1] Stuiver *et al.* 1998; [2] Stuiver and Reimer 1993.

RESULTS (from Best 2000)

SEDIMENTOLOGY

Stratigraphy and sedimentology is shown in Figures 5 to 10. See Best (2000) for detailed descriptions.

PLANT REMAINS

Wood

The identification of pieces of natural wood preserved in the sediments is shown in Table 2. The assemblage in Layer E suggests a conifer-hardwood forest and the assemblage in Layer C suggests a kanuka-based low forest. The piece of exotic hardwood in Layer E can only be a root; a similar piece of wood in the same trench, about 15 cm higher in Layer D (see Fig. 7), was definitely identified as a root.

TABLE 2

Species identified from wood samples

Species	**Layer E**	**Layer C**
Bark (hardwood sp.)	2	-
Pukatea *Laurelia novae-zelandiae*	1	-
Tawa *Beilschmiedia tawa*	3	-
Rimu *Dacrydium cupressinum*	2	-
Matai *Prumnopitys taxifolia*	1	-
Flax flower stem *Phormium tenax*	1	-
Tree fern frond stem *Cyathea/Dicksonia* sp.	1	-
Tutu *Coriaria arborea*	-	2
Ironwood *Pouteria costata*	-	2
Kanuka *Kunzea ericoides*	-	15
Mahoe *Melicytus ramiflorus*	-	1
Rata/pohutukawa *Metrosideros* sp.	-	3
Exotic hardwood	2	-
Total	**13**	**23**

Seeds and leaves

The sample of seeds and leaves, well preserved, from Layer E also included twigs, grasses, moss and fragments of fern fronds (Table 3). The latter were not identified.

These provide a further five species not found in the wood identification, and again are characteristic of conifer-broadleaf forest. The hinau fruit stones were examined for evidence of rat gnawing (see Best 1992); however, none was found.

TABLE 3

Seeds and leaves from Ruakaka

Seeds	nikau (*Rhopalostylis sapida*) or supplejack (*Ripogonum scandens*)
Fruit stones	hinau (*Elaeocarpus dentatus*) maire (*Mida salicifola*) matai (*Prumnopitys taxifolia*)
Leaves	rimu (*Dacrydium cupressinum*) or possibly kahikatea (*Dacrycarpus dacrydioides*) rewarewa (*Knightia excelsa*) towai (*Weinmannia silvicola*) ?tawa (*Beilschmiedia tawa*) ?lily (*Collospermum hastatum*)

Pollen (Fig. 11)

132–115 cm, ca. 850 ^{14}C yr BP to 700–550 ^{14}C yr BP, pre-impact. The boundary dates of this zone are extrapolated from the age determination of 790 ± 50 ^{14}C yr BP of leaves and seeds from 130–120 cm depth in the same trench (Trench 3). This pollen zone corresponds with Sediment Layer E and the lower part of Layer D1. Forest taxa, especially beech *(Fuscospora)* and *Cyathea* tree fern type, dominate the pollen assemblages in the two samples representing the zone. The forest taxa kauri, rata (*Metrosideros*) and *Ascarina* record small but significant percentages. Dryland herb and swamp taxa have low pollen values during this zone.

115–45 cm, 700–550 ^{14}C yr BP to ca. AD 1800, Polynesian. This zone corresponds with the upper part of Layer D1 and most of Layer D. Pollen and spores of the disturbance indicators *Pseudopanax*, tutu (*Coriaria*), *Taraxacum* type and especially bracken increase during this zone, at the expense of pollen and spores of the forest taxa rimu, kauri, rata, *Ascarina* and *Cyathea* type tree fern. This coincides with an increase in microscopic charcoal fragments. Swamp taxa continue to record low values, although raupo (*Typha*) pollen is recorded for the first time at the upper zone boundary.

45–0 cm, post ca. AD 1800, European. This zone corresponds with the upper part of Layer D1, and all of Layers C, B and A. Pollen values for grasses (Poaceae) and manuka/kanuka increase during this zone, and those for bracken spores decline. Values for the swamp taxa sedges (Cyperaceae), *Myriophyllum* and raupo (*Typha*) increase. Exotic pollen of pine (*Pinus*) and *Plantago lanceolata* are recorded during this zone.

