NEW ZEALAND JOURNAL OF ARCHAEOLOGY

European Perceptions of the Roles of Bracken Rhizomes (*Pteridium esculentum* (Forst. f.) Cockayne) in Traditional Maori Diet

Helen M. Leach[1]

ABSTRACT

European perceptions of the roles of bracken rhizomes (fernroot) in Maori diet were coloured from the onset by the reputation of the closely related bracken fern in Europe. The explorers offered three 'default' explanations for its use as food: as a seasonal stop-gap, rations for times of stress, and as a substitute staple wherever cultivation of crops was impossible. It was not until Europeans travelled overland with Maori guides that a few of them discovered that fernroot was the food of choice for travellers. It was light, easy to process, lasted well, and could be quickly cooked and often replenished en route. Its use in this role continued until flour was readily available.

Keywords: MAORI, DIET, *Pteridium esculentum*, BRACKEN RHIZOMES, FERNROOT, EUROPEAN EXPLORERS.

From the moment in 1769 that Europeans stepped on to the shores of Aotearoa, they began to speculate about the nature of Maori subsistence and settlement types, and to ponder the potential of the land to support European farming. The East Coast locations that Captain James Cook and his party walked over or observed from the *Endeavour* were seen through eyes accustomed to a British rural mix of fields, woods, heaths, grassy downlands, farmsteads and hamlets. The New Zealand pattern was not dissimilar. Cook climbed a hill near Tolaga Bay trying to get a better view of the interior, and wrote

> the tops and ridges of the hills are for the most part barren, at least little grows on them but fern. But, the Vallies and sides of many of the Hills were luxuriously clothed with woods and Verdure and little Plantations of the Natives lying dispers'd up and down the Country. (Cook 1968: 186)

Unlike the trees in the woods, the New Zealand fern (*Pteridium esculentum* (Forst. f.) Cockayne) was very familiar. The closely related brake or bracken (*Pteridium aquilinum* (L.) Kuhn), found throughout Europe, was a species of prehistoric pedigree whose long rhizomes invaded hill pasture, and was common in dry acid heathland (Tutin *et al.* 1993: 17) (Figs 1 to 3). Though its young fronds were occasionally eaten in spring, particularly in

[1] Anthropology Department, University of Otago, PO Box 56, Dunedin, New Zealand

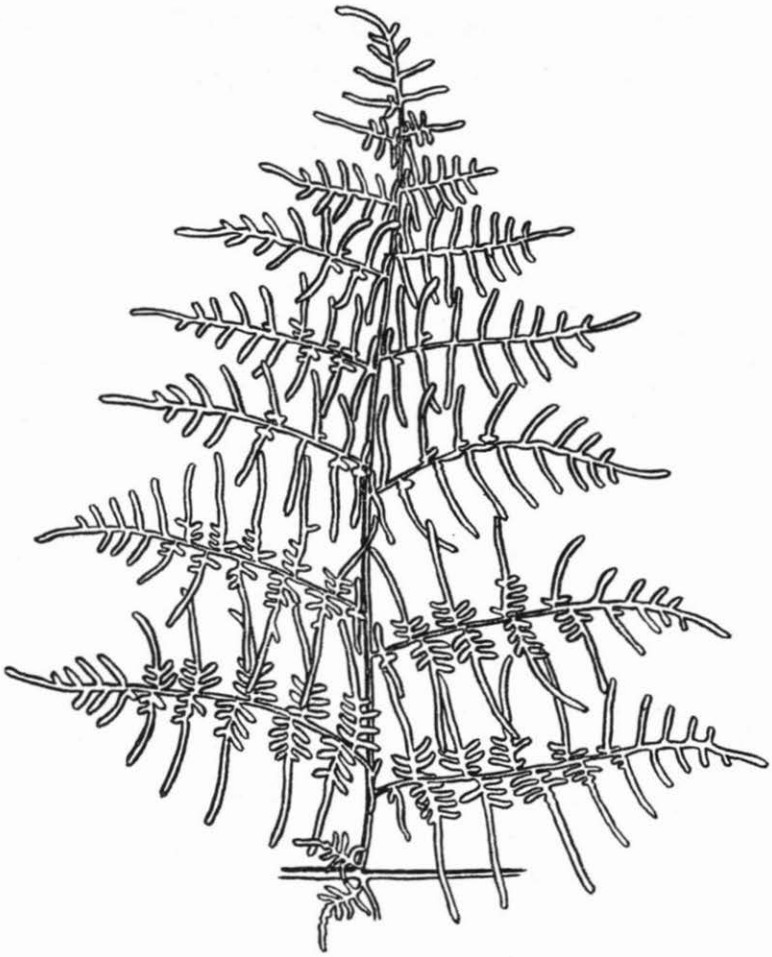

Figure 1: Frond form of *Pteridium esculentum*, the New Zealand bracken (adapted from Stevenson 1954).

