MOTUWETA

A RESCUE FROM EXTINCTION

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Adult male Mercury Islands tusked wētā. Photo: Leigh Marshall

WĒTĀ AND MOTUWETA

I choose to use the Māori word wētā rather than the anglicised words weta, wetas or weta's. The context shows if it is singular or plural (as is also the case with sheep and species).

Motuweta, as used here, is not a Māori word: it was created from the Māori words *motu* (island) and *wētā* by Peter Johns as the genus of *Motuweta isolata* (the specific name of the Mercury Islands tusked wētā) (Johns 1997).

KIA ORA

Not long ago, in the early 1990s, all the Mercury Island tusked wētā – perhaps 120 or so large juveniles and adults – survived within a few hectares on Atiu or Middle Island, a small (13 ha) island in the Mercury Island Group east of the Coromandel Peninsula. They once lived on most of the adjacent islands and the nearby mainland until rats arrived in New Zealand and annihilated them. Rats never reached Middle Island, though, so tusked wētā survived there.

A NAÏVE FAUNA

Before humans arrived in New Zealand around 1200 to 1300 AD, the fauna, like that of other oceanic islands, consisted of birds, reptiles, bats, and invertebrates. The only terrestrial mammals were three species of bat. A few species of small frog were also present, which is unusual for oceanic islands.

Predatory birds, reptiles, and bats hunt using sight and sound, except for kiwi and possibly short-tailed bats that use scent as well, so prey either hid or used camouflage for protection, and many became nocturnal. Only two of the bat species – the short-tailed bats – could hunt like other mammals by scuttling about on the forest floor and burrowing into leaf litter. The fauna of New Zealand was therefore completely unprepared when mammalian predators arrived that can hunt using smell so many native species went extinct.

A single small population of tusked wētā meant the species risked going extinct, either by pure chance – few had been seen after a severe drought that began in 1993 – or if rats happened to get ashore. This threat of extinction originally caused the Department of Conservation to classify this wētā as Critically Endangered. We successfully re-populated six islands with tusked wētā after rats were exterminated, and their threat classification was then changed to Not Threatened – Nationally Uncommon. This is my account of how we did this.

The owners of Great Mercury Island (Ahuahu) recently exterminated the mammalian predators from their island and introduced tusked wētā, which subsequently bred successfully. I had little involvement but have nevertheless included my experiences.

This book is written from my point of view so if it reads as if I was largely responsible for our success, I was not! I was, in effect, the nominal leader of a group of experts, conservation workers, and volunteers who worked closely together. Everyone worked cooperatively and wholeheartedly contributed their practical help and/or expertise whenever it was needed. What we achieved is a credit to the whole group.

The story of how we rescued this tusked wētā from extinction is the insect equivalent of saving the black robin, as told by David Butler and Don Merton in the book *"The black robin: saving the world's most endangered bird"* (Oxford University Press). All black robins alive today originated from a single breeding pair,[1] whereas the innumerable Mercury Islands tusked wētā now living originated from a single male and two females, and one of these females laid few eggs.

My story starts in 1998 when the Department of Conservation awarded me a contract to establish tusked wētā on other rat-free islands near Middle Island. First, we needed to capture tusked wētā on Middle Island so that Chris Winks at Landcare Research in Auckland could breed enough for release – Chris had a separate contract to do this. We also needed to develop an effective way to release captive-reared wētā and monitor them so we could check how successful the releases were. Monitoring also allowed us to improve the release method if necessary and it was also needed to verify the long-term survival of the wētā on the islands, or, in other words, to confirm whether the species became established.

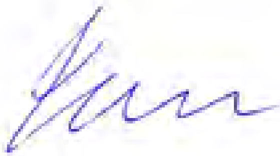
The Department of Conservation, very wisely, didn't give us free reign to do whatever we wanted with the Mercury Islands tusked wētā, given that it was Critically Endangered. They created the Mercury Islands Tusked Wētā Recovery Group (the MITW Recovery Group) to oversee and give official approval of our intended actions. The recovery group also helped develop our strategies and provided constructive discussion. It comprised Department of Conservation staff, some appropriate external experts, together with Rob Chappell, Corinne Watts (Landcare Research Ltd.), and me. George Gibbs (Victoria University of Wellington) attended in 2006 when he independently reviewed the project (Gibbs, 2006).

1 The black robin, an endemic bird of the Chatham Islands, became confined to Little Mangere Island and their numbers there declined to just five birds including a single breeding pair. The fertile female – "Old Blue" – hatched about 1970 and produced young between 1979 and 1982. She raised 11 chicks, and all the black robins alive today are descended from her. The successful recovery programme was devised by Don Merton (Butler & Merton, 1992).

The best option to ensure long-term survival was to establish the insect on other nearby islands that were rat-free.[2] So, Chris Winks, assisted by Paul Barrett (who worked at Butterfly Creek near Auckland Airport), successfully bred hundreds of progeny from the male and two females we captured, and we released them onto four additional Mercury Islands and two islands nearby. They are now established on all six islands as mentioned above, and the first island-bred juveniles have now been found on Great Mercury Island. So, the Mercury Islands tusked wētā is now very much less likely to go extinct.

Lastly, a warning! I've included some technical information if you want additional information. Most of it is in text boxes except for Part 3 "Growth and development" which is entirely 'technical'. If this is of no interest, then skip to Part 4 because you don't need to know the details to continue following the story.

Tēnā koe



2 Pacific rats were exterminated from the Mercury Islands administered by the Department of Conservation between 1987 and 1995.

ACKNOWLEDGEMENTS

I sincerely thank Rob Chappell for his considerable help and unwavering support. We initiated most of the strategies and formulated the day-to-day tasks by drawing on his wide-ranging experience with practical conservation. His extensive knowledge of the Mercury Islands and many practical skills significantly contributed to the success of this project. It was a pleasure working with him: his irrepressible humour made the fieldwork much more enjoyable.

I am deeply grateful to the following who assisted me on Middle Island: Avi Holzapel, Carl McGuiness, Cathy Lake, Corinne Watts, Darryl Gwynne, Esta Chappell, Glenice Hulls, Graeme Murtagh, Grant Blackwell, Halema Flannagan, Hayden Hewitt, Jarn Godfrey, Jens Jorgensen, Kahori Nakagawa, Katie Cartner, Katrina Hansen, Larry Field, Leigh Marshall, Lisa Sinclair, Malcolm Wood, Maree Hunt, Marieke Lettink, Mark Fraser, Mathew Wong, Matthew Low, Megan Mclean, Melissa Thompson, Miranda Oliff, Oliver Overdyck, Paul Barrett, Phillip Eades, Richard Overwijnk, Richard Parrish, Rob Chappell, Suzanne Bassett, Yvette Cottam. All cheerfully searched for long periods at night without complaint, even when conditions were unpleasant. They contributed substantially to the pleasure I got working on the island, and I hope they enjoyed the experience even more than I did.

Corinne Watts, Danny Thornburrow, and Robbie Price (all Landcare Research Ltd.) collaborated with Rob and me during the last five years of the project. They helped establish tusked wētā on additional islands, thereby ensuring the insect's long-term survival. Corinne's innovative use of footprint tracking tunnels for detecting wētā enabled us to survey large areas intensively. I enjoyed their company and thank them for the huge amount of work they did. I also thank James Russell, Jo Peace, Peter Corson, and Steve Bolton for helping with the final survey of tusked wētā on Red Mercury Island in October 2018; and the 35 volunteers (named in Appendix 1) who assisted Rob Chappell with the field work when I was not present.