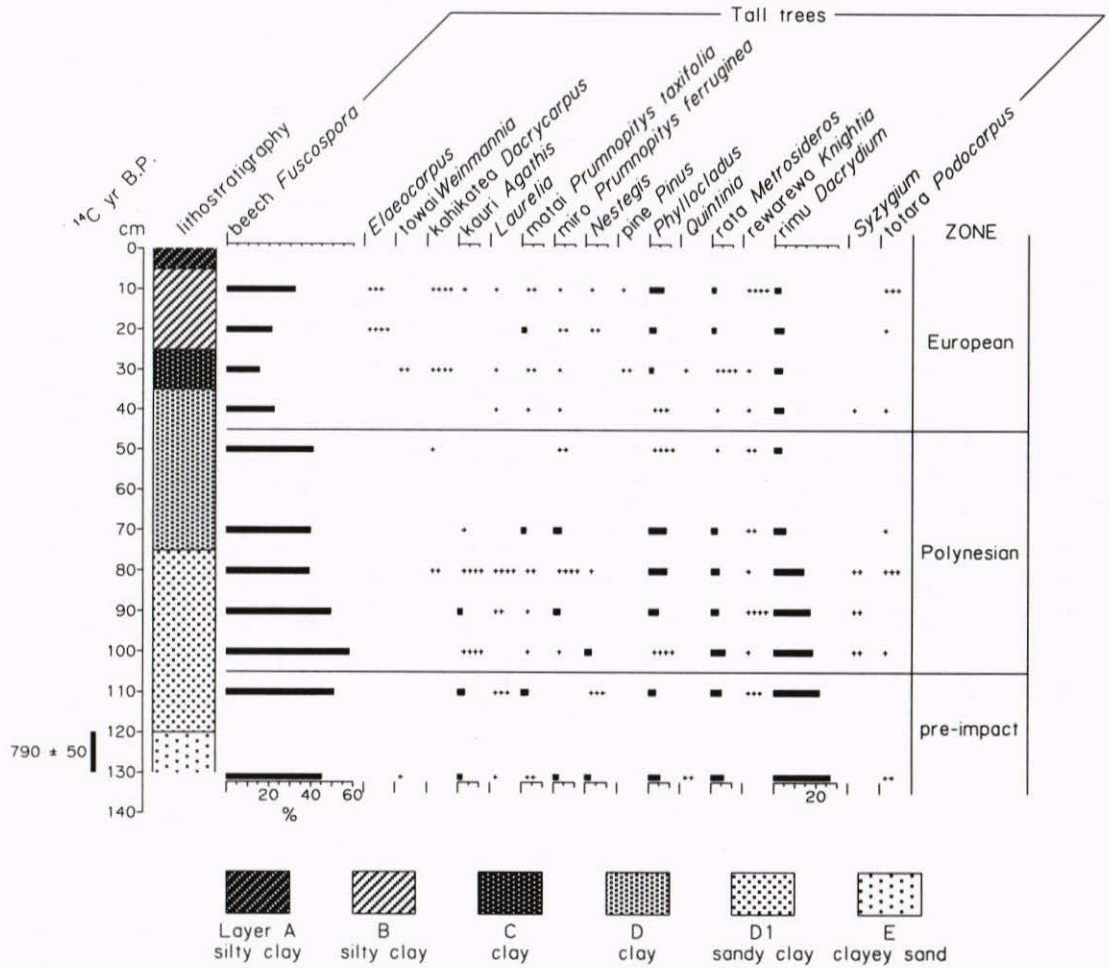

Figure 11: Pollen diagram from Ruakaka, northern New Zealand (after Best 2000) (first part).