times of famine or war (Banks 1980: 71; Mabey 1997: 15–17), bracken was regarded as essentially inedible, a non-food. In the late sixteenth century, the herbalist John Gerard repeated Dioscorides' report that bracken "bringeth barrennesse, especially to women; and that it causeth women to be delivered before their time" (Gerard 1975: 1130). Its value to the Elizabethans lay as a fuel, especially in treeless areas, as shelter for animals and plants in winter, and as bedding for animals in yards and stalls (Tusser 1984: 28, 37, 46, 225). These uses continued into the twentieth century. As a competitor to grass, it was traditionally mown down at midsummer to improve pasture growth (Tusser 1984: 112). Joseph Banks' view (Morrell 1958: 137), as expressed in his journal, that "in Europe no Animal, hardly even Insects will taste" it, would have been shared by his companions. It was subsequently found that stock forced to eat it during feed shortages were prone to thiamine deficiency

Figure 2: Frond and rhizome form of *Pteridium aquilinum*, the European bracken (adapted from Fitch 1916).

(seen in horses and pigs), tumours of the bladder (in cattle) and acute haemorrhagic disease (in cattle and sheep) (Cooper and Johnson 1984: 55–62). Though the aetiology of these conditions was not understood in the eighteenth century, landowners and farmers knew that animals did not thrive on bracken-infested pastures. Thus from the moment they came ashore, the European visitors had a prior classification of bracken in mind which was to colour their observations of its roles in New Zealand.

It must have come as a surprise, when they first observed Maori sitting down to a meal in the Tolaga-Anaura Bay area, to see that the rhizomes of the bracken fern were a main component. Both Banks and Monkhouse described the process of roasting and beating what they and later commentators referred to as bracken roots, or fernroot (but which were structurally rhizomes), and obviously tasted some while at Anaura Bay. To Banks, what remained after the bark and dry exterior had been knocked off,

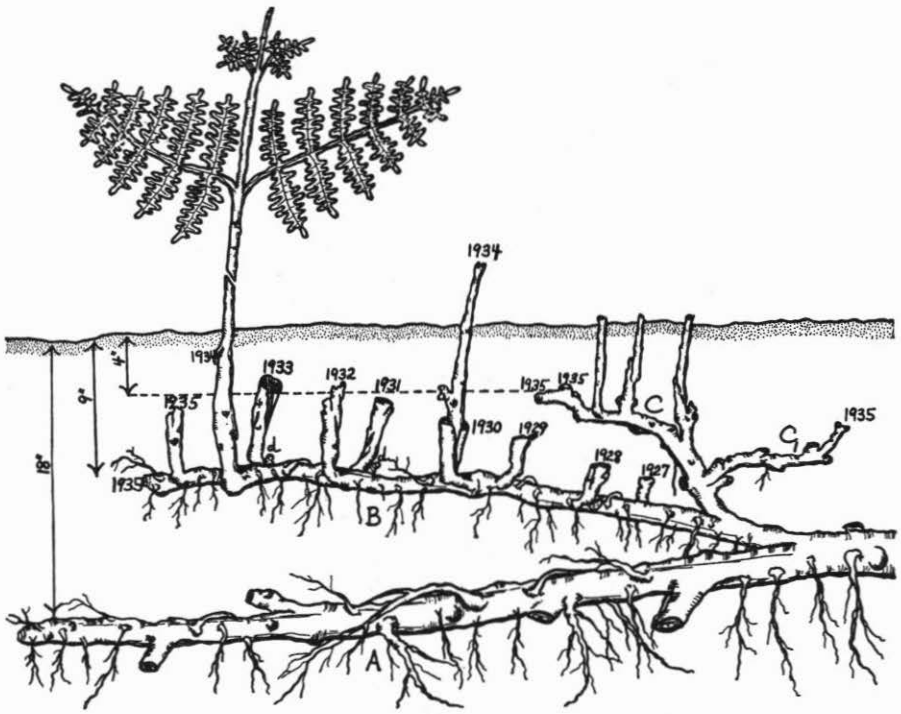

Figure 3: The underground parts of *Pteridium aquilinum* showing annual branching growth of rhizomes and their attached roots (from Robbins *et al.* 1952: Fig. 146 — redrawn from a paper by K.W. Braid).