I am most grateful to Liz Grant and Hamish Mack for collaborating with the laboratory research. They took ownership of the care and husbandry of the wētā and ensured that the insects thrived. They also obtained most of the data, provided valuable discussion and ideas, and ensured the project's continuity when I had other commitments.

Jim Hope, Rob Ray, and Russell Clague provided transport to the islands when Rob Chappell was not available, and I thank them for their cooperation and helpfulness.

I acknowledge the following people whose work behind the scenes helped ensure the success of this project. All gave of their very best, as do all who work in conservation.

Chris Winks' expertise in captive rearing was crucial. He developed an effective method and, with help from Paul Barrett,[3] provided all the insects for translocation. This involved a huge amount of time and effort. Without his help, the Mercury Islands tusked wētā would now be extinct.

The recovery Group developed the overall conservation strategy and provided guidance and valuable support. Avi Holzapel, the initial convener, skilfully welded us into a cohesive group while suffering our humour with benevolent tolerance. Leigh Marshall took over after Avi left in 2004 and continued in his tradition. The other members were Chris Green, Chris Smuts-Kennedy, Chris Winks, Corinne Watts, Graeme Ramsay, Jason Roxborough, John Gaukrodger, Paul Gasson, Rob Chappell, and me. George Gibbs (Victoria University of Wellington) attended in 2006 while he was independently reviewing the project.[4] He also provided helpful advice. Larry Field (University of Canterbury) attended in 2004 while supervising an MSc student investigating the behaviour of tusked wētā.

Our debates were impartial and the meetings were constructive, effective, and refreshingly different from many other meetings I have attended. I believe our success was in part due to the Recovery Group taking some calculated risks (after much debate and careful consideration). Conservationists are normally very risk-averse for obvious and perfectly understandable reasons, especially when a critically endangered species, such as this tusked wētā, are involved. The risks we took fortunately paid off and expedited the successful outcome.

Historical information was provided by Alison Balance, Chris Winks, David Riddell, Ewen Cameron, Grace Hall, Graeme Ramsay, Ian Southey, John McCallum, Mark Bellingham, Mary McIntyre, Murray Potter, Paul Scofield, Peter Bellingham, Phil Thomson, Sandy Bartlet, and Tony Whitaker. I am very grateful to them for sharing their experiences and for patiently answering my queries. I am further

3 Two Paul Barretts were involved with this project. Paul Barrett from Massey University helped me on Middle Island whereas Paul Barrett from Butterfly Creek (www.butterflycreek.co.nz) captive-reared 60 tusked wētā for translocation.

4 Gibbs (2006).

indebted to Mary McIntyre for providing helpful advice on how and when to search for tusked wētā and for generously sharing many of her unpublished observations.

Corinne Watts, Richard Parrish, Greg Sherley, Rob Chappell, and Suzanne Bassett kindly checked the facts in relevant chapters. I am indebted to Andrea Forde for editing the first draft, and to Paula McCool for subsequently editing and guiding me through the process of publication. All errors, though, are mine.

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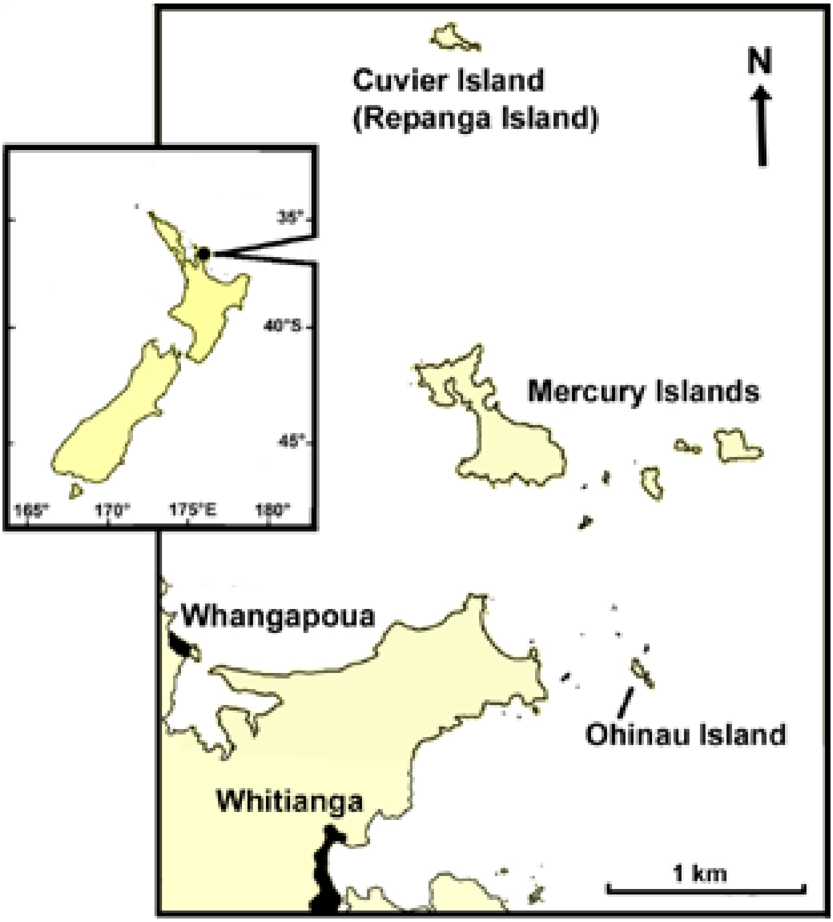
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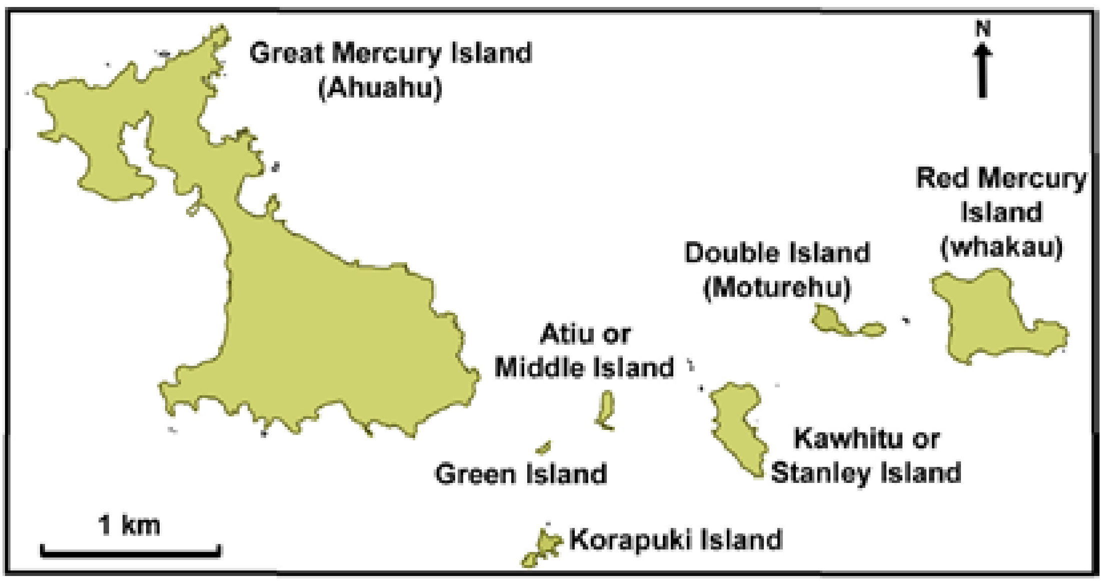
Great Mercury Island
(Ahuahu)
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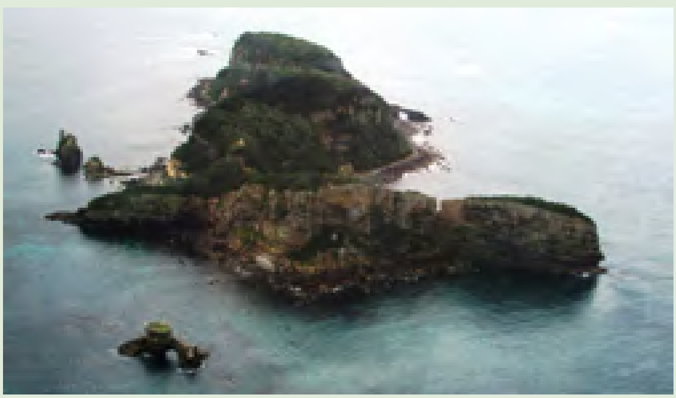
Island
(whakau)
Double Island
(Moturehu)
Atiu or
Middle Island
Kawhitu or
Stanley Island
Green Island
1 km
Korapuki Island