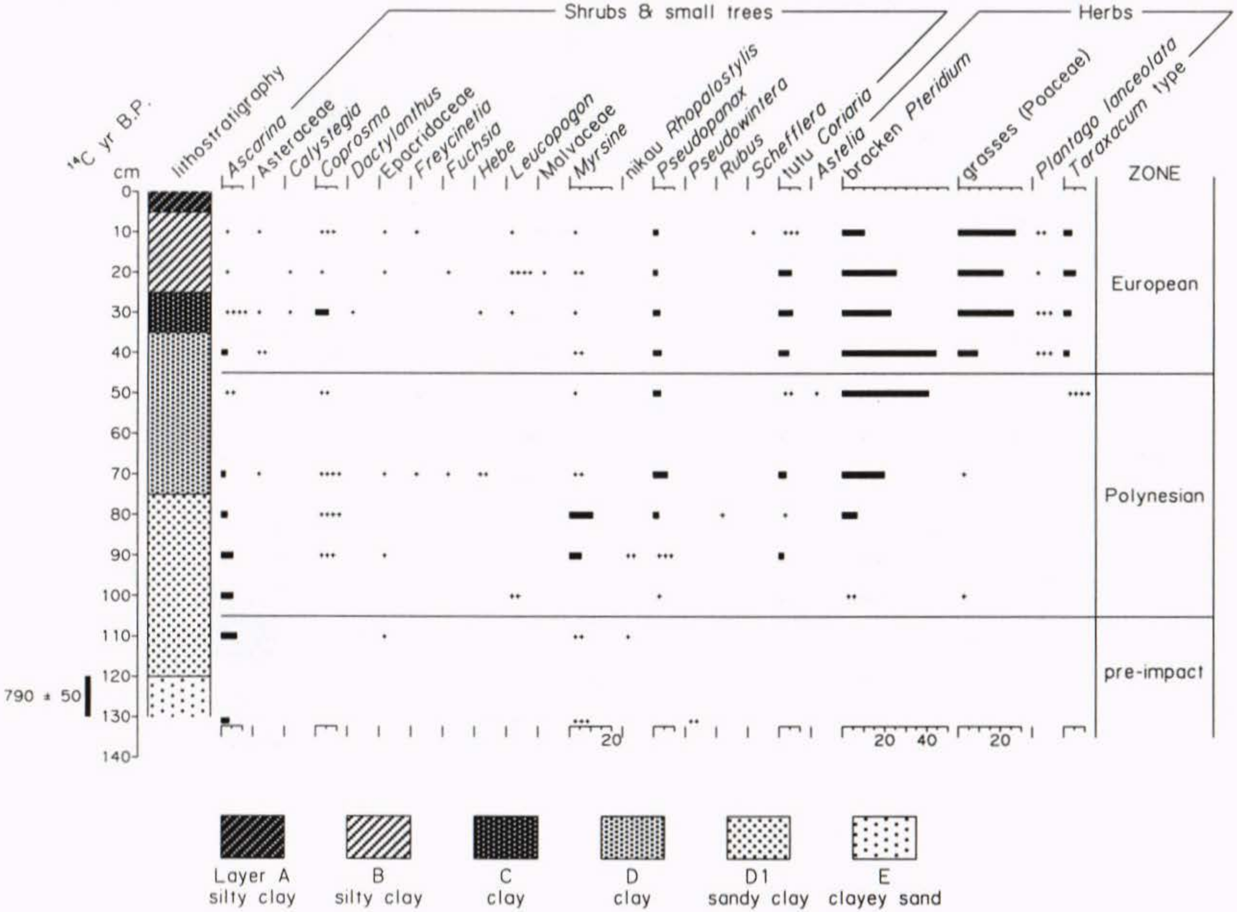

Figure 11 continued.

