Old bones tell new tales

David Lowe

Of all the so-called evidence that has been presented in support of human settlement in New Zealand before the second millennium, only a set of radiocarbon-dated rat bones has appeared scientifically credible. Now even that is coming under close scrutiny.

IN 1996 a paper with the rather sexy title Arrival of rats in New Zealand appeared in the journal Nature. It was by Dr Richard Holdaway and described radiocarbon studies of Pacific rat (*Rattus exulans*, called kiore in New Zealand) bones collected from avian predator sites, most in the South Island, which were interpreted to be evidence of the arrival of rats in New Zealand around AD 50 to AD 150, and humans as well, on the assumption that rats arrived as a human commensal. The results were very controversial because there is no supporting archaeological or ecological evidence for the presence of humans or rats in New Zealand until much later (around AD 1250). To be fair, Holdaway has always maintained that the 'early' humans were here only temporarily as fleeting visitors, ie it was transient contact, not settlement. But he has gone on to develop models involving rapid spread of the rats over both islands and also attributes the decline (possibly extinction) in some birds and other animals to predation by rampant rats well before *c.* AD 1250.

As well as lacking any archaeological or ecological evidence (such as change in vegetation as recorded by pollen profiles) for the 'early' arrival, problems with rat-bone ages had emerged during the dating of archaeological sites where ages of various cultural material (including charcoal, wood, eggshell, marine shell, and large bone) were all in good agreement with one another and with other sites, but rat bone ages from the same layers were sometimes older by more than 1000 years. Critics suggested various explanations for the anomalously old rat bone ages including:

- contamination of bone through dietary uptake of old carbon (eg if rats eat seal meat – note that dates on *modern* rats and ducks at Taupo can give ages of about 2000 years because of hydrothermally derived old carbon getting into the food chain and hence rat bones)
- old carbon contamination from the environment
- dating tiny jaw bones is technically very difficult and processing of bones to produce gelatin can easily produce the wrong results, as was demonstrated in an experiment conducted by Prof. Atholl Anderson (of Australian National University, formerly Otago University). He sent 'blind' samples of rat bones of known age to three different radiocarbon labs and one lab returned ages that were too old by more than 1000 years, ie he showed that subtle differences in pre-treatment of bones can markedly affect outcome (paper published in 2000)
- Oxford University AMS radiocarbon lab has shown that there was the possibility of contamination in the pre-treatment and filtering process involved in gelatin preparation – although probably a relatively minor effect (paper published in 2004)
- Anderson also demonstrated that dates produced on bones from one lab from both natural and archaeological sites showed a 'production trend' and 'age disconformity' pre- and post-1997, ie the ages changed (got younger) generally as samples were processed, the implication being that the pre-treatment techniques were gradually improved with time so that correct ages were obtained eventually. The 'trend/age disconformity' was published in two papers (2000, 2004) but its existence was denied by the lab director; Holdaway said that he (Holdaway) had caused the trend by submitting older samples first – this argument broke down because the trend existed also from archaeological sites (never studied by Holdaway) as well

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as natural sites such as the avian predator sites.

In 1987 Professor Doug Sutton, formerly at Auckland University and now at Waikato University, had published a paper suggesting early settlement of New Zealand (approximately AD 0–500) on the basis mainly of disturbance indicators in pollen records, primarily short-lived increases in bracken. That there was no evidence apart from the pollen record disturbances (easily accounted for by natural factors such as lightning or volcanic eruptions or storms) was explainable according to Sutton by a tiny population which was 'archaeologically invisible'. So the 'old' rat-bone dates seemed to support his hypothesis (called the early settlement model).

Meanwhile, I and colleagues (including Prof Rewi Newnham of Plymouth University) had published several papers in 1998 and 2000 using volcanic-ash layers as markers to try to date the earliest archaeological and earliest *sustained* forest disturbance indicators from pollen profiles. We obtained a new wiggle-match date (at Waikato University Radiocarbon Dating Lab, led by Dr Alan Hogg, and facilitated by tree-ring work by Dr Jonathan Palmer) on a widespread ash layer, the Kaharoa Tephra, which was erupted from Mt Tarawera in AD 1314 ± 12 (published in 2003). This provides a maximum age for many archaeological sites in eastern parts of the North Island – no artefacts have ever been found beneath it. It also gives an approximate near-maximum age for the start of sustained disturbance by burning: out of around twenty pollen profiles which contained Kaharoa Tephra, four showed the start of sustained disturbance (presumably by people) was just before the eruption. From sedimentation rates this is likely to be around 50 years or so at most, ie some decades before AD 1300. This, then, appeared to be the most likely date for the human settlement of the eastern North Island.