> had a sweetish clammyness in it, not disagreable to the taste it might be esteemed a tolerable food, was it not for the quantity of strings and fibres in it which in quantity 3 or 4 times exceeded the soft part (Morrell 1958: 59).

He noted that most people spat the fibre out into a personal basket, like "chaws of Tobacco". So why was "this most homely fare" as he called it, referred to as "their principal Diet"?

Banks' answer, consistent with the 150–200 acres of cultivation seen in Anaura Bay, was that "in the proper Season they certainly have plenty of excellent vegetables" to accompany their fish (Morrell 1958: 59) but that in late October, the time of their visit, a substitute was required since the crops were still immature. This view was reiterated by Sydney Parkinson (1972: 99) who described the kumara as "young and unfit for use". This was the first explanation offered by Europeans for the consumption of what to them was an unpleasantly fibrous item: that bracken rhizomes were a **seasonal stop-gap**.

A few days later, the *Endeavour* anchored in Mercury Bay, and the Europeans encountered a group of 40–50 Maori who were living in the open at the mouth of the Purangi River. There were no signs of cultivation, the countryside produced little but fern, and the people seemed to be subsisting "wholy on shell and other Fish and Fern roots" (Cook 1968: 197). Their canoes were "mean and without ornament, and so are their houses or hutts and in general every thing they have about them", wrote Cook (1968: 203). At first Cook considered

them refugees with "no fix'd habitations", impoverished by the "frequent wars in which they are certainly ingaged" (Cook 1968: 203), but later learnt (probably from Banks) that they had pā of their own elsewhere (cf. Morrell 1958: 72). Parkinson (1972: 103) was convinced that plundering was "the principal cause of their poverty and wretchedness". Banks seems to have come closer to the truth when he wrote that the bay "may be a place to which parties of them often resort for the sake of Shellfish" and ferns, "the roots of which they had got together in large quantities as they said to carry away with them" (Morrell 1958: 70).

A visit to a burnt and abandoned pā, as well as to the Ngati Hei stronghold, Wharetaewa on the northern side of the bay, reinforced and led to the expansion of this interpretation. Inside Wharetaewa, the Europeans saw "vast heaps of dryed fish, & fern roots piled up in heaps", but outside a mere half acre of garden, the only cultivation visible in the whole of Mercury Bay (Morrell 1958: 76). Generalising later, Banks (Morrell 1958: 147) spoke of the preserved fish and dried fernroot as a "reserve...for times when the neighbourhood of a Enemy or other circumstances make the procuring of fresh Provisions difficult or dangerous". Cook (1968: 199) referred to these supplies as siege provisions, but the observant Banks believed there was not enough water stored inside Wharetaewa to withstand a siege (Morrell 1958: 76, 147). The combination of observations made at Mercury Bay culminated in the identification of a second role for the rhizomes: as **rations for people under stress**, such as groups expecting to be attacked or those defeated in warfare.

Later in November 1769, the *Endeavour* spent a few days in the Bay of Islands which they found more populous, apparently peaceful (though with numerous occupied pā), and with many visible gardens. But in Cook's words "this was not the season for roots" (Cook 1968: 218), and there were no comments in the journals about Maori diet. In contrast, Queen Charlotte Sound in January 1770 presented a picture of small dispersed groups, some uninhabited or abandoned villages, and no gardens at a time of the year when they should have been obvious. Their daily bread, wrote Cook, "is fish and firn roots for they cultivate no part of the lands"(Cook 1968: 238–9, 247). Fortunately, bracken fern was abundant on the tops of the hills (Forster 2000: 273; Parkinson 1972: 115). The European perception that the Sounds were too cold for cultivation is evident in Banks' generalisation that "To the Southward w[h]ere little or nothing is planted, Fern Roots & Fish must serve them all the Year" (Morrell 1958: 137). The third role for the bracken rhizome was thus established: as a **default staple where cultivation of crops was difficult or impossible**. Several of the Europeans who visited Queen Charlotte Sound in the two subsequent Cook expeditions in the 1770s underlined this staple role by referring to the fernroot as 'bread' (e.g. Bayly 1914: 204; Edgar 1914: 225).