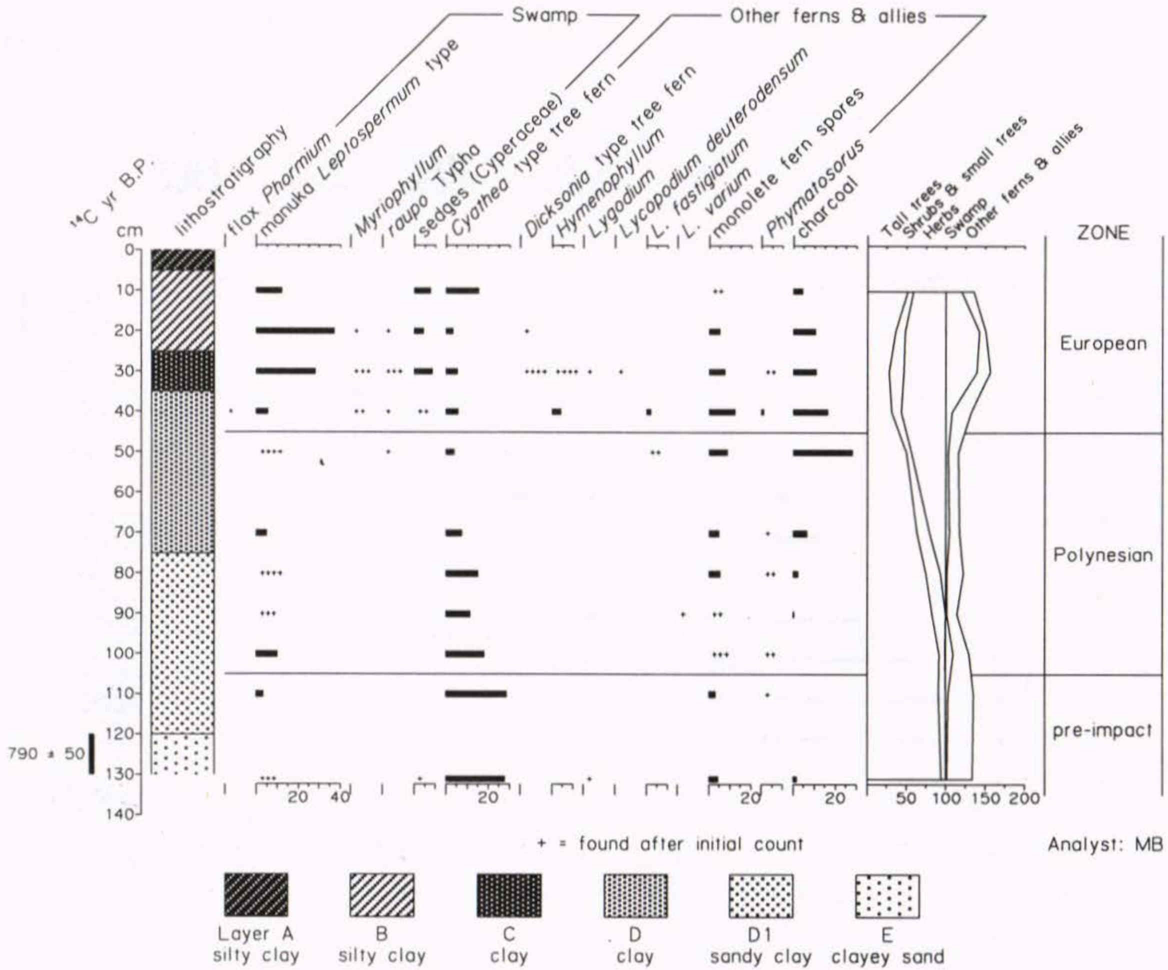

Figure 11 continued.

OTHER ARTEFACTS

Several pieces of wood with metal cut marks were found during the excavation, all except one in the old stream channel (Layer C1) exposed in Trenches 2, 5 and 6. The other was found during the machine excavation on the arm of the stream immediately up from the culvert. One of these pieces of wood can be seen in Figure 6. See Best (2000) for detailed descriptions.

DISCUSSION

THE HISTORY OF THE CATCHMENT

The stratigraphic and sedimentological evidence from the excavation units shows a high degree of similarity, with most of the same sediment layers present in all units, allowing a reconstruction of the formation of the valley. The deep fill of the valley may consist of several metres of clay, as found at the base of Trench 7 (Fig. 9). At some undetermined time a layer of stones formed on top of this, in the base of the watercourse, which was then at least 4 m wide. The depth of this basal clay deposit is not clear, neither is its relation to the overlying stony gravel — they may be part of the same deposition process. In any case this must have been a major event or process involving slip erosion.

Lying on top of the stones is a clayey sand (Layer E), which in Trenches 3 and 8, and to a lesser extent Trench 2, occurs on the outside of the bends of the stream and is deeper than the equivalent material across the stream. The lower organic deposits occur in this material. This layer follows the original stony riverbed and belongs to a much wider watercourse than is present now.

Layer E appears to pre-date human impact in the area. This is indicated by the mainly sandy (i.e., low clay and silt) component of this layer, and also the high values of pollen of forest taxa coinciding with low values of charcoal and pollen indicators of disturbance. The clean sand lens immediately below Layer E in Trench 3 (Fig. 7), with its fine graded clear grains (Layer H), indicates a stable, low energy environment at that time. The slope of the watercourse appears to have altered, with a slower running stream in which organic material was preserved. Leaves and twigs from 130–120 cm in this layer provide a minimum date of 790 ± 50 ^{14}C yr BP. However, the date of bark fragments of 1560 ± 60 ^{14}C yr BP from 95–85 cm depth in Trench 8 (30 m distant) may push the start of this period back at least another 500 years or so. These fragments would not have an inbuilt age factor of more than about 50 years (Rod Wallace, pers. comm.). The lower organic layer may thus have accumulated over several centuries or millennia during a period of environmental stability that enabled organic material to be preserved and extremely well sorted sand lenses to be laid down.

The botanical evidence indicates that tall, dense conifer-hardwood forest covered the valley floor and surrounding slopes during this stable period. The pollen data suggest that the forest canopy was dominated by rimu trees, and also comprised some rata and kauri. Small trees of *Ascarina* and especially *Cyathea* tree ferns comprised a major part of the understorey. The assemblages of wood, seeds and leaves (Table 2) also suggest conifer-hardwood forest, providing evidence for the local presence of two more taxa: tawa (rare in fossil pollen assemblages due to very low pollen production [McGlone 1988]) and towai (which has local pollen dispersal). Although beech macrofossils were not found in the organic layer, high pollen values for this taxon suggest that beech was growing in the area, if not the valley, at the time. Although beech pollen is produced and wind-transported long distances in abundance, a recent modern pollen study (Elliot 1999) suggested that pollen values for beech >5% in Northland spectra may indicate local presence. This forest is nonetheless similar to that of the last *ca.* 6500 years as recorded in the pollen core from McEwan's Bog (Kershaw and Strickland 1988) 5 km to the northeast, except that the McEwan's Bog area appears to have had a higher component of totara trees. In contrast, pollen records from Hikurangi (15 km north of Whangarei) (Newnham 1992) and in the Bay of Islands area (Elliot *et al.* 1997, 1998) show that beech forest was negligible in those areas for the last *ca.* 5000 years. Low values for pollen types of swamp taxa in our profile indicate that swampy conditions had not yet developed at the site.