ATIU OR MIDDLE ISLAND

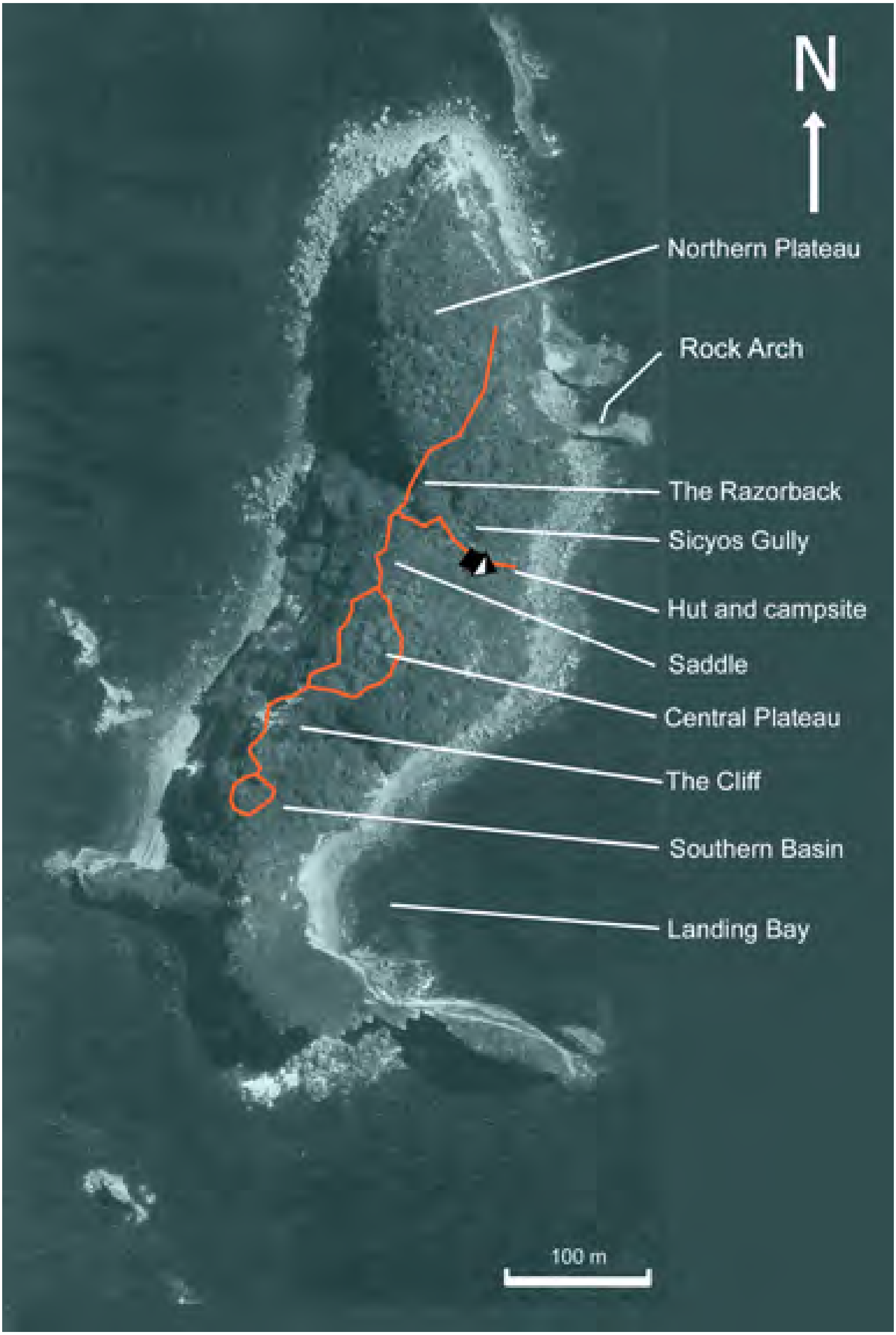
The correct names are Atiu or Middle Island, but we always referred to it as Middle Island. The Island is approximately 80 m high and covers around 13 hectares. High cliffs surround it, except in three places where you can land safely when the sea is relatively calm and climb up to the top. The best landing is a small east-facing boulder beach, which I call The Landing Bay.

There is no fresh water on the island, so humans have never lived there permanently, and neither have rats, those ubiquitous companions of man. Māori certainly visited in the past to harvest seabird chicks for food, but nowadays the only people allowed there are scientists and field workers.

Middle Island is one of the few remaining places in New Zealand that has retained most of its original pristine condition. The Department of Conservation administers it as a Scenic Reserve with secondary conditions of use as a Wildlife Sanctuary. Access is restricted to reduce the chances of accidentally introducing alien species and diseases (the text box 'Administration of the Mercury Islands' in Chapter 3 has more historical information). The only non-native animals present are introduced birds such as blackbirds, chaffinches, and starlings that fly in to roost at night. A small Australian cricket (*Ornebius aperta*: Orthoptera: Gryllidae) was introduced accidentally. It can be heard in summer, usually around evening, near the top of Sycios Gully, where it lives amongst the foliage of taupata and coastal maire trees. Males produce a soft chirping with a ventriloquist quality that makes them extremely difficult to locate. The insect is flightless (although the male retains forewings with which it makes the sound), so it must have been introduced inadvertently by people. The vegetation "although not necessarily unaltered by Polynesians, appears to have been little disturbed for a considerable time" (Atkinson, 1964). John Cameron reported that a quarter of the 92 species of vascular plants recorded from Middle Island are "introduced weeds, and that most ... were probably brought in by birds [carrying seeds in their droppings]" (Cameron, 1990).



Atiu or Middle Island viewed from the south. Photo: Ian Stringer



Map of Atiu or Middle Island showing the paths we followed when searching for tusked wētā. The names follow Cameron 1990 and McIntyre 1991

INTRODUCTION

"There's only one problem with islands, Ian."

"What's that, Rob?"