Elsewhere in New Zealand the earliest known archaeological sites are dated reliably (using moa eggshells) from the late 13th Century to AD 1300 (eg the Wairau Bar site in Marlborough). Hence the current model for settlement (called the late settlement model) is set at *c.* AD 1250–1300.

New approaches

So, how to test the two competing hypotheses and especially to verify or otherwise the 'old' rat bone ages? One way was to obtain more dates from the original sample material that led to the 1996 paper. However, it was embargoed by Te Papa, and then when that lapsed it was reported that 'no further material is available'. Two scientists, Dr Janet Wilmshurst (Landcare Research, Lincoln) and Dr Tom Higham at Oxford University (formerly at Waikato University) came up with two approaches.

The first was to use an alternative method for dating the arrival of rats which bypassed the need for bone dating. This was done by obtaining AMS (accelerator-based) radiocarbon ages on unequivocally rat-gnawed woody seed cases preserved in sediments. Wilmshurst and Higham dated numerous seeds at three sites, one on Coromandel Peninsula and two in Taranaki (ie opposite sides of North Island). The results were extremely clear: all rat-gnawed seeds were younger than about 750 years old. The results at the Coromandel sites were confirmed by my unequivocal identification of Kaharoa Tephra there – no rat-gnawed seeds were found beneath the Kaharoa layer, but plenty above it which had given the young ages. The conclusion from this work (published in 2004) was that rats arrived after *c.* AD 1250, and not before.

The rat-gnawed seeds dating was supported by a similar study by Dr Fred Brook who dated rat-gnawed land-snail shells in Northland – his results (published in 2000) were the same: no snail shells had been nibbled before *c.*

AD 1250–1300. His dates were done at the Waikato University Radiocarbon Lab.

Together, the newly dated rat-gnawed seeds and snail shells (from widely spaced sites) showed it was extremely unlikely that there were any rats in the North Island before *c.* AD 1250–1300, but plenty after that date.

Otago revisited

The second approach was to re-examine independently the original avian predator deposits and collect new materials for dating and re-analysis. The results from one site have been published by Anderson and Higham (in 2004) – that site was called Earthquakes #1, north Otago, one of Holdaway's key 1996 sites.

They obtained two new radiocarbon dates for pigeon bones and two on rat bones: the pigeon-bone dates were as reported in the first series (ie 'young') but the two rat-bone dates were much younger than in the first series, suggesting that the 'old' rat-bone ages from that site were not reliable for estimating the timing of human settlement.

Wilmshurst, Higham, Anderson and Trevor Worthy (Adelaide University) have collected rat-bone and bird-bone samples from other avian predator sites in the South Island, including Holdaway's original sites. The results, as for the new seed dating work, were presented at a conference in Oxford in April and are in the process of being written up and so are not yet available.

Holdaway attempted to re-date his sites using another technique called optical luminescence dating (OSL), which involves dating quartz grains. He claimed to have verified the 'old' rat-bone ages with OSL dates (in 2002). OSL dating relies on the assumption that the luminescence signal of grains is fully reset to zero by sunlight exposure before deposition. If this requirement is not fulfilled, ages may be grossly overestimated. In particular, poor bleaching can significantly affect age estimations of young sediments (especially within the last 3000 years). Because the sites are so disturbed and because the technique has uncertain (at best) to virtually zero reliability for such young deposits, the OSL dates have zero credibility.

My position has been one of scepticism for the early settlement model because of the lack of hard unequivocal evidence for it, but a reasonably open position regarding the 'transient contact' model, and the 'old' rat bone dates were intriguing. The wiggle-match date for the Kaharoa Tephra helped cement the late settlement story.

But I believe Anderson especially was unconvinced from the start by the 'old' rat bone dates hence he set about his examination of the literature and discovered the 'dating trend' from one laboratory and set up the 'blind sample' test. It seemed that it would be impossible to establish the truth when it was announced that no material was available for re-testing – but then the prescient rat-gnawed seeds and snails work came along.

The rat-gnawed seeds paper of 2004 especially, plus the re-dating of rat bones at Earthquakes #1 site paper, convinced me and most others that the 'old' rat-bone dates were highly questionable. Our 'gnawing' (!) doubts about the possibility of erroneous ages were confirmed.

Sutton's paper certainly has stimulated a lot of work and he may well still be right. But the evidence is very strong now for late settlement. The next move is to publish the South Island nibbled seeds and rat-bone and avian-bone data from re-examined sites. That might be the end of the story.

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