The change from predominantly sandy to predominantly clayey sediments above Layer E indicates a dramatic change in the local disturbance regime. The deep deposit of mottled or streaked clay, up to about 1 m in depth, with a weathered rock content usually in the lower part, shows that this disturbance was related to a sudden and prolonged increase in sheet erosion, with some gullying. The movement of particles of soil downhill is a natural process and is dependent on the steepness of the slope, frequency of rain and especially vegetation cover (Dimbleby 1985). When this cover is disturbed, and especially if the humic surface horizon of the soil is broken, the effect of rainfall on soil movement is greatly increased. Although gullying may occur, more typically there is mass movement of the upper layers of the soil downhill, known as sheet or accelerated erosion. This process narrowed the bed of the stream in the study catchment considerably, from over 4 m wide to its present width of about 1 m.

The plant remains preserved in the sediments provide evidence for a cause of this erosion in the valley and for when it occurred. Declining values for pollen of forest taxa, especially rimu, and coinciding increases in pollen and spores of disturbance indicators, especially bracken, during the period covered by the middle pollen zone (estimated 700–550 ^{14}C yr BP to *ca.* AD 1800) indicate forest decline. The assemblages of wood from layer C (Table 2) also suggest forest disturbance, especially with regard to the shade intolerant kanuka and tutu.

The increase in fragments of microscopic charcoal at the same time as the evidence for forest decline indicates that this disturbance was related to fire. However, on the basis of the charcoal evidence alone (macroscopic charcoal was not found) we do not know whether the microscopic charcoal in our pollen samples is from local or distal fires. While macroscopic pieces of charcoal are clearly of local origin, studies indicate that areas of source for microscopic, "pollen-slide charcoal" (Clark 1988a) are sub-continental to global and that diagrams of such charcoal are biased toward non-local charcoal (e.g., Clark 1988a, 1988b; Clark and Royall 1995; Carcaillet *et al.* 2001). Carcaillet *et al.* (2001) found that the critical size to exclude long-distance charcoal fragments varies between studies from 80–200 µm. As charcoal size in our study is <130 µm, we cannot exclude the long-distance possibility. However, the dramatic nature of the change in the sedimentological regime, coupled with the appearance of locally dispersed pollen types (e.g., tutu and *Pseudopanax*), provides compelling evidence for fires within the catchment. Local pollen dispersers are typically animal-pollinated plants that, unlike wind-pollinated plants, produce small amounts of pollen that are deposited mostly within a few metres of parent plants. The sustained nature of this fire disturbance, that is, the occurrence of repeated forest fires, very strongly suggests that it was anthropogenic (McGlone 1983, 1989; Ogden *et al.* 1998). The sheet erosion in the catchment was thus most likely a result of anthropogenic deforestation. The apparent absence of exotic European pollen types in Layer D shows that the people responsible would have been prehistoric Polynesian settlers, rather than subsequent Europeans. These lines of evidence agree with most pollen records from elsewhere in northern New Zealand (e.g., Elliot *et al.* 1997; Newnham *et al.* 1998; Horrocks *et al.* 2001). These records show that widespread, large-scale deforestation by Polynesians in the region occurred at the earliest around the time of deposition of the 665 ± 15 ^{14}C yr BP (Lowe *et al.* 1998) Kaharoa tephra (not noted in our profile). However, a Bay of Islands pollen study (Elliot *et al.* 1998) reported a date of *ca.* 1000 ^{14}C yr BP for deforestation.

Although the pollen core from McEwan's Bog in northern Ruakaka (Kershaw and Strickland 1988) shows a similar increase to our profile in microscopic charcoal during the Late Holocene, apart from a decrease in kauri pollen it does not show associated forest decline to the same degree. This may in part be due to 'patchy' deforestation, that is, fires occurring at different places and times within relatively small areas. This has been recorded in pollen studies of the eastern coast of Great Barrier Island in the Hauraki Gulf (Horrocks *et al.* 2001). This may also in part be due to the younger portion of the McEwan's Bog sequence being too condensed and/or having been mixed by European farming activities. For the same latter reason, the timing of the increase in charcoal in the McEwan's Bog profile is uncertain.