Were these perceptions of the bracken rhizome's roles peculiar to the English explorers? For the scurvy-ridden members of de Surville's expedition who spent two weeks in Doubtless Bay at the end of December 1769, the only vegetable food to be seen in use was fernroot, for the plantations of sweet potatoes were only just starting to grow (Salmond 1991: 324). Both Monneron and l'Horme identified fernroot as the Maori equivalent of bread, and together with de Surville viewed it as "terrible", "full of little hard bits" and "miserable" nourishment (Ollivier *et al.* 1982: 39, 122, 165). There are elements of both the seasonal stop-gap and default staple role in what they wrote. As Salmond (1991: 317) has pointed out, most of the settlements visited in the Doubtless Bay area were for summer fishing and de Surville's party did not see the rich Oruru Valley and its large areas of garden land. In

contrast Marion du Fresne's two ships spent just over two months in the Bay of Islands, over May and June 1772. For the first time sweet potatoes were offered to the Europeans in trade, since the harvest period had just finished. But the storehouses in the pā which the French visited held not only sweet potatoes but bundles of suspended fernroot (Ling Roth 1891: 35, 73), and it was the latter that the French insisted was the basis of Maori food (Du Clesmeur 1914: 473). Le Dez concluded that "Fernroot is what they eat most often because the land is covered with it" (Ollivier and Spencer 1985: 323).

Roux (1914: 399) tasted beaten fernroot paste and "always found the juice of the root very pleasant", while Le Dez found it "bitter and pasty", but clearly a nutritious food for the Maori (Ollivier and Spencer 1985: 323). Crozet made the interesting observation that mothers "chew the fern root, pick out the stringy parts, and then take it out of their mouth in order to put it into that of their nurslings" (Ling Roth 1891: 66). His comment that Maori teeth were "more used up than spoiled" has been interpreted by Salmond (1991: 409) as evidence of excessive wear caused by the shellfish and fernroot diet.

Just over four decades after these observations had established fernroot as the staple vegetable food of the Bay of Islands Maori, Europeans became aware of the great extent of cultivated land around Lake Omapere, inland from the Bay of Islands (Nicholas 1817 I: 341–4). This area included not only recently cleared plantations for potatoes to supply the European whalers, but also traditional kumara and taro gardens which would have been producing crops during the eighteenth century and earlier, a fact confirmed by archaeological discoveries at Pouerua (Sutton 1993). So why then were the Maori in the Bay of Islands so dependent on fernroot?

For the past century, this question has been answered by calling on the three European explanations of the roles of fernroot outlined above:

- the seasonal stop-gap explanation first discussed by Colenso (1880: 4) has proved the weakest, as Shawcross (1967: 333–4) noted, because the French were present just after the kumara harvest;
- the fernroot as wartime rations hypothesis accords rather better with the high number of inhabited fortifications and obvious signs of conflict in the southeastern Bay of Islands (Kennedy 1969);
- the default staple explanation also gained support after Shawcross (1967) argued that the conditions for the cultivation of sweet potato were far from favourable in the coastal areas, compared to the prevalence and productivity of fernroot. My paper on the incompatibility of gardening and fernroot harvesting as alternating land uses (Leach 1980) added indirect support to this view. Although much land in the immediate environs of the Bay of Islands was under fern, the population was so dense that the long fallow needed for the restoration of forest cover and the elimination of the bracken in order to resume gardening, could not be sustained.

Early nineteenth century observers like John Nicholas, who accompanied Marsden to the Bay of Islands in 1814, described a landscape covered in fern (Nicholas 1817 I: 190, 260). No wonder kumara and potatoes were luxury foods that in Nicholas' experience might "occasionally afford...a delicious treat". And no wonder Thomas Kendall's Maori-English primer of 1815 had sentences such as "Let us go above to eat fern root" and "Friend! Let us pound fern root" (Kendall 1815: 28–9). His 1820 vocabulary contained four words for fernroot, two for fernroot beaters, a word for fernroot juice, another for the fibre, and a term for red land from where fernroot had been collected (Kendall 1820).

I quoted evidence in 1999 (Leach 1999: 131–2) that the imperative to trade the Solanum potato for European goods, first described by John Savage in 1805 (1807: 55) and reiterated by Richard Davis in 1826 in the Bay of Islands, helped to perpetuate the reign of fernroot. At the same time the demand for potatoes resulted in increased destruction of lowland forests in order to make potato gardens — for the potato demanded higher levels of nutrients than the kumara (Leach 1980). According to Richard Cruise (1974: 247, 250), a late October dinner in the year 1820, for a chief and his family living just inland from the Whangaroa Harbour, consisted of "dried fish and pounded fern root". Little more than a week later, Cruise's ship was supplied with "very good new potatoes" that had been planted on speculation. A decade later, William Yate (1835: 218) described the Sabbath silence at a Christian village, broken only by the sound of the fern-pounder "which was, in fact, a work of necessity, as they had nothing else to eat". By the mid–1830s, Maori in northern New Zealand had been growing Solanum potatoes for between forty and sixty years. If Shawcross was correct in believing that the Solanum potato eventually replaced the fernroot, rather than becoming a substitute for the kumara (K. Shawcross: pers. comm. 1967) why then was fernroot still in use in the mid-nineteenth century? Was trade really so important that Maori had to treat the potatoes as a cash crop and continue eating the inedible?

