A molecular study of a rare Maori cloak

Katie Hartnup¹, Leon Huynen¹, Rangi Te Kanawa², Lara Shepherd¹, Craig Millar³ and David Lambert^{3 & 4}

1. Allan Wilson Centre for Molecular Ecology and Evolution
Institute of Molecular Biosciences, Massey University
Private Bag 102 904 NSMC, Auckland, New Zealand.
Email: K.Hartnup@massey.ac.nz

2. Te Papa Tongarewa
PO Box 467, Wellington, New Zealand.

3. Allan Wilson Centre for Molecular Ecology and Evolution
School of Biological Science, University of Auckland
Private Bag 92019, Auckland, New Zealand.

4. Griffith School of Environment and School of Biomolecular
and Physical Sciences, Griffith University, 170 Kessels Road, Nathan
4111, Australia.

ABSTRACT

Kakahu or Maori cloaks are *taonga* (treasures) and are iconic expressions of Maori culture. Unfortunately much of the original information relating to the ‘origins of the cloaks’ has been lost. We present mitochondrial 12S sequence data from feathers sampled from a rare cloak that appeared to have been adorned with feathers from New Zealand moa. These species belonged to the ratite group of birds and have been extinct since soon after human arrival in New Zealand. Using microscopic amounts of feather tissues from this cloak, we have been able to show that this garment was actually adorned with Australian emu feathers. At the likely time of construction of the cloak, the then Governor of New Zealand, George Grey, kept emu on Kawau Island in the Hauraki Gulf. It seems probable that the remains of these individuals were the source of the feathers used, although we are not able to exclude the possibility that Maori obtained them as a result of early trading with Australia. To our knowledge this study is the first to use genetic techniques to identify the species of bird used in feather adorned Maori cloaks and illustrates the potential for molecular techniques to provide important information about these *taonga*.

KEYWORDS

Maori cloaks, species identification, ancient DNA

INTRODUCTION

Museum specimens and artefacts are now widely regarded as important genetic resources that can be utilised in a broad range of molecular studies (Wanderler *et al.* 2007). Such studies are aimed at many issues such as the taxonomic status of specimens, their provenance, past levels of genetic diversity and how changes in genetic diversity affect the population structure and the diversity of modern populations. The latter has implications for the conservation and management of fragile populations. Studies such as these often require museum specimens with detailed

accompanying records, stating species, location, and time of collection. However, it is often the case that museum records are incomplete, particularly for historic samples. Alternatively, we can apply known ecological and genetic information from modern populations to uncover information about museum specimens that has either been lost or not originally collected. For example, this approach has been used to test the assumptions that a skeleton of a 19th century lion housed in a museum in Amsterdam belonged to the now extinct cape lion (*Panthera leo melanchaita*) (Barnett *et al.* 2007). Similar methods have been used to determine the specific status of kiwi remains that are indistinguishable using skeletal morphology alone (Shepherd and Lambert 2008). In the case of Maori feather cloaks, it is potentially possible to recover a wealth of information pertaining to the provenance, sex and species of the birds used in cloak construction and relate these findings to Maori culture and practices.

Maori cloaks (*kakahu*) are treasured items, or *taonga*, and are examples of one of the earliest forms of weaving (Best 1952), a process of hand knotting without the use of a loom. When Maori reached New Zealand from Polynesia in the 13th century their preferred material for clothing was the bark of the paper mulberry tree (*Broussonetia papyrifera*). This tree was brought to New Zealand with Maori but failed to flourish in the temperate climate (Best 1952). When searching for a viable alternative, the native flax (*Phormium* spp.) was discovered. From this flax a strong, pliable fibre called *muka* could be extracted and this was woven into cloaks. The earliest written records of Maori cloaks are from Captain Cook's first visit to New Zealand in 1769-1770 (Pendergrast 1997). At this time a crudely woven flax rain cape was the most common cloak type. Finely woven *muka* cloaks, often covered with strips of skin from the Polynesian dog (*kuri*), were worn only by chiefs.