*"**Scientists!** We know how to look after islands, but scientists just want to interfere and change everything."*

It was early afternoon on September 22, 1998, and Rob Chappell was taking me to Middle Island to show me where to land, camp, where I could and should not go, and generally what I could or should not do. We had left Whitianga in the *Kuaka*, a Department of Conservation open runabout, and were skimming over a glassy sea on a gloriously fine day. Rob had not spoken for 20 minutes or so. He was glowering – the expression 'a face like thunder' came to mind. He was seriously worried. He had experience with university staff and students before and was deeply concerned about letting me, a university lecturer, loose on Middle Island. He strongly suspected that I had my head in the clouds, had little or no common sense, and lacked any practicality.

His comment broke the silence as we rounded the north headland of Mercury Bay, and revealed a scattered archipelago of islands spread out ahead of us. I had no answer to his assertion, but the sight of all those islands, both near and far, big and small, was just too much, so I began asking endless questions: which ones are the Mercury Islands? Which one is Middle Island? Do you expect me to climb those cliffs? What are these small islands in front of us? Who owns them? Have you been onto them? ...

We had brought 10 thick concrete tiles (230 mm x 190 mm) to carry over to the Southern Basin and scatter about near a large rock in an area that Mary McIntyre called "The Weta Bank". Mary was the first to do field research on tusked wētā – between 1991 and 1994 – and had named the area after finding most tusked wētā there. Mary had also suggested placing the tiles there in case they helped us locate some of the insects. She had noticed they often dug their shallow chambers next to rocks or by tree roots and reasoned that they might do the same by tiles. If they did, then all we had to do to find wētā on subsequent trips was to look under the tiles.

Mary told me a lot about tusked wētā, and I am most grateful to her for generously sharing it. Her most important discovery relating to my field work was that most tusked wētā emerge and are active on the ground on moonless nights, especially if it had rained a few nights earlier (Chapter 3). This saved me a huge amount of time because I timed my trips around the new moon when the darkest periods of the night were longest.

Even so, there were still some constraints. I had to try to go when the weather forecast indicated that the sea would be calm enough to get ashore safely. I was also limited to periods when I had no teaching commitments at Massey University. This all meant that I had to ignore any forecast of rain, but fortunately, the weather was usually good.

A light breeze ruffled the surface when we arrived at Middle Island, and only small waves splashed onto the rocks. Rob nosed the small inflatable dinghy (which we used to ferry everything between the *Kuaka* and the shore) right up against the boulders below the campsite, and we unloaded the concrete tiles. Rob then rowed us around to the Landing Bay and pulled the dinghy well up onto the gravel beach. We exchanged our diving booties for tramping boots and rock-hopped back to where we had left the tiles. This took about 20 minutes.

Rob first took me on a conducted tour of the route I was to follow when searching. He had previously marked this with pink flagging tape tied to tree trunks, and I was given strict instructions to *always keep to the path*.

We started up a steep slope, hunched over beneath low bushes of taupata and karo while struggling to stop slipping on the crumbling, dry, reddish soil underfoot. The air was heavy with the ammoniac stench of bird guano – white splattered droppings were scattered abundantly over the ground – and we were plagued by persistent flies that we constantly waved off. Entrances to seabird burrows were everywhere, and we had to be careful not to step too close above the entrances or they would collapse.

About 30 m up, the vegetation changed to tall karo with a few milk trees (*Streblis banksii*), and we could stand upright. We then passed three small level areas, each

The Landing Bay and surrounding cliffs on Middle Island. Photo: Kahori Nakagawa only big enough to pitch a small tent (the Department of Conservation allows only three people on the island at a time to minimise damage to the habitat). We followed the marked path up an even steeper section through taupata-wharangi scrub until we emerged onto a wide saddle between the Northern and Central Plateaux. Here we turned left up a gentle slope towards the Central Plateau and followed the flagging tape around its eastern side, passing a meteorological station that Rob had installed previously for Chris Winks at Landcare Research in Auckland. Chris was developing a method for captive-rearing tusked wētā and needed to know what temperature and humidity the insects were subjected to on the island.

Our route continued about five metres in from the eastern cliff edge and led into a forest of milk trees, up to 10 m tall. The ground sloped slightly to the east and was surprisingly open – in most places, the forest floor was visible for 15 m or so. The ground was only obscured in a few places by fallen tree trunks and the occasional low fern (mostly *Asplenium haurakiense* and *Asplenium oblongifolium*). The soil was largely hidden beneath leaf litter, and I could see that the dry brown leaves might make it hard to spot wētā if they were a long way off. The only places where wētā would be almost impossible to find were amongst the occasional patches of ink weed (*Phytolacca octandra*) that grew in dense clumps wherever there were gaps in the canopy. Seeds of this adventive weed are brought in by European birds, such as starlings, which fly to the island in the evening to roost undisturbed by predatory mammals. Rob pointed out where he had found tusked wētā previously, but most of this was lost on me because the base of one milk tree looked much like any other.

The ground was honeycombed with bird burrows, and it wasn't long before the soil beneath Rob gave way, and he broke through into one. He then showed me what to do when it happened to me. He dug out the soil that had fallen in with his hands until he was sure the burrow was completely clear in both directions. Burrows can be quite long and twist and turn, so you usually don't know which way leads to the nesting chamber or the entrance, and Rob was concerned that nothing got trapped – a tuatara or a seabird, for example – in the blind end. He then covered the hole with a meshwork of sticks, spread a thick layer of dry leaves on top, and finished it off with a thin layer of soil he had excavated. The rest of the soil was left to the side so the tunnel didn't become blocked when the sticks eventually gave way. Rob stressed that it was important to cover a nesting chamber if I ever happened to step into one, hopefully without damaging the bird or chick. We both broke through into several more burrows as we walked around the island: it was unavoidable – the soil just gave way suddenly without warning. It was obvious why I should *always keep strictly to the marked route* so that any damage was restricted to a narrow pathway, but Rob worried that I might forget and so repeated it like a mantra now and then.

We, of course, also stepped preferentially on any rocks or exposed tree roots, but there were few of these.

The route forked at the southern end of the Central Plateau: the branch to our right went back along the western cliffs to complete a loop around the plateau, while the left-hand branch led to a steep, narrow path that curved down around a cliff to the Southern Basin. I called this The Cliff, and we went down it. The path here was a narrow ledge that sidled downward steeply, and the cliff itself had a slope of perhaps 80°. It provided a bird's eye view of the Landing Bay about 80 m below us – seemingly vertically beneath our feet – with the *Kuaka* anchored a few hundred metres out in the bay. A climbing rope strung between waratahs (steel posts with Y-shaped cross-sections used by farmers as temporary fence posts) provided something to hold on to.

The Southern Basin slopes less steeply – about 30° – towards the tops of the cliffs that encircle the northern end of the Landing Bay. Our search route here was more or less circular: we followed it south, passing through the area Mary McIntyre called the Weta Bank, then it curved around downslope and back up steeply to complete the loop.

We climbed back up The Cliff, hauling on the rope to help us up the steep path, and then followed the path along the western edge of the Northern Plateau, a few metres in from the edge. Here, a sheer cliff drops 80 m to a rocky shore platform, but a ribbon of dense scrub along the edge makes it difficult to reach the lip, and I could see that it would prevent anyone from accidentally blundering over at night. Our path eventually rejoined the eastern route at the start of the Central Plateau.