Behind these frequently asked questions lie the European perceptions of the roles of fernroot, all of which can be categorised as default explanations (i.e., fernroot was used only because kumara wasn't ready, wasn't accessible, or couldn't be grown). Why don't we ever ask the question: why isn't fernroot used as a food today? The reason is that we still think of fernroot as Europeans did in the eighteenth century, as a substance that no-one would voluntarily choose to eat. In matters of food, disgust has been found to have a biological foundation (Rozin *et al.* 1997) which strengthens its cultural manifestations, as seen in food taboos, eating disorders, and denigration of the eating habits of the 'other'. This may explain why the three default hypotheses of fernroot's roles emerged so rapidly and persisted to the present in academic writing. For example, in a description of Maori efforts in the gathering and processing of wild plant foods, I wrote: "Their investment turned bitter, excessively fibrous, tooth-breaking and in two cases highly toxic plants into edible foodstuffs" (Leach 1987: 91). To correct this distortion, two other explanations need to be considered, which will better explain the persistence of fernroot use long after the Solanum potato had penetrated the most remote parts of New Zealand, and European tools had made the preparation of cultivations less laborious.

The first is that the taste of the bracken rhizome was rated highly by Maori consumers. This cannot now be assessed other than by reference to the few nineteenth century European commentators who suspended personal judgement of the plant and recorded details of Maori perceptions of its qualities. The most instructive is Colenso (1880: 37–8), who observed that on the East Coast, "the best kinds were called *kaitaa* = gentlemen's food, and *renga* = mealy", referring also to several named grades of fernroot. Nevertheless the bracken did cease to be a Maori food item by the late nineteenth century, an outcome which would not be expected if it had been ranked more highly than the Solanum potato. The second explanation is that the bracken rhizome possessed qualities that under specific circumstances of nineteenth century Maori life gave it an advantage over the potato or other European starch sources.

Some European commentators believed that fernroot's continued use was the result of bad management of potato supplies and/or laziness. In Otago, the Rev. James Watkin (n.d.) wrote in his journal on February 13th, 1841:

> Have not had so many at the schools this week as in time past, many of the natives being away in quest of food etc the former a scarce article at present, and only necessity can drive them to dig and prepare the fernroot which annually saves them from famine, it possesses a good quantity of nutriment but is disagreable to the taste of the uninitiated and from the woody particles which belong to it is rough eating, a little more labour would generally secure them abundance, but labour they do not love... .

Watkin failed to mention that Maori were supplying large quantities of potatoes to European consumers, probably including his own mission station.

In the summer of 1843–1844, Edward Shortland (1851: 170) described the occupants of an eel fishing settlement on the Taieri River as living on eels, wild turnip tops and fernroot, "all their old potatos having been consumed or planted, and the young crop not being yet ripe". This observation placed the fernroot in a default role. But Shortland was soon to see fernroot in a very different light. His enlightenment occurred on an overland walk with local Maori guides from Waikouaiti to Akaroa in 1844. On January 11th they stopped on the south bank of the Waitaki River. While some Maori cut raupo to make *mokihi* (reed boats), others dug fernroot. Shortland (1851: 201) pointed out that even in the favourable spot from which they were extracting fernroot "a great deal of discrimination was used in selecting the best roots, which were discoverable by their being crisp enough to break easily when bent". He continued: "Here a quantity sufficient for several days was procured and was packed in baskets to last till another spot equally favourable could be reached". Then he wrote the following significant passage:

> The natives consider that there is no better food than this for a traveller, as it both appeases the cravings of hunger for a longer period than their other ordinary food, and renders the body less sensible to the fatigue of a long march. It is in this respect to the human frame, what oats or beans are to the horse. (Shortland 1851: 202)

The same choice of fernroot as travellers' food was made on the West Coast of the South Island, where it became important, even critical, rations for Charles Heaphy and Thomas Brunner in their joint expedition of 1846, and for Brunner's longer walk in 1847–8. Although good fernroot was scarce on the West Coast, many days were spent collecting and drying it wherever it was encountered. In addition to his gun, 7 lb of shot, 8 lb of tobacco, 2 tomahawks, 2 pairs of boots, 5 shirts, 4 pairs of trousers, a rug and a blanket, Brunner (1959: 267–8) personally set off with at least 30 lb of fernroot. He wrote a few days later, "My back very very sore". Soon after that he experienced two hours of "excruciating pain" in an unspecified location, which his native guides ascribed to the fernroot diet (Brunner 1959: 269). But three months later he boasted that he had "acquired the two greatest requisites for bushmen in New Zealand, viz., the capability of walking barefoot, and the proper method of cooking and eating fern root" (Brunner 1959: 288). This allowed him to enjoy the "welcome of strangers" at Paringa — "a bountiful supply of fern root, preserved wekas, and fish" (Brunner 1959: 291).

