NEW ZEALAND
ARCHAEOLOGICAL
ASSOCIATION

ARCHAEOLOGY IN NEW ZEALAND

MAORI PREHISTORY: ANCIENT DNA OF THE KIORE AND KURI

John S. Allen, Thegn N. Ladefoged and Elizabeth Matisoo-Smith[1]
Mere Roberts[2]
Waerete Norman[3]
Hori Parata[4]
Stephanie Clout[1]
Dave Lambert[5]

[1] Anthropology Department, The University of Auckland. [2] School of Biological Sciences, The University of Auckland. [3] Maori Studies Department, The University of Auckland. [4] Ngatiwai Trust Board. [5] Department of Ecology, Massey University, Palmerston North.

INTRODUCTION

Mitochondrial DNA (mtDNA) from the Pacific rat (*Rattus exulans*), known in New Zealand as the kiore, and Maori dog (kuri; *Canis familiaris* spp) contains potentially valuable information that can be used to examine the exploration and colonisation of Aotearoa by the Polynesian ancestors of Maori. Since neither the kiore nor the kuri moved without human help (Roberts 1991, Matisoo-Smith 1996, see also Anderson 1996), their population histories are a proxy for human behaviour, or more specifically, they are an indicator of the movements of Polynesian voyagers. By comparing the DNA from different kiore and kuri populations, patterns of relatedness and movement can be inferred.

The Foundation for Research, Science and Technology (FRST) has funded a three year project to trace the genetic trail of kiore and kuri, by focusing on ancient DNA from skeletal remains. We are now at the end of the first year of the project, and have begun to analyse DNA extracted from kuri and kiore remains found in securely dated archaeological sites and zoological collections. For the kuri, this is virtually our only source of true Polynesian or Maori dog, since they have admixed beyond recognition with dogs introduced by Europeans in the 19th century. The kiore, on the other hand, is an extant species that does not interbreed with other introduced species of rat (Williams 1973). By using DNA from dated kiore bone, we can add the dimension of time to the patterns of relatedness derived from DNA taken from living kiore populations. In this way we can gain clearer insights into past patterns of human movement throughout the Pacific.

The project consists of two main objectives. The first is concerned with the kiore and the second with the kuri. The objectives are in effect parallel, with the shared goal of increasing our understanding of the settlement of Aotearoa by Maori, from the perspective of the commensal/domesticated animals they brought with them. Our study of kiore DNA is based on a strong foundation of previous research (Matisoo-Smith 1994, 1996, Matisoo-Smith *et al.* in prep), while the genetic project involving the ancient DNA of the kuri has required more basic investigations.

KIORE DNA

In our previous work, we suggested that a phylogenetic analysis of mtDNA variation in the kiore provided unique biological evidence of prehistoric human movement in Polynesia. The analysis of mtDNA is particularly useful in trying to understand Pacific settlement since it evolves very quickly compared to nuclear DNA. Our results, based on analysis of extant populations of kiore, identified patterns of genetic variation that are congruous with patterns of human exploration, colonisation, settlement, and post-settlement contact suggested by archaeological, cultural and linguistic evidence. We can conclude that the genetic history of kiore provides an excellent model for human mobility in prehistoric Polynesia.

Moving on from this research, we are obtaining DNA sequences from the highly variable D-loop region of the mitochondrial DNA from dated skeletal remains of kiore. We are interested in determining in more detail the phylogenetic relationships among Polynesian rat populations, in order to further elucidate or confirm patterns of prehistoric human movement in New Zealand and other parts of the Pacific. This can be accomplished either by phylogenetic analyses, as used in the previous study of extant kiore, or through analyses of the distribution of single site point mutations, as seen in the analysis of human mtDNA variation in Polynesia (Lum *et al.* 1994, Sykes *et al.* 1995). Analysis of mtDNA from archaeological kiore skeletal material will allow us to include populations from islands where kiore are now extinct, for example, Easter Island, Niue, and the North Island and most of the South Island of New Zealand. Analysis of DNA from dated archaeological sites will also provide a degree of chronological control which is not possible in analyses of extant populations. Also, compared to trapping live kiore, it is much easier to obtain large numbers of kiore from archaeological sites or museum collections.

Towards this end we have obtained over 420 kiore bone samples from a variety of contexts. These include samples from museum and excavation collections from New Zealand, the Chatham Islands, the Cook Islands, the Marquesas, Australs, the Tuamotus, Henderson, Rotuma, Kapingamarangi, mainland Papua New Guinea, Bougainville Island, the D'Entrecasteaux Islands,

Woodlark Island, Vanuatu, Loyalty Islands, Saipan, the Philippines, Borneo, the Celebes, and Indonesia. We are currently soliciting samples from other regions from throughout the Pacific and would welcome communication with potential contributors.