We retraced our steps back along the Saddle, passed the track down to the campsite, climbed over a tangle of exposed roots, skirted a huge, rounded boulder[5] and arrived at what Mary called The Razorback. This is a narrow ridge of crumbling rock 21 m long that slopes up at 20° to join the Northern Plateau. Access to its lower (southern) end is gained by scrambling up a bank about three metres high. Rob had thoughtfully driven a waratah in at the top and tied a rope to its base as an aid to climbing up.

The top of the Razorback varies from 30 cm to about one metre in width. An almost sheer cliff runs along the western side, and a hedge of dense pōhutukawa foliage – up to about two metres high – runs along the eastern side. These trees grow along the eastern base of The Razorback, and the hedge is formed by windshear over their tops. It provides a feeling of security, but there is nothing substantial to hold on to, just the ends of thin terminal branches. The western cliff increases in

5 Tony Whitaker discovered the first tusked wētā under this boulder as explained in Chapter 1.

height to about 15 m where it joins the Northern Plateau. There is a similar cliff along the eastern side but I was unaware of it at the time – I discovered it during a later trip when I peered into the hedge looking for a plastic wine glass I had knocked over.[6] Mary had named The Razorback well.

Rob hauled himself up onto The Razorback using the access rope, then nonchalantly strolled along the narrow ridge, glancing at the view on either side as if he were wandering along Queen Street in the centre of Auckland. I first baulked and then decided, well, if he can do it, then so can I. And I had better start before he turned around to see what was delaying me. So off I set gingerly and apprehensively.

We had to push through low bushes at the top of The Razorback to gain entry onto the Northern Plateau, then the route led us along near the edge of the eastern cliffs. It passed through a small grove of karaka trees first, then entered a forest of mature milk trees and ended abruptly after about 90 metres. This meant a lot of the Northern Plateau wouldn't be searched, but Rob didn't want me to go there because Mary had never found tusked wētā there, and the density of seabird burrows was too high to justify all the damage I would do to the nests.

We retraced our steps back to the Razorback, where I discovered, to my dismay, I had to step down about half a metre or so onto the Razorback. I didn't notice it going up, but I certainly noticed it going back down because this was where The Razorback was at its narrowest and highest. Beneath me, to my right, was a view straight down the western cliff face onto a steep slope that ended at the rocks at the seashore. Stout bushes at the edge of the Northern Plateau, however, helped me get down by providing secure handholds. On later trips, volunteers and I simply jumped down this step once we became used to it.

The rope at the lower end of The Razorback helped us get back down onto the Saddle: we grabbed hold of it, leaned backwards, braced our legs against the bank, and walked ourselves backwards and down. Easy! We especially appreciated this on later trips when we were tired at the end of a long night of searching.

When we returned to the coast below the campsite, we filled our backpacks with the concrete tiles and carried them over to the Southern Basin, where we scattered them around on the Weta Bank. We also pegged them firmly with pieces of Number 8 wire bent into appropriate U-shapes. This was necessary, according to Rob, to prevent the tiles from being dislodged when seabirds tried to burrow under them – as Rob was sure they would.

6 We often watched the sunset on The Razorback with some wine and cheese when the weather was suitable.

Seabird burrows at the base of a cliff at Landing Bay, Middle Island. Photo: Ian Stringer

It was late afternoon by the time we reached the rocks below the campsite, so we sat down to await nightfall and ate our dinner of sandwiches we had purchased in Whitianga. I perched on a rock looking out towards Stanley Island opposite us, and enjoyed both the view and the still, warm, calm evening. Rob tucked himself behind a huge rock nearby, looking back inland at the bush. I remember thinking how strange. I said nothing because I hardly knew him. I supposed different things interested different people.

As dusk deepened, diving petrels started to arrive. They approached flying with rapidly beating wings just above the sea and most then curved upward towards the forest higher up the island. Some, however, arrowed straight into the bushes behind me. A few of these flew straight at me, making me duck quickly. Even so, their feet lightly tapped the top of my head as they deflected off. What if one flew right into my face beak first! I quickly scuttled over and took cover beside Rob.

"Thought you would join me eventually," he said with a wide grin.

Sitting looking back at the island, I eventually noticed a small solar panel that I presumed powered Chris Wink's met station. It was attached to a stout branch that projected way out over the steep hillside near the top of the island. I was about to ask Rob how he managed to fix it so far out when he announced that it would soon be dark enough to search, and we should get ready. We bustled about sorting out what we needed, fixed our spotlights to their headbands, connected them to batteries in our backpacks, and started up towards the campsite. It was 7 pm.

Rob then led me into a world that was so very different from the one we had explored in daylight. The transformation was truly amazing. During the day, the island appeared to be asleep except for birds such as tui, blackbirds, and red-crowned kakariki, and the occasional tuatara that basked in small patches of dappled sunlight. Nothing else seemed to be around except, of course, the ubiquitous flies. At night, the island burst with life. Large numbers of diving petrels were landing by simply falling through the canopy: it rained birds. Each hit the ground with an audible thump and a faint expulsion of breath; they then sat for a few moments as if dazed, shook their heads a few times, and then scampered off. As expected, a few landed on our heads. They were soft and light, so they didn't hurt at all, but they gave us a shock because they arrived silently and so hit us unexpectedly. Most disappeared down burrows, so, although numerous birds arrived, surprisingly few remained on the surface. They made short mewing calls, rather like a person replying "Mmmm" to a comment but ending with a slight increase in pitch suggestive of asking a question. As the evening wore on and more birds arrived, their calls combined to create quite a loud cacophony.

Tuatara were out in numbers – grey statues waiting in ambush for prey – skinks scuttled about amongst the leaf litter, geckos clambered on tree trunks and amid foliage, and we saw lots of insects. The most common were black darkling beetles, 1–2 cm long, which seemed to be grazing on a thin layer of green moss or lichen on tree trunks. We saw a few small wētā, which we presumed were ground wētā, but none were large enough to be tusked wētā.

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We got back to the Saddle at 9:25 pm after completing a full circuit of the route. Rob then wanted to wait for an hour or so before we started a second search, so we sat on the bone-dry ground and turned off our spotlights. This allowed us to discuss what needed to be done before I started my research in earnest. What I most wanted was a rope along The Razorback to act as a 'handrail' like the one down The Cliff. This would provide some security when it was wet and windy, and especially when we were tired at the end of the night. Rob advised me to replace the flagging tape with permanent orange triangular plastic track markers on my next visit and suggested attaching reflective tape to them, so they were visible at night.

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We had seen a couple of giant centipedes, so we spent some time discussing them. I knew that their bite is excruciatingly painful because many years ago, a friend got bitten by one that had crawled into his sleeping bag during a field trip. Rob suggested that hospitalisation might even be required and then mentioned, more as an afterthought, that it's sometimes almost impossible to get off the island.

This was another very good reason, he said, to avoid stepping into burrows if possible: a centipede could very well be in residence!

In general, I was not too worried about giant centipedes and had even kept one in an aquarium in my office at Massey University for a few years. That one had emerged from a hole an architect had made by pushing her finger into a rotten weatherboard while assessing the Palmerston North Hospital morgue for repairs. She was married to a lecturer who taught with me, so she kindly and very thoughtfully caught it. I subsequently kept it alive to show to students during the appropriate laboratory session. I recalled that Richard Parrish, who also worked for the Department of Conservation, described the sound these centipedes make when moving through dry leaf litter as a chittering noise like that made by old sewing machines. We carried on chatting while listening intently for such a sound, but no centipedes came near us.

