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UPDATE

Population genetics in the rat race

Norway rat on Okahu Island, Bay of Islands. Photo: Stephen Cope.

Many ecologists consider rats to be the biggest pest problem in New Zealand, especially the ship rat, *Rattus rattus*, and the Norway rat, *R. norvegicus*, both introduced by European settlers in the 19th century. Rats can live almost anywhere and eat almost anything, easily out-competing native birds for food, as well as feeding directly on their eggs and chicks. They also have a rapacious appetite for seeds and vegetation, and can bring the usual processes of forest regeneration to a halt.

Control of mainland rat populations is difficult and expensive, so conservation effort is largely focused on rat-free sanctuary islands. But do rat-free islands always remain rat-free? Rats have proved themselves to be formidable colonisers in the past, assisted by timber-constructed boats and indifferent human attitudes. What is the invasive threat posed to sanctuary islands by the modern rat?

With the support of a Marsden grant and the Department of Conservation, a team led by Dr Rachel Fewster, from the Department of Statistics at The University of Auckland, has been studying the movements of rats among islands using population genetics. The idea is that rat populations that are isolated from one another become genetically distinct, whereas populations that are linked by continuous migration have genetic elements in common. The genetic record, therefore, stores a complete history of rat migrations, albeit a complicated history that is scrambled at every generation. Rebuilding the history from the genetics of modern-day island populations of rats has been a statistical challenge for the team, which includes PhD students Steven Miller and James Russell, and lab technician Hamish MacInnes.

The team's first task was to go rat-catching, and they quickly learnt not to underestimate the cunning of the field-work rat (*Rattus catchusifyoucanus*). While local island residents complained of plague-like proportions of rats, 12-hour fieldwork days were often rewarded with only one or two catches. James Russell, studying the behaviour of a Norway rat released as an "invader" on an island, lost an entire season of fieldwork when his radio-tagged rat, Razza, left the island and swam across 400 m of open sea to another rat-free island. The saga earned James Russell a *Nature* publication, and his Tom-and-Jerry-like exploits with Razza were featured by over a hundred news agencies worldwide. Razza's adventures

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Dr Rachel Fewster and three members of the Department of Conservation on Poroporo, Bay of Islands. Photo: Stephen Cope.

Dr Rachel Fewster. Photo: Murray Efford.

have even been immortalised in a book by best-selling author Witi Ihimaera.

Eventually, by building links with half a dozen conservation and research agencies, rat DNA samples came pouring in and, by the end of the project, the genes of over 800 rats had been examined. Major study sites were the Bay of Islands, Great Barrier Island, the Hauraki Gulf, and Stewart Island.

The work has confirmed some suspicions and turned up some surprises. Norway rats, known to be good swimmers, are rampant throughout the seven islands in the eastern Bay of Islands, and genetically, the populations on these islands are almost indistinguishable, showing that rats move around freely between islands. Swimming a few hundred metres presents no difficulty to the athletic Norways.

Ship rats, on the other hand, appear to be more reluctant swimmers, as island populations of ship rats can be genetically different even if they are separated by tracts of water as little as 100 m wide. This result appeared puzzling, as ship rats are known to be capable of swimming gaps of this size. The research team believe that the determining factor might be the availability of landing sites on the islands. Islands surrounded by rocks may be less vulnerable to invasion than islands offering gentle beach landings. Alternatively, there could be social and behavioural factors that inhibit migrations among island ship rat populations.

Author Witi Ihimaera shows James Russell his book, *The Amazing Adventures of Razza the Rat*, inspired by James's fieldwork.
Photo: Godfrey Boehnke, The University of Auckland.

One of the most interesting study sites in the project is Big South Cape Island (Taukihepa), located 1.5 km to the west of Stewart Island. Ship rats reached the island in the early 1960s, a disastrous invasion which caused the global extinction of the Stewart Island snipe, the greater short-tailed bat, and Stead's bush wren. For 40 years it has been assumed that the rat invaders came from a fishing boat from Port Pegasus, on the eastern side of Stewart Island, but was this the case? In collaboration with Dr Grant Harper of the University of Otago, the research team examined the genes of ship rats from several locations on Stewart Island and Big South Cape, and historical samples from the 1970s and 1980s stored in Te Papa. They found, first of all, that the historical DNA was astonishingly close to that of the modern-day rats, and secondly, the Big South Cape invasion almost certainly did not come from Stewart Island. The research team are now sampling other regions in an attempt to solve this mystery.

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