Fernroot was in fact the food of choice for cross-country travel in New Zealand for five reasons:

- it was pre-dried and hence lighter than root crops such as kumara or Solanum potatoes;
- it stayed sound for months, or even years (Colenso 1880: 21), provided it was kept dry;
- it could be cooked in the embers of a camp fire and did not require an umu to be made;
- it could usually be replenished en route;

- its preparation involved less labour and time than the processing of another travellers' food, the *kāuru* (cooked and dried cabbage tree), which involved the construction of a large oven, and the accumulation of firewood and ovenstones (Fankhauser 1989).

It is significant that at the time of Brunner's expedition, the Poutini Ngai Tahu were making potato gardens at convenient locations along frequently travelled land routes, emulating the dispersed fernroot harvesting sites (Brunner 1959: 280; Leach 1969: 65–6). The difference in the weights of food carried is instructive: Heaphy and Brunner had been obliged to set off carrying 60 lb of potatoes each on the Grey River to Heaphy River return leg of the first expedition, whereas they had started their trek at Golden Bay with 35 lb each of flour (Heaphy 1959: 205, 242). When Brunner (1959: 267–8) began his trip in the following year he was carrying 30 lb of fernroot.

Cross-country travel by Maori was not a specifically South Island phenomenon, nor was it a nineteenth century development, judging from prehistoric artefact find-spots along inland routes. Even in the north where conditions were far more favourable for sea travel, and hence the transport of cultivated root crops, the dispersed pattern of the gardens required networks of footpaths. The incidence of undefended pit complexes in the close vicinity of gardens along much of the eastern coast of the North Island suggests that unless their security was in doubt, crops were frequently stored on the edges of the gardens. In 1821 Ensign McCrae (McNab 1908: 538) responding to Commissioner Bigge's question, as to whether the Maori were "fixed in their abodes, or do they wander from place to place?", stated that the Maori of the Bay of Islands area "change their places of abode in their own districts" — just as the Ngati Hei were doing in Mercury Bay in 1769. William Colenso argued that the dispersed gardens seen on the East Coast by Cook were an insurance against total loss of crops to war parties or groups bent on *utu* (Colenso 1880: 4, 7–8). Wallace and Irwin's (2000: 80) recent demonstration, that the 'pre-fabricated' components of the pre-contact Kohika *wharepuni* were ideally suited to a mobile lifestyle, reinforces the antiquity of this flexible settlement pattern.

The advent of European crops added to the complexity of this pattern of mobility. William Yate (1835: 155) emphasised in his account of the 1830s Maori that

> Their cultivations are scattered; the kumera-ground is sometimes many miles from the potato-field; the early potato is sometimes many miles from either: and the Indian corn is planted any where, as it flourishes in almost any place where they choose to plant it.

Yate (1835: 246–7) accounted for the deserted village phenomenon with the opinion that the native mind "naturally soon tires of one situation" and that "his habits of going from one residence to another are formed in youth". This view was shared by Edward Markham in 1834

> They have their different Stations and...patches of Cultivation in Twenty places, and one here one season and there an other and at one time they like Fish and Pippies and at an other Cumeras and Potatoes." (Markham 1963: 70)

In 1839 Ernst Dieffenbach interpreted the dispersed bush potato plots of his Taranaki guide Tangutu as a response to "the insecurity of their persons and property", regarding the practice as "very usual with the Taranaki natives" (Dieffenbach 1843 I: 144). But it was not potatoes that Tangutu brought out from his forest hiding place as supplies for their first

(unsuccessful) ascent of the mountain, but fernroot and dried shark. In this instance the dried foods were selected as the best travelling rations because of their manifest advantages of lightness and ease of cooking.

Independently, Dieffenbach's, Shortland's, and Brunner's Maori guides treated fernroot as a food of choice for cross-country travel, not as a default foodstuff. As a 'food on the move', potatoes were clearly not the substitute that led to the abandonment of fernroot, though they may have played this role in village life. Instead it was wheat flour that replaced the bracken root when mobility was required, and that could not occur until flour became a widespread commodity in the mid–nineteenth century (Hargreaves 1961; 1962). Weight for weight, flour's nutrients were more concentrated because milling had removed much of the fibre. Mixed with water to make damper, it replaced fernroot at the travellers' campfire.