The humus-stained Layer C appears to be the A horizon of the deposit resulting from the sheet erosion outlined above. Thus, layers D and C represent a buried palaeosol. The formation of this A horizon reflects the eventual abatement of large-scale disturbance in the catchment. Pollen records from elsewhere in the North Island (e.g., Wilmshurst 1997; Horrocks *et al.* 1999) suggest relatively lower rates of Polynesian-induced erosion in pre-European times as bracken fern and other plants that colonise new surfaces became established (and were maintained by repeated burning) after initial forest destruction. However, the presence of the widely dispersed exotic European pollen types pine and *Plantago lanceolata* in, and 5 cm below, this buried A horizon suggests that this relative environmental stability did not occur until European times, that is, after *ca.* AD 1800. Maritime pine (*Pinus pinaster*), the most likely source of this pollen type since it was probably the first conifer to be introduced to New Zealand, was successfully naturalised in the northern North Island by AD 1830 (Webb *et al.* 1988). The major increase in grass pollen occurring around the same depth in the profile indicates the establishment of pasture in the area also in European times, which appears to have thus stabilised previously eroding soils on hill slopes surrounding the site. Although forest cover reduces sheet erosion to the minimum, even a grass sward exerts effective control (Dimbleby 1985).

The fairly weak topsoil formation of the clay surface layer (Layers A and B, present only in places) suggests that it was deposited during the twentieth century, possibly within the latter half. It is probably the result of hill slope disturbance related to European farming or logging and/or a storm.

The pollen evidence shows that swamp conditions along the edge of the local stream, characterised mainly by sedge vegetation with possibly some manuka, did not establish until the early European period. Raupo may have comprised a minor part of this vegetation (although this particular pollen may have been wind-transported from an adjacent catchment). The presence of *Myriophyllum* (an aquatic) pollen indicates that the water level of the stream was frequently at least about 0.5 m in depth.

POLYNESIAN ACTIVITY IN THE REGION

The large scale of the human impact signals in the Ruakaka profile, in particular the dramatic increase in the local rate of erosion, might indicate a significant Maori presence at the time with the area well settled by a substantial population. However, large populations of people may not necessarily be a pre-requisite for large-scale deforestation (and subsequent large-scale erosion) because small numbers of people with fire technologies might be just as capable of destroying large areas of forest (McGlone *et al.* 1994).

Although the Ruakaka pollen profile does not encompass more than the last 850 years or so, the possibility of the presence of people in the area, invisible in the palaeoenvironmental record, before our estimated date of *ca.* 700–550 ^{14}C yr BP for initial human impact (cf. Holdaway 1996) cannot be ruled out. We thus use the term 'pre-impact' rather than 'pre-human' for that part of our pollen record prior to the estimated date of 700–550 ^{14}C yr BP.

The cache of gardening implements found at the site provides direct evidence for Polynesian gardening in the area. However, the stratigraphic context of the cache will never be known because the cleanout of the stream that removed them also removed their context. It seems highly unlikely that the tools belong to the pre-impact period, since this would presumably have put them in the middle of a stream at least 4 m wide, lying flat in a layer not much thicker than the tools themselves. In addition, none of the wood found in this layer was as well preserved as the tools. They could have been buried in the clay deposits laid down during the Polynesian period. However, the apparent paucity of other organic material in this layer suggests that preservation of such material laid down with it was poor. The most logical explanation is that the tools were cached in the banks or base of the stream, most probably towards the end of the Polynesian period or during the start of the European period.

The relationship between the artefacts found in this excavation, the pieces of wood with metal cut marks, and the cache of Polynesian tools is unclear. Their location in an old infilled stream channel (Layer C1) means that they could have been swept downstream. These artefacts may be Polynesian or European.

Although the archaeology of the Ruakaka area is under-researched, the few previous studies give an idea of the type and distribution of other archaeological sites in the region, allowing our site to be put into a regional context. Starting from the coast, a band of undated shell middens exists along at least part of the back dunes (Best 1996) (Fig. 2). A line of undated *pā* runs along the inland side of the Ruakaka River, in the start of the foothills at about the 30–50 m contour, and on the banks of the river itself. All *pā* inland of this line, likewise undated, are at about the 100 m contour (Ferrar and Cropp 1934). In a comparable situation on the north side of the Ruakaka River, again at about the 100 m contour, a total of 10 sites are recorded in Topomap Q07 along a 6 km length of hills overlooking the river. Although marked as *pā*, most are probably pit/terrace complexes (Best 2000). The excavated site fits in the first order with the adjacent *pā* and pit/terrace settlements overlooking the valley. The presence of more *pā* on the higher ridges of our valley might be inferred from the situation both to the north and south. The valley is only 3 km from the line of *pā* on the coast, and if of the same age would have been part of their sphere of influence.