At 10:40, Rob decided we should start the last search. This time, we split up and went in opposite directions, but neither of us saw any tusked wētā. Negotiating the razorback no longer worried me, but I had a real problem finding my way back to it after I finished searching the Northern Plateau. The route seemed so obvious when I followed Rob earlier, but it turned out that the flagging tapes were hidden under low, dense vegetation around the junction with The Razorback. I just couldn't find them. I carefully retraced my steps back and forth several times before I finally bent down sufficiently low to see the first of the pink tapes leading to The Razorback. Rob was visibly relieved when I eventually got back to the rocks below the campsite about midnight, and he told me he was about to set off to search for me. I think he imagined that I had bumbled over a cliff in a vague dreamy world of my own.

As we clambered around the rocks to the Landing Bay, the noise from the sea seemed so loud that I became concerned we might have difficulty leaving the island. Rob, however, explained that the sea always sounds much louder at night, especially on moonless nights when you can't see the waves. He was right: when we pushed off in the inflatable dinghy, the small waves were no bigger than when we had landed.

Rob then told me what happened to him on an early trip when he went searching for tusked wētā. Steve Bolton, a Department of Conservation field worker, was with him on that occasion. The night was pitch-black, and when they finished searching, the waves were making a tremendous noise crashing onto the rocks around them – the noise was undoubtedly amplified by reflecting off the surrounding cliffs. All they could see were dimly reflected areas of white foam dancing about and little else because their headlights were only good for searching a few metres in front of them. It seemed that it had become so much rougher that they would get drenched rowing back to the *Kuaka* or, even worse, their dinghy could get overturned in the

BITTEN BY A GIANT CENTIPEDE

(Excerpt from pages 6–7 in 'AhuAhu (Great Mercury Island): Memoirs of Cameron Buchanan, resident of Mercury Island 1859 – 1873')

"I was awakened at 2 a.m. one morning by my mother who called for a light and said that something had bitten her foot, a candle that I hurriedly took in, disclosed a large centipede as it ran down the valance towards my bare feet. I got so excited that I set fire to the mosquito net, which flared towards the ceiling, but Mother showed great presence of mind, tearing it down before the ceiling went ablaze. The wound made by the centipede was very painful and caused a swelling and a blueness like a bruise. The patient was given a teaspoon of brandy at intervals and the foot well soaked in hot water, followed by an application of fluid Ammonia to the wound between the toes. The treatment proved effective although the pain lingered. ...Mothers toe was blue and painful for six weeks after this incident. We were very fortunate in having the remedies at hand."

Note: The Buchanan family was the first European family to live on Great Mercury Island. They originally leased it for £5 per year from the Crown Lands Board.

Giant centipede (19 cm long). Photo: Kahori Nakagawa

surf. They would then have to endure a 40-minute trip in wet clothes in an open boat until they reached Whitianga. Not good.

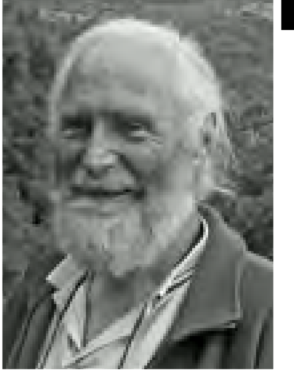
They decided that their best option was to remove their clothes, bundle them up tightly, and jam them into the bow under the tiny quarter deck in the hope they would stay dry. Stark naked, they waited for a lull and then rushed the dinghy out to sea, tumbled aboard, and rowed for dear life. To their utter amazement, they found it was no rougher than when they had arrived. They didn't even get splashed. Rob then stressed how important it was to have a powerful torch in addition to spotlights if we ever planned to leave the island on a dark night.

We finally got back to Rob's home in Coromandel about 2 am.

PART 1
HISTORY

Quite a lot was known about Mercury Islands tusked wētā when I started working with them, so it's appropriate – before I start my story – that I explain what other people had discovered together with some of the adventures they had.

A species 'new to science'. Photograph taken by Tony Whitaker of the first Mercury Islands tusked wētā he found in 1970[7]



Tony Whitaker

7 The original photograph is a colour slide that is reproduced here in black and white because the colours have changed over time.

CHAPTER 1
DISCOVERY

An extraordinary find

Early in the night of Monday, 16 March 1970, Tony Whitaker struggled through scratchy scrub up the steep western side of Middle Island from his campsite. He reached the base of a rocky cliff near the top (The Razorback ridge), turned right, and followed it up diagonally to a saddle between two plateaux. It was a dark, moonless night (moonrise was at 1:38 am), and Tony, a reptile expert, was there with Ian Crook, a veterinarian, to survey lizards and tuatara. Tony turned right at the saddle and was confronted with a huge, rounded boulder perched on a low, wide pedestal of reddish soil. There was a rabbit burrow-sized hole beneath this rock, so he bent down to look in, thinking it was a likely place for a tuatara. There, facing him, was a large wētā with a pair of tusks shaped like those of an elephant. He immediately realised he was looking at a new species because it was much larger than a small species of tusked wētā that he knew lived in Northland.[8] The insect Tony was looking at was even larger than the common tree wētā.

A section of the rugged western cliffs of Middle Island. Tony Whitaker found the first tusked wētā in 1970 after climbing up to the Razorback ridge, then following its base diagonally up to the Saddle on the right. The Razorback slopes up from the saddle and provides access to the Northern Plateau on the left (stanchions for a safety rope are just visible along the top). Photo: Ian Stringer

8 A third medium-sized species, the Raukūmara tusked wētā, was discovered much later in August 1995.

Imagine what he felt! A new species! And such a spectacular one. He captured it in one of the cloth bags he always carried for collecting reptiles and clambered back down to the campsite where Ian Crook, Ian Atkinson, Bob Simpson, and Don Merton (of Black Robin fame) were gathered. People never camp on the western side of Middle Island now because it is too steep and exposed, but they do occasionally land or leave the island from the jumbled boulders along the shore there when the sea is too rough on the eastern side of the island.

Tony worked in the Ecology Division, Department of Scientific and Industrial Research (DSIR), and didn't have a permit from the New Zealand Wildlife Branch of the Department of Internal Affairs (renamed the Wildlife Service in 1974) for collecting anything from the island. But Ian Crook, the expedition leader, did work for the Wildlife Branch and didn't need one. So, he took possession of the wētā, and it subsequently resided in a jar of preservative in his office for some time afterwards.[9]

A cryptic species

News that a most unusual wētā had been found on Middle Island eventually leaked, and several trips were made over the next 13 years to search for it. All were unsuccessful. Graeme Ramsay, a scientist at DSIR Entomology Division in Nelson, went along on one of these trips in November 1973 because he was especially interested in wētā (he had researched Cook Strait giant wētā on Mana Island for his MSc degree).[10] This trip to Middle Island again included Ian Crook, Tony Whitaker, and Don Merton, and although they found no tusked wētā, they all remembered the trip because Graeme injured an eye.

The navy put them ashore on Ruamahuanui Island (usually referred to as Nui Island) in the Alderman Islands, where they camped. They were there to survey wildlife on all the Alderman Islands, and they had a dinghy to get to the other islands from Nui. The navy was going to take them to Middle Island in the Mercury Islands Group when they had completed their survey.