However unappetising they seemed to Europeans, the dried rhizomes of the bracken fern possessed several positive qualities that appealed to Maori consumers: they were easy to transport, they could be stored for long periods, and the least fibrous sorts were considered sustaining and enjoyable. Bracken played a pivotal role in sustaining Maori life wherever resource and settlement distribution demanded mobility, or inter-group conflict threatened crops in gardens or store-pits. Portraying it as an inferior foodstuff, a staple by default, diminishes this role and reflects the mistaken application of European perceptions.

ACKNOWLEDGEMENTS

The research for this paper was conducted with the support of a Royal Society of New Zealand Marsden Fund grant for the project "An investigation into the prehistoric significance of the bracken rhizome".

REFERENCES

Banks, R. 1980. *Living in a Wild Garden*. The Windmill Press, Kingswood Tadworth, Surrey.

Bayly, W. 1914. Extract from the Journal kept by William Bayly. *In* R. McNab (ed.), *Historical Records of New Zealand*, Volume II, pp. 201–18. Government Printer, Wellington.

Brunner, T. 1959. Journal of an Expedition to Explore the Interior of the Middle Island, New Zealand, 1846–8. *In* N.M. Taylor (ed.), *Early Travellers in New Zealand*, pp. 257–320. Clarendon Press, Oxford.

Colenso, W. 1880. On the vegetable food of the ancient New Zealanders before Cook's visit. *Transactions of the New Zealand Institute* 12: 3–38.

Cook, J. 1968. *The Journals of Captain James Cook on his Voyages of Discovery. I. The Voyage of the* Endeavour *1768–1771* (edited by J.C. Beaglehole). Cambridge University Press for the Hakluyt Society, Cambridge.

Cooper, M.R. and Johnson, A.W. 1984. *Poisonous Plants in Britain and their effects on Animals and Man*. Ministry of Agriculture, Fisheries and Food, Reference Book 161. Her

Majesty's Stationery Office, London.

Cruise, R. 1974. *Journal of a Ten Months' Residence in New Zealand.* Facsimile of 2nd edn, 1824. Capper Press, Christchurch.

Dieffenbach, E. 1843. *Travels in New Zealand.* 2 vols. Murray, London.

Du Clesmeur, A.-B.-M. Le J. 1914. Journal of the 'Marquis de Castries'. *In* R. McNab (ed.), *Historical Records of New Zealand*, Volume II, pp. 445–81. Government Printer, Wellington.

Edgar, T. 1914. Extracts from the Journal of Thomas Edgar. *In* R. McNab (ed.), *Historical Records of New Zealand*, Volume II, pp. 222–29. Government Printer, Wellington.

Fankhauser, B. 1989. The nutritive value and cooking of *Cordyline australis* (*Tī kouka*). *In* D. G. Sutton (ed.), *Saying So Doesn't Make It So: Papers in honour of B. Foss Leach*, pp. 199–221. New Zealand Archaeological Association Monograph 17, Dunedin.

Fitch, W.H. 1916. *Illustrations of The British Flora.* 4th edn. Reeve, London.

Forster, G. 2000. *A Voyage Round the World* (edited by N. Thomas and O. Berghof). University of Hawaii Press, Honolulu.

Gerard, J. 1975. *The Herbal or General History of Plants.* Facsimile of 1633 edn. Dover Publications, New York.

Hargreaves, R. 1961. Maori flour mills of the Auckland Province 1846–1860. *Journal of the Polynesian Society* 70 (2): 227–32.

Hargreaves, R. 1962. Maori flour mills south of the Auckland Province (1847–1860). *Journal of the Polynesian Society* 71 (1): 101–105.

Heaphy, C. 1959. Notes of an expedition to Kawatiri and Araura, on the Western Coast of the Middle Island. *In* N.M. Taylor (ed.), *Early Travellers in New Zealand*, pp. 203–48. Clarendon Press, Oxford.

Kendall, T. 1815. *A Korao no New Zealand; or, the New Zealander's First Book.* G. Howe, Sydney.

Kendall, T. 1820. *A Grammar and Vocabulary of the Language of New Zealand.* Church Missionary Society, London.

Kennedy, J. 1969. *Settlement in the Bay of Islands 1772: a study in text-aided field archaeology.* Studies in Prehistoric Anthropology 3, Department of Anthropology, University of Otago, Dunedin.

Leach, H.M. 1969. *Subsistence Patterns in Prehistoric New Zealand.* Studies in Prehistoric Anthropology 2, Department of Anthropology, University of Otago, Dunedin.