The earliest direct evidence of the presence of people in the valley is a radiocarbon date of 560 ± 50 ^{14}C yr BP (Wk8270) of cockle shells from the pit/terrace/midden complex (N24/588) on a spur end a few score metres from the site. However, the calibrated age range (2 sigma, AD 1640–1870) well overlaps European arrival in the area. Nonetheless, on the basis of archaeological studies from elsewhere in New Zealand it is not unreasonable to assume 400–500 years of human activity inland from the coast in the Ruakaka area. The gardening tools and the pit/midden/terrace complex in our valley appear to be from the later part of this period. When missionaries tried to establish a base in the Bream Bay-Whangarei area in 1823 they found the area "depopulated thru war, with many fled into the interior of the country for protection" (from William Hall's journal, quoted in Richards 1984). It is possible that the site was part of this inland movement.

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REFERENCES

Best, S.B. 1992. *The Queen Street Gaol. Auckland's first courthouse, common gaol and house of correction (Site R11/1559).* Final archaeological report. Auckland Conservancy Historic Resource Series No. 2, Department of Conservation, Auckland Conservancy.

Best, S.B. 1996. *Paradise Shores Resort Ltd. Proposed subdivision at Ruakaka.* Initial Archaeological Survey. Report for Reyburn and Bryant, Whangarei.

Best, S.B. 2000. *The Prescott's Dam Site, Ruakaka, Site N24/581: archaeological excavation of artefact findspot.* Report for Whangarei District Council.

Best, E. 1925. *Maori agriculture.* Dominion Museum Bulletin 9, Wellington.

Carcaillet, C., Bouvier, M., Frechette, B., Larouche, A .C. and Richard, P.J.H. 2001. Comparison of pollen-slide and sieving methods in lacustrine charcoal analyses for local and regional fire history. *The Holocene* 11: 467–476.

Clark, J.S. 1988a. Particle motion and the theory of charcoal analysis: source area, transport, deposition, and sampling. *Quaternary Research* 30: 67–80.

Clark, J.S. 1988b. Stratigraphic charcoal analysis on petrographic thin sections, application to fire history in northwestern Minnesota. *Quaternary Research* 30: 81–91.

Clark, J.S. and Royall, P.D. 1995. Particle-size evidence for source areas of charcoal accumulation in Late Holocene sediments of eastern North American lakes. *Quaternary Research* 43: 80–89.

Clark, R.L. 1982. Point count estimation of charcoal in pollen preparations and thin sections of sediments. *Pollen et Spores* 24: 523–525.

Dimbleby, G. W. 1985. *The palynology of archaeological sites.* Academic Press, London.

Elliot, M.B. 1999. Modern pollen–vegetation relationships in Northland, New Zealand. *New Zealand Journal of Botany* 37: 131–148.

Elliot, M.B., Striewski, B., Flenley, J.R., Kirkman, J.H. and Sutton, D.G. 1997. A 4300 year palynological and sedimentological record of environmental change and human impact from Wharau Road Swamp, Northland, New Zealand. *Journal of the Royal Society of New Zealand* 27: 401–418.

Elliot, M.B., Flenley, J.R. and Sutton, D.G. 1998. A late Holocene pollen record of deforestation and environmental change from the Lake Tauanui catchment, Northland, New Zealand. *Journal of Paleolimnology* 19: 23–32.

Ferrar, H.T. and Cropp, W.H. 1934. Geological map of the Ruakaka Survey District. *New Zealand Geological Survey Bulletin* 34.

Holdaway, R.N. 1996. The arrival of rats in New Zealand. Scientific correspondence. *Nature* 384 (No. 6606): 225–226.

Horrocks, M., Ogden, J., Nichol, S.L., Alloway, B.V. and Sutton, D.G. 1999. The palynology and sedimentology of a coastal swamp at Awana, Great Barrier Island, New Zealand, from *ca* 7000 yr B.P. to present. *Journal of the Royal Society of New Zealand* 29: 213–233.