9 At the time, Middle Island had just become a Scenic Reserve and Wildlife Sanctuary and a permit, issued by the Wildlife Service, was required for removing anything from it.

10 Ramsay (1955).

At one stage, three of the scientists went to Middle Chain Island, leaving Graeme behind on Nui to look after the main campsite. They planned to camp on top of one of the islets for 24 to 36 hours while they collected specimens of the fauna.

Middle Chain Island consists of a row of three large bush-covered islets linked together by a series of lower rocks and reefs. Vertical cliffs almost completely surround them, and no one can get onto two of them unless they are experienced rock climbers, but there is one place where you can get up onto the third islet (if you are keen enough). The islet is small, so the scientists finished surveying the fauna and flora during the first day and decided to return to Nui that night. As they approached the campsite about 1 am, they heard Graeme calling for help and found him tucked up in his sleeping bag, nursing an eye from which a matchstick-sized twig projected. Luckily, the twig had gone between the tissue layers of the eye (the sclera and choroid layers) and had not penetrated the centre (the vitreous body).

Graeme explained how the accident happened. He leaned over a cliff to see how high up he was and held on to a small tree for security, but the tree sprang back unexpectedly when he pulled himself back, and the end of a dead twig caught him in the eye and snapped off. He told me he knew he was in trouble when he saw a small piece of the white of his eye stuck to the part of the twig still attached to the bush. He made his way back to camp, took some pain-killing tablets, and crawled into his sleeping bag to await the return of his companions, expecting them the next day.

Ian Crook realised how serious the injury would be if it became infected because the eye is close to the brain. He carefully extracted as much of the twig as he could, disinfected the eye, and fastened dressings over both eyes to try to immobilise them. In the meantime, Tony Whitaker was dispatched to the top of the island with their two hand-held radio telephones and all but one of the spare batteries. His instructions were to keep calling for help until the batteries were dead. This was well before cell phones, and the radio telephones they used in those days only had a range of perhaps a kilometre or so. Fortunately, a fishing boat came close enough during the night to hear the distress call and passed it on to the navy anchored in Tairua Harbour for the night. By the time the navy arrived the next day, the sea had become much rougher. Graeme had to be led, blind, to a calmer part of the island where he was picked up, taken to Whitianga, and flown to Auckland Hospital.

Later, when the navy collected the expedition members from the Aldermen Islands to transfer them to Middle Island, there, much to the surprise of the others,

EXTRACTING SMALL INVERTEBRATES FROM LEAF LITTER

This is done by pouring leaf litter onto a mesh fixed halfway down a wide funnel (called a Tulgren or Berlese funnel) and gently heating it from above with light bulbs. As the leaf litter progressively dries down from the top, the invertebrates migrate downward and eventually pass through the mesh and fall into a container of preservative beneath the spout. Think how difficult and time-consuming it would otherwise be if the tiny invertebrates were all dead and had to be picked out (some not much bigger than motes of dust) under a microscope!

was Graeme, sporting a patch over his eye. Graeme had discharged himself from the hospital as soon as he could so he could rejoin the expedition: he was not going to miss the chance of finding such an unusual wētā! Graeme's eye eventually recovered fully, and he suffered no ill effects.

There was, however, an unexpected and revolting ending to this story. When Graeme was rescued, the other scientists took the opportunity to get the navy to take two big bags of leaf litter off the island and post them to the Entomology Division in Nelson. They had collected the litter to sample the tiny invertebrates that lived within it, and they were very keen to send it to the laboratory as soon as possible because it is much easier to extract small invertebrates when they are still alive.

In all the confusion and rush, some smaller bags containing dead rats were included by mistake. The rats had been killed and put into sealed bags for a few days so ectoparasites such as fleas and lice could be recovered after they had left the carcasses. The intention was to bury the rat carcasses on the island, but the bags had gone when the scientists looked for them. The upshot was that Entomology Division received an urgent call from the post office in Nelson a few days later: would they please collect the bags as quickly as possible because an overpoweringly disgusting stench was emanating from them and maggots were escaping all over the floor.

RATS AND EXTINCTIONS

When Tony Whitaker discovered tusked wētā on Middle Island, he and Ian Crook were investigating how the presence or absence of kiore (Polynesian rats) affected the abundance or absence of lizards and tuatara on offshore islands. Their papers (Crook 1973, Whitaker 1973) demonstrated, for the first time, how kiore depress lizard and tuatara communities, and their work eventually led to a wider appreciation of just how destructive kiore (and other rat species) can be to wildlife. Graeme Ramsay later followed with a scientific paper on the harm rodents can inflict on New Zealand invertebrates (Ramsay, 1978).

Nowadays, most people take it for granted that rodents and other mammalian predators (including humans) have caused the extinction of some species in New Zealand (and on many other oceanic islands). Scientists, however, have not always held this view: most biologists in the first half of the 20th century vehemently denied that rats and other predatory mammals could extirpate a species (one notable exception was Sir Charles Fleming, a distinguished geologist and ornithologist). They were influenced by scientific theories that originated in the northern hemisphere, where predator-prey associations were stable, although some showed cyclical changes. Most biologists in New Zealand therefore considered that predators could not cause extinction! Instead, the reasons for the extinctions that had already taken place in New Zealand – most notably among the birds – were ‘unknown’ and suggested causes included genetic senescence (an innate drive towards extinction), disease, or environmental changes (they argued that in unmodified habitats, change occurs so subtly and slowly that it is undetectable).

Recognition of how destructive novel mammalian predators can be to the naïve New Zealand fauna came later. Such predators can hunt at night using smell and sight, whereas our predatory birds and tuatara use sight (Kiwi are exceptional in that they use smell). Our invertebrates also evolved with smaller birds (and Kiwi), reptiles (again, mostly visual hunters), and bats together with a suite of predatory invertebrates, including tusked wētā.

Gross environmental change certainly did occur after humans arrived, and this reduced the numbers of many native species. Examples include habitat reduction (sometimes to small refugia) by burning and felling forest, while browsing by introduced herbivores changed the composition of the vegetation. Mammalian predators and hunting by humans (for food or for specimens to sell – e.g., the depredations on Huia made by Sir Walter Buller and Andreas Reischek) then ‘cleaned up’ the remaining survivors (and Huia became extinct).

An often-quoted example of how effective predators can be was on Taukihepe / Big South Cape Island after ship rats got there (possibly from a fishing boat moored to the shore). The island had the last remaining populations of South Island saddlebacks, greater short-tailed bats, Stead's bush wrens, and the South Island snipe. Desperate attempts were made to save the birds by translocating some to nearby rat-free islands, but only the translocation of saddlebacks succeeded. The bat was considered (incorrectly) to be a larger version of the lesser short-tailed bat and so was ignored. The efforts to save these birds were vigorously opposed by some biologists who were sure that the populations of rats and birds would eventually develop a stable relationship. This didn't happen: the bat, the wren, and the snipe went extinct (Bell, Bell, and Merton, 2016).