Feathered garments are commonly mentioned in the oral histories of Maori and other Polynesian groups, but were not a common feature of Maori culture when the first European explorers reached New Zealand (Pendergrast 1997). Early flax cloaks sometimes had feathers, or skin with feathers attached, scattered across the cloak surface or woven into the cloak borders (Ling Roth 1923; Pendergrast 1987). Production of Maori cloaks completely covered in feathers began in the second half of the 19th century. The most prestigious of Maori cloaks were adorned with kiwi (*Apteryx* spp.) feathers and were known as *kahu kiwi* (Pendergrast 1987). Cloaks were held in high regard in Maori society, took a considerable amount of time to construct (up to eight months; Te Kanawa 1992), and were associated with high status. Prestigious cloaks such as *kahu kiwi* were empowered by a chief's *mana* - a Maori term signifying a combination of authority, integrity, power and prestige. There are cloaks in museums within New Zealand and overseas with good accompanying records, however a large number lack any information with respect to age, provenance and the species used to adorn cloaks. Our research programme is aimed at providing precise data regarding the origin and construction of cloaks.

During part of a larger study of Maori feathered textiles, our team encountered an unusual cloak at the Hawkes Bay Museum and Cultural Trust. This was the first cloak of this type to have been observed. The cloak's construction comprised a finely woven *muka* body or *kaupapa*, completely adorned with feathers that were extremely similar in morphology to moa feathers (Worthy and Holdaway 2002) (Figure 1). Moa (Aves: Diornithiformes) were foremost among the evolutionary novelties of New Zealand. Richard Owen first brought the presence of moa in New Zealand to the attention of Western scientists in 1842, when he described a femur shaft. Since that time the number and age of fossil specimens has grown considerably and suggests that moa inhabited New Zealand from over two million years ago (Worthy and Holdaway 2002:8-10). Although small groups of moa likely survived in remote locations for slightly longer, the main populations were probably extinct by AD 1400 (Worthy and Holdaway 2002).

Very few moa specimens have been excavated with their feathers intact. The few feathers recovered possessed a range of colours including white, reddish brown grading distally to black with a white tip, and purplish brown with a yellow stripe. Feathers were typically no longer than 18 cm in length, although feathers up to 23 cm in length have been recorded (Worthy and Holdaway 2002).

Figure 1. A comparison of known moa feathers (A) with those from the cloak under study (B).

It is possible to estimate the age of Maori cloaks due to variations in weaving techniques over time. The potential ‘moa’ cloak has been estimated by one of us (Rangi Te Kanawa, Maori Textile Conservator) to have been constructed in ~1850. Therefore, despite the similarity in feather morphology between the cloak and moa feathers, there is a large disparity between the time that moa became extinct and the estimated time of cloak construction. Despite this disparity, it is possible that moa feathers were stored for some time prior to their use in the construction of the Hawkes Bay cloak.

In order to test the possibility of a ‘moa’ cloak, ancient DNA techniques were employed to recover DNA sequences from cloak feathers and to compare these sequences with those obtained from moa bones and from a range of other ratite species.

MATERIALS AND METHODS

Seven feather shafts were kindly provided to us from the suggested moa cloak #45_264 from the Hawkes Bay Museum and Cultural Trust. Feathers are woven into Maori cloaks twice (Figure 2). This enables the removal of an approximately 2 mm section from the shaft of the feather with sterilised forceps and surgical scissors. This method minimises any detrimental effects on the integrity and the appearance of cloaks. DNA was extracted from each feather shaft by overnight incubation, with rotation, at 55°C in 300 µl of extraction buffer (10mM Tris-HCl pH 8.0, 50mM NaCl, and 1mM EDTA) supplemented with 30 µl of 10% SDS, 5µl of 1M DTT, and 5µl of 20mg/ml proteinase K. 200 µl of each mix was then purified using a QIAamp DNA Mini Kit (Qiagen) as outlined by the manufacturer.

Ratite-specific mitochondrial 12S primers, ratite12S1 (5'-CCTCAGAAGGCGGATTAGCAGTAA) and ratite12S4 (5'-ATCTTTCAGGTGTAAGCTGAATGCTT), were designed using sequences retrieved from GenBank: rhea (*Rhea americana* – AJ002923), ostrich (*Struthio camelus* – AF069429), great spotted kiwi (*Apteryx haasti* – AF338708.2), cassowary (*Casuarius casuarius* – AF338713.2) and emu (*Dromaius novaehollandiae* – AF338711.1). DNAs extracted from cloak feathers and moa bone (*Emeus crassus*, Canterbury Museum CM_Av9132) were then amplified using the primers ratite12S1

Figure 2. The DNA sampling method used for feather cloaks. (A) Details of the method used to weave feathers into the flax backing of a Maori cloak. The circle indicates the part of the feather shaft that was removed for DNA analysis. (B) Removal of a ~2 mm tip of a feather shaft, indicated by a circle, from a cloak.

and ratite12S4 as described in Huynen *et al.* (2003). Successfully amplified fragments of ~220 bp were sequenced in both directions using Applied Biosystems BigDye Terminator v3.1 chemistry and aligned to homologous sequences from other ratites using the Sequencher programme.

RESULTS

Two of the seven feather shafts sampled from cloak #45_264 amplified for a 220 bp sequence from the 12S region of the mitochondrial genome. These two sequences were aligned with homologous data from ratite species as shown in figure 3A. The two cloak sequences differed from each other at just two sites of the ~220 bp fragment (sites 5 and 16), suggesting the use of feathers from at least two different individuals in cloak construction. Cloak sample 2 was identical to the sequence of emu from Genbank. Both of the cloak sequences varied substantially from the moa sequence (11% average), and from other ratites for which sequences were available (rhea - 14.3%, kiwi - 8.6%, ostrich - 6.8% and cassowary - 5.9%). On average, the cloak sequences differed from the emu sequence by just 0.45%. Figure 3 presents an unrooted, neighbour-joining tree of 12S sequences created in PAUP* (Swofford 2002). The tree groups the sampled cloak feathers with emu. As the 12S mtDNA sequences targeted in this study are highly variable and difficult to align, they do not effectively resolve relationships amongst ratites. Haddrath and Baker (2001) used whole mitochondrial genomes to successfully investigate ratite phylogeny. However, the variability within the 12S region is ideal for species identification, making it a suitable choice for identifying the cloak samples.

Figure 3. Aligned mitochondrial 12S DNA sequences of cloak feather samples, moa and other ratites (A). (-) indicates a base identical to the consensus sequences, (:) indicates a deletion in relation to the consensus sequence. An unrooted, neighbour-joining tree of 12S sequences from a range of ratite species (B), together with the two sequences recovered from the cloak samples.

DISCUSSION

We can conclude that this unique cloak from the Hawkes Bay Museum and Cultural Trust was not constructed using moa feathers. It was, however, adorned with feathers from emu, a ratite that originated in Australia and is not found in wild populations in New Zealand. Taking these findings

into account, how did Maori in the second half of the 19th century obtain feathers from a native Australian bird species? There are two possible explanations for this. First, the emu feathers may have come from Sir George Grey's exotic flora and fauna collection on Kawau Island, north of Auckland. Second, the emu feathers may have been brought from Australia during a period of extensive timber and flax trading.

Sir George Grey

George Grey had a relationship with New Zealand spanning many years. He was appointed governor of New Zealand in 1845. Arguably his greatest success during this nine-year period was his management of Maori affairs. He scrupulously observed the terms of the Treaty of Waitangi and assured Maori that their rights to their land were fully recognised. He subsidised schools for Maori children, built several hospitals and encouraged Maori agriculture (Sinclair 2007). Grey enjoyed great *mana* among Maori, often travelling with chiefs. He was instrumental in efforts to record Maori traditions, legends and customs in written form. Te Rangikaheke, a Te Arawa tribal leader, taught Grey to speak Maori and lived with Grey and his wife in their house. Although Grey's second term as Governor from 1860-1868 was less successful because of extensive battles between Maori and settlers, he remained respected by Maori.

Grey purchased Kawau Island, located North of Auckland in the Hauraki Gulf, in 1862 (Figure 4). He poured a great deal of his energy, effort and fortune into the 2000 ha island. He turned the existing copper miners cottage into the formidable Mansion House and turned the land around the house into a botanical and zoological park. Grey imported seeds and cuttings from all over the world including redwood (*Sequoia sempervirens*) from Western USA, the Chilean wine palm (*Jubaea spectabilis*), the giant bird of paradise (*Strelitzia nicolai*) from South Africa and the Japanese cedar (*Cryptomeria japonica*). Grey also imported various exotic fauna. Four species of wallaby (*Macropus eugenii*, *Macropus parma*, *Petrogale penicillata* and *Wallabia bicolor*) (Eldridge *et al.* 2001) were introduced and remain on Kawau today. Other animals, such as the zebra imported to pull his carriage (Eldridge *et al.* 2001), failed to acclimatise to their new home. Grey also imported birds such as peacocks (*Pavo* spp.), kookaburra (*Dacelo* spp.), and notably for this study, emu (Graham 1919).

It is highly likely that the feathers used to construct the emu feather cloak originated from Kawau, given the estimated construction of the cloak in around 1850, Grey's purchase of Kawau in 1862, the presence of emu on Kawau, and Grey's favorable association with Maori. It should be noted that emu were also found in the Hauraki Gulf on Motutapu Island, which was purchased in 1869 by the Reid brothers from Victorian entrepreneur Richard Graham. They introduced exotic fauna such as emu, deer, ostriches and wallabies (McClure 2007). It is known, however, that the flock of emu on Motutapu Island was provided from Governor Grey's flock on Kawau Island (Graham 1919).

Trade with Australia

European explorers visiting New Zealand in the 1700s quickly sought to make use of and to export resources, including timber and flax. Maori fashioned flax into ropes for visiting ships and bartered flax and weaving for European goods. Merchants in Sydney showed an interest in flax fibre and by the 1820s a trade began with Australia, peaking in the 1830s (Wigglesworth 1981). Trading stations were set up around the coast of New Zealand. Stations were present on the coasts of Northland, Waikato, Taranaki, the Coromandel, the Bay of Plenty, the East Cape, Southland, both sides of the Cook Strait, and the Banks Peninsula. Taking into account the extent of the trade between these two countries, and the timing of that trade, at present it is not possible to rule out these trade routes as the source of the emu feathers used to adorn the cloak. It is known that Maori flax producers were not paid in cash but in goods, usually muskets, although other goods such as feathers cannot be discounted (Swarbrick 2007).

Emu were known to be present on Kawau Island in about 1862. This coincides with the peak of the flax and timber trade with Australia (~1830). In addition, our estimate of the date

Figure 4. The location of Kawau Island off the coast of New Zealand north of Auckland, where Governor Grey kept his Zoological Park which included emu, together with a portrait of Governor Grey and an early photograph of Mansion House.

of construction of the emu cloak is approximately 1850. This makes it difficult to confirm with certainty that the emu feathers adorning the cloak came from George Grey's emu on Kawau Island. However, the definite presence of emu on Kawau versus only the potential for emu to be brought from Australia during the timber and flax trade makes the Kawau Island option more compelling. Further investigation could be conducted to test this idea. For instance, it is possible to look at more variable regions of the mitochondrial DNA genome to distinguish between different emu populations. If there were emu remains on Kawau, it would be possible to see if the feathers adorning the cloak match genetically to those remains and to compare these to Australian populations.

Recently, our team has come across two cloaks in the cloak collection at the Auckland War Memorial Museum. Both were constructed from feathers similar to those observed on the emu feather cloak from the Hawkes Bay. One of these is a *kahu hurhuru* which is a cloak adorned

with feathers from many different species of birds and the other is completely adorned with what appears to be emu feathers. It is estimated that both cloaks were manufactured more recently than the Hawkes Bay example. The bodies of both cloaks are constructed from candlewick as opposed to *muka*. Cloak making using this material was typically observed from 1890 onwards. Future work will be conducted to determine if the feathers of the two newly observed cloaks are indeed emu, and if they are, how genetically similar these feathers are to those from the Hawkes Bay cloak. Generally, this study highlights the effectiveness of genetic analyses in recovering lost history from important ethnological artifacts.

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