Horrocks, M., Deng, Y., Ogden, J., Alloway, B.V., Nichol, S.L. and Sutton, D.G. 2001. High spatial resolution of pollen and charcoal in relation to the c. 600 yr B.P. Kaharoa Tephra: implications for Polynesian settlement of Great Barrier Island, northern New Zealand. *Journal of Archaeological Science* 28: 153–168.

Kershaw, A.P. and Strickland, K.M. 1988. A Holocene pollen diagram from Northland, New Zealand. *New Zealand Journal of Botany* 26: 145–152.

Lowe, D.J., McFadgen, B.G., Higham, T.F.G., Hogg, A.G., Froggatt, P.C. and Nairn, I.A. 1998. Radiocarbon age of the late Holocene rhyolytic Kaharoa tephra, a key marker bed in New Zealand's pre-history. *The Holocene* 8: 487–495.

Maingay, J. 1988. Proposal for an archaeological excavation at site N24/581, Prescott Dam, Ruakaka. Unpublished report, Regional Archaeology Unit, Department of Conservation, Auckland.

McGlone, M.S. 1982. Modern pollen rain, Egmont National Park, New Zealand. *New Zealand Journal of Botany* 20: 253–262.

McGlone, M.S. 1983. Polynesian deforestation of New Zealand: a preliminary synthesis. *Archaeology in Oceania* 18: 1–10.

McGlone, M. S. 1988. New Zealand. *In* B. Huntley and T. Webb, (eds), *Vegetation history,* pp. 557–599. Kluwer, Dordrecht.

McGlone, M.S. 1989. The Polynesian settlement of New Zealand in relation to environmental and biotic changes. *New Zealand Journal of Ecology (Suppl.)* 12: 115–129.

McGlone, M.S., Anderson, A.J. and Holdaway, R.N. 1994. An ecological approach to the Polynesian settlement of New Zealand. *In* D. G. Sutton (ed), *The origins of the first New Zealanders,* pp. 136–163. Auckland University Press, Auckland.

Moore, P.D., Webb, J.A. and Collinson, M.E. 1991. *Pollen analysis.* 2nd edn. Blackwell Scientific, London.

Nevin, D. 1986. Ruakaka Area Water Supply; Prescott's Dam, Springfield Dam; Archaeological Site Survey. Unpublished Report for Tonkin & Taylor Ltd., Whangarei.

Nevin, G.E. 1988. Inspection of Archaeological Site N24/581 for proposed Prescott's Dam, Ruakaka. Draft Report, Regional Archaeological Unit, Science Directorate, Department of Conservation, Auckland.

Newnham, R.M. 1992. A 30,000 year pollen, vegetation and climate record from Otakairangi (Hikurangi), Northland, New Zealand. *Journal of Biogeography* 19: 541–554.

Newnham, R.M., Lowe, D.J., McGlone, M.S., Wilmshurst, J.M. and Higham, T.F.G. 1998. The Kaharoa Tephra as a critical datum for earliest human impact in northern New Zealand. *Journal of Archaeological Science* 25: 533–544.

Newsome, P.F.J. 1987. *The vegetative cover of New Zealand.* Water & Soil Miscellaneous Publication No. 112. Ministry of Works and Development, Wellington.

Ogden, J., Basher, L. and McGlone, M. 1998. Fire, forest regeneration and links with early human habitation: evidence from New Zealand. *Annals of Botany* 81: 687–696.

Richards, J. 1984. *Ruakaka. A brief history.* Ruakaka Parish Residents and Ratepayers Association.

Stuiver, M. and Reimer, P.J. 1993. University of Washington Quaternary Isotope Lab. Radiocarbon calibration program REV 3.0.3A. Mactest version #6. *Radiocarbon* 35: 215–230.

Stuiver, M., Reimer, P.J., Bard, E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, G., van der Plicht, J. and Spurk, M. 1998. INTCAL98 radiocarbon age calibration, 24,000–0 cal BP. *Radiocarbon* 40: 1041–1052.

Sutherland, C.F., Cox, J.E., Taylor, N.H. and Wright, A.C.S. 1981. *Soil map of Hukerenui-Whangarei area (sheets Q06/07, R06/07), North Island, New Zealand. Scale 1:100,000.* N.Z. Soil Bureau Map 187.

Wallace, R. 2000. Wood Identifications from Prescotts Dam, Ruakaka (N24/581). Report to Simon Best.

Webb, C.J., Sykes, W.R. and Garnock-Jones, P.J. 1988. *Flora of New Zealand Vol. IV*. Department of Scientific and Industrial Research, Christchurch.

Wilmshurst, J.M. 1997: The impact of human settlement on vegetation and soil stability in Hawke's Bay, New Zealand. *New Zealand Journal of Botany* 35: 97–111.

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