Leach, H.M. 1980. Incompatible land use patterns in Maori food production. *New Zealand Archaeological Association Newsletter* 23 (3): 135–47.

Leach, H.M. 1987. The land, the provider. *In* J. Wilson (ed.), *From the Beginning. The Archaeology of the Maori*, pp. 85–94. Penguin Books in association with the New Zealand Historic Places Trust, Auckland.

Leach, H.M. 1999. Food processing technology: its role in inhibiting or promoting change in staple foods. *In* C. Gosden and J. Hather (eds), *The Prehistory of Food. Appetites for change*, pp. 129–38. Routledge, London.

Ling Roth, H. 1891. *Crozet's Voyage to Tasmania, New Zealand, and the Ladrone Islands, and the Philippines in the Years 1771–1772.* Truslove and Shirley, London.

McNab, R. (ed.) 1908. *Historical Records of New Zealand.* Vol. I. Government Printer, Wellington.

Mabey, R. 1997. *Flora Britannica.* Chatto and Windus, London.

Markham, E. 1963. *New Zealand or Recollections of It* (edited by E.H. McCormick). Government Printer, Wellington.

Morrell, W.P. (ed.) 1958. *Sir Joseph Banks in New Zealand from his Journal.* Reed, Wellington.

Nicholas, J. 1817. *Narrative of a Voyage to New Zealand.* 2 vols. James Black and Son, London.

Ollivier, I., Hingley. C. and Spencer, J. 1982. *Extracts from Journals relating to the Visit to New Zealand of the French ship* St Jean Baptiste *under the command of J.F.M. de Surville.* Alexander Turnbull Library Endowment Trust with the National Library of New Zealand, Wellington.

Ollivier, I. and Spencer, J. 1985. *Extracts from Journals relating to the Visit to New Zealand in May–July 1772 of the French ships* Mascarin *and* Marquis de Castries *under the command of M.J. Marion du Fresne.* Alexander Turnbull Library Endowment Trust with Indosuez N.Z. Ltd, Wellington.

Parkinson, S. 1972. *A Journal of a Voyage to the South Seas.* Facsimile edn. Libraries Board of South Australia, Adelaide.

Robbins, W.W., Crafts, A.S. and Raynor, R.N. 1952. *Weed Control.* 2nd edn. McGraw-Hill, New York.

Roux, J. 1914. Journal of the 'Mascarin'. *In* R. McNab (ed.), *Historical Records of New Zealand*, Volume II, pp. 351–443. Government Printer, Wellington.

Rozin, P., Haidt, J., McCauley, C. and Imada. S. 1997. Disgust. Preadaptation and the cultural evolution of a food-based emotion. *In* H. Macbeth (ed.), *Food Preference and Taste: Continuity and Change*, pp. 65–82. Berghahn Books, Oxford.

Salmond, A. 1991. *Two Worlds. First Meetings Between Maori and Europeans 1642–1772.* Viking, Auckland.

Savage, J. 1807. *Some Account of New Zealand; Particularly the Bay of Islands, and Surrounding Country*. J. Murray and A. Constable, London.

Shawcross, K. 1967. Fern root and 18th century Maori food production in agricultural areas. *Journal of the Polynesian Society* 76 (3): 330–52.

Shawcross, K. pers. comm. Letter to H. Leach 15 May 1967.

Shortland, E. 1851. *The Southern Districts of New Zealand*. Longman, Brown, Green and Longmans, London.

Stevenson, G. 1954. *A Book of Ferns*. McIndoe, Dunedin.

Sutton, D.G. (ed.) 1993. *The Archaeology of the Peripheral Pa at Pouerua, Northland, New Zealand*. Auckland University Press, Auckland.

Tusser, T. 1984. *Five Hundred Points of Good Husbandry*. Oxford University Press, Oxford.

Tutin, T.G., Burges, N.A., Chater, A.O., Edmondson, J.R., Heywood, V.H., Moore, D.M., Valentine, D.H., Walters, S.M. and Webb, D.A. 1993. *Flora Europaea*. Vol. 1. 2nd edn. Cambridge University Press, Cambridge.

Wallace, R. and Irwin. G. 2000. A Kohika *wharepuni*: house construction methods of the late pre-contact Maori. *New Zealand Journal of Archaeology* 21 (1999): 67–86.

Watkin, J. n.d. Journal May 1 1840—June 29 1844. Scrapbook of Clippings from *Evening Star*, Hocken Library, Dunedin.

Yate, W. 1835. *An Account of New Zealand*. 2nd edn. R.B. Seeley and W. Burnside, London.

Received 8 June 2001
Accepted 26 June 2001