Chapter 15 (Extinction: the final word) in the book "The Lost World of the Moa" by Trevor Worthy and Richard Holdaway (2002) gives a good account of the depressingly horrific story of extinctions in New Zealand

The Alderman Islands viewed from The Razorback. Middle Chain Island is a series of three lower islets between larger Ruamahuanui Island to the left and Ruamahuaiti Island on the right. Honiora Island is the largest island on the far right. Photo: Ian Stringer

CHAPTER 2

REDISCOVERY

The second tusked wētā (a female) found on Middle Island. This photograph was taken as proof that the species had been rediscovered. Photo: Ewen Cameron, 19 January 1983

Tusked wētā were not seen again for 13 years until Ian Southey arrived on Middle Island in January 1983 to begin field work on skinks for his MSc degree.[11] Ian, a student at the University of Auckland, was helped by another student, Ewen Cameron. The pair climbed up onto the Southern Basin from the Landing Bay with all their gear and found that the ground was too steep to pitch a tent. They had no spade, so they set to digging a suitable flat area using sticks and unearthed the second tusked wētā ever seen. It was a large female and so lacked tusks, but Ian knew immediately what it was because it was larger than a tree wētā. He also recalled hearing that an unusual, large wētā had been found on Middle Island when he attended a symposium on rodents in 1978.[12] Unfortunately, they had damaged the female's abdomen, but Ewen still photographed it as proof of their find.

Later, when Ian and Ewen became familiar with the island, they discovered a much better place for camping. This was in a wide valley facing west that they named Sicyos Gully because *Sicyos mawhai*, also known as native cucumber vine or ambush vine, grew there (it was still present when I camped there). This creeper is best avoided because its 6–10 cm ovate fruits are covered with fine, sharp spines armed with barbs. The spines break off readily and are almost impossible to remove from clothing. Most people end up throwing such clothes away!

11 Southey (1985).
12 Ramsay (1978).

Sicyos Gully is around the rocks to the north of the Landing Bay, and everyone now camps there. When I used it, the largest of the three sites for pitching tents was a level area of soil behind a 1.5 m high stone retaining wall that Ian Southey and his helpers had constructed by lugging large rocks up from the coast. The other two sites were small flat areas that had been levelled with spades.

A female tusked wētā photographed on Ewen Cameron's leg after it had climbed up inside his jeans.
Photo: Ian Southey, 14 December 1983

Ian Southey's research was on nocturnal skinks, and he spent a lot of time searching for and observing them at night, so it's hardly surprising that he found tusked wētā. He made 15 trips to Middle Island between January 1983 and October 1984 and told me he saw tusked wētā relatively frequently. Unfortunately, the details of how many he saw have been lost. How, may you ask? Well, Ian required a permit from the Hauraki Maritime Park Board [13] to visit Middle Island, and one of the conditions was that he provide a written report after each trip. He included the numbers of tusked wētā he found in these reports but never kept copies. Unfortunately, I cannot find the reports in the archives of the Hauraki Maritime Park Board. The archives contain numerous reports relating to birds and the occasional one on tuatara, so I suspect that Ian's reports may have been deliberately discarded as irrelevant because insects and lizards were widely ignored as unimportant in those days.

Ian remembers seeing numerous tusked wētā each night during two trips in April and one in May. He also recalls seeing none on some trips. The only precise information is from Ewen Cameron, who accompanied Ian on his sixth trip (13–17 December 1983). On that occasion, they found three tusked wētā and Ewen, once again, photographed them and recorded the dates on his colour slides. One tusked wētā ran up inside the leg of Ewen's jeans while he was trying to photograph it, and as you can imagine, he pulled up the trouser leg so quickly that the wētā never got

13 Middle Island was administered by the Hauraki Maritime Park Board at the time.

past his knee. The insect, fortunately, didn't bite him, so he got Ian to photograph it on his leg.

The only other information I could find on how many wētā were seen was from the people who helped Ian: Paul Scofield remembers seeing one tusked wētā in the Southern Basin in August 1984, while none were seen when David Riddell (late 1983 or early 1984), Grace Hall (February 1984) and Alison Balance (October 1984) were there. Further information is sketchy: Ian saw "up to 40 in a night"[14] while John McCallum recalls 'seeing them everywhere' on the Central Plateau in April 1983, when it was too wet and slippery to search elsewhere. John also remembers that four people searched Middle Island over eight nights in November 1983 and found two juvenile females. Peter Bellingham remembers seeing one or two in September 1984; Mark Bellingham saw several dozen above the campsite in Sicyos Gully and on the Northern Plateau in September 1984[15] and Murray Potter remembers seeing some mostly above the campsite in Sicyos Gully one summer.

Ian's rediscovery eventually reached Graeme Ramsay in the Entomology Division, Department of Scientific and Industrial Research, and he asked Ian to collect a pair of adults so they could be formally named. This Ian did on April 3, 1983, using a permit for general collecting issued by the Wildlife Service. David Riddell, who was on that trip, added the following: "As I was being dropped off at my house afterwards one of the Middle Island party (who perhaps should remain nameless) asked Annette if she'd like to see one of the weta ... He carefully lifted one corner of the lid of the ice-cream container it was in, and it immediately leapt out and started hopping for the cover of our rock garden! Annette grabbed the collar of our border collie Eddie, who was very interested in the escapee, while hasty efforts were made to return it to captivity."

Ian kept these wētā alive in the laboratory for some time because he didn't want them killed. He reported that they were "thriving on a diet of carrots, cabbages and pōhutukawa, māhoe and broad plantain leaves".[16] He eventually handed them over to Graeme Ramsay, hoping Graeme would take the opportunity to try to keep them alive a bit longer, but I've been unable to find what Graeme did with them.

The Wildlife Service, however, apparently took a dim view that Ian had collected these wētā because removing "such a rare insect (known only from one tiny island)" was not specifically covered in his permit. Ian never found out exactly what transpired, but worrying rumours reached him that his research might be stopped altogether, although it never was.

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14 Ian Southey also told Mary McIntyre this (McIntyre, 1994a).
15 Bellingham (1991).
16 New Zealand Herald, 31 August 1983.

Realisation that extinction is possible

Ian Southey and Ewen Cameron's campsite in the Southern Basin with Ian Southey in the hammock. Photo: Ewen Cameron, 23 January 1983

We know that people searched for tusked wētā after Ian Southey, but I can find no records of their trips before a combined Victoria University of Wellington, Department of Conservation and World Wildlife Fund expedition to Middle Island from March 15 to 22, 1989. During that trip, Phil Thomson and Tony Whitaker collected one adult female tusked wētā and two adult males for researchers at Victoria University. They wanted to determine if this tusked wētā was a distinct species and, if it was, what was its taxonomic relationship to other wētā? The permit, issued on February 25, 1989, was for collecting a maximum of three for genetic analysis. DNA analysis was not available then, so the researchers used chromosome analysis and gel electrophoresis of proteins. Both methods necessitated killing the insects.

This was probably the trip when Tony Whitaker lost a tusked wētā after capturing it. He put it in a plastic container ready to transport to the mainland, but the insect pushed the lid up during the night and vanished. Tony then frantically searched for a replacement and, fortunately, managed to find one. [17]

During this trip, Phil Thomson began to realise how rare the insect was. He later wrote that a "major mistake had been made … issuing … a permit to take weta from an unknown but surely endangered population … [in order] to determine its specific status, when it was quite clear … that the tusked weta was a different species (or even genus) [from] any other weta." He wrote to Mary McIntyre at Victoria University of Wellington, who was looking after the wētā in captivity, and requested that she "make the most of the wetas by keeping them … (with adequate opportunities for egg laying etc) … to find out more about their behaviour, and habitat requirements and until the female had been given an opportunity to breed." As the conservation manager "responsible for the future of the tusked weta" at the time, Phil was disappointed to learn that the wētā were "later killed for electrophoresis when the sacrifice of only