During the first year of the project we have refined our ancient DNA extraction protocol. Initially, the DNA extraction protocol consisted of the standard phenol/chloroform method (Pääbo 1989). This method required relatively large amounts of bone and was not particularly consistent, given the limitations of the size and density of archaeological rat bones. We have now developed and are using a modification of the protocol described by Höss and Pääbo (1993), which uses a silica-based purification method. This new and unique protocol has been extremely successful. We have surpassed the 50% success rate initially expected, and have successfully extracted DNA from *R. exulans* material dating from 400 years BP to 3,000 years BP. We have also consistently been able to amplify and sequence a 150 base pair fragment from archaeological material, and have successfully amplified a larger fragment (450 base pairs) from some of the more recent (400 years old) material from the Chatham Islands.

KURI DNA

The second objective of the project is to obtain DNA sequences from the D-loop region of the mtDNA from dated remains of the Polynesian dog or kuri. This will enable us to examine relationships among Polynesian dog populations compared to other dogs such as dingo, Highland PNG dogs, or Taiwanese dogs, which will also help inform on prehistoric human movement in the Pacific. One interesting fact about dogs is that they seem, as a whole, to possess very little mtDNA variation; for example, domesticated dogs and grey wolves are far more similar to one another than many human populations are to each other (Wayne *et al.* 1992). This indicates to us that it is likely that tracing single point mutations will be more valuable than classic phylogenetic analyses in understanding the distribution of dogs in New Zealand and the Pacific.

Initial DNA extractions have been conducted using fresh dog tissue obtained from a local veterinarian. Using standard mammalian primers, we have amplified and sequenced the entire D-loop, and from that have designed internal primers, useful for investigating ancient DNA. We have now successfully extracted, amplified and sequenced DNA from modern dog bone, and are ready to begin work on the archaeological bone and teeth. Dog bone material and/or teeth from sites in New Guinea, Island Melanesia, Micronesia, Polynesia and New Zealand has been located, and despite earlier reports that suggested a paucity of archaeological dog remains, our search has identified a reasonable amount of material.

CONCLUSIONS

The first year of this project was designed to serve as a foundation for the next two years of the project. A major accomplishment has been the establishment of a working relationship with interested and concerned Maori groups via an Advisory Committee. The committee, chaired by Mere Roberts of the School of Biological Sciences, consists of Hori Parata, representative of Ngatiwai (Kaitiaki of the kiore); Waerete Norman, representing Ngati Kuri (Kaitiaki of the kuri); and John Allen, Thegn Ladefoged, Lisa Matisoo-Smith and Stephanie Clout, of the Department of Anthropology, University of Auckland. Members of the research team have attended hui with Ngati Wai and Ngati Kuri, and have prepared a brochure describing our project in lay language (please write or e-mail to us if you would like copies). In addition, we have obtained kiore and kuri bone samples from a wide variety of sources, representing sites throughout New Zealand and Oceania. A new protocol has been developed for the extraction of ancient DNA from bone, and has been successfully applied using a number of ancient kiore bone samples. DNA from kiore bone has also been successfully sequenced and amplified, and can now be used in prehistorical analysis. Our work on the kuri has just begun, with the extraction, amplification and sequencing of DNA from modern dog remains. These procedures will now be applied to the ancient dog material that we have collected. Additional archaeological rat and dog material from throughout the Pacific and New Zealand would be most welcome, and researchers are asked to contact us concerning the details of the project. The analysis of this material will undoubtedly contribute to new understanding of prehistoric patterns of movement throughout the Pacific.

REFERENCES

Anderson, A. 1996. Rat colonisation and Polynesian Voyaging: another hypothesis. *Rapa Nui Journal*, 10(2):31-36.

Höss, M. and S. Pääbo, 1993. DNA extraction from Pleistocene bones by a silica-based purification method. *Nucleic Acids Research*, 21:3913-3914.

Lum, J.K., O. Rickards, C. Ching, R.L. Cann, 1994. Polynesian mitochondrial DNAs reveal three deep maternal lineage clusters. *Human Biology* 66:567-590.

Matisoo-Smith, E. 1994. The human colonisation of Polynesia - a novel approach: genetic analyses of the Polynesian rat (*Rattus exulans*). *Journal of the Polynesian Society*, 103:75-87.

Matisoo-Smith, E. 1996. *No Hea Te Kiore*: MtDNA variation in *Rattus exulans* - a model for human colonisation and contact in prehistoric Polynesia. Unpublished PhD dissertation, University of Auckland.

Pääbo, S., 1989. Ancient DNA: Extraction, characterization, molecular cloning, and enzymatic amplification. *Proceedings of the National*

Academy of Science 86:1939-1943.

Roberts, M. 1991.Origin, dispersal routes, and the geographic distribution of *Rattus exulans* (Peale) with special reference to New Zealand. *Pacific Science*, 45:123-130.

Sykes, B., A. Leiboff, J. Low-Beer, S. Tetzner, M. Richards, 1995. The origins of the Polynesians: an interpretation from mitochondrial lineage analysis. *American Journal of Human Genetics*, 57:1463-1475.

Wayne, R.K., N.M. Lehman, M.W. Allard, R.L. Honeycutt, 1994. Mitochondrial DNA Variability of the Gray Wolf: Genetic Consequences of Population Decline and Habitat Fragmentation. Conservation Biology 6(4): 559-569.

Williams, J.M. 1973. The ecology of *Rattus exulans* (Peale) reviewed. *Pacific Science*, 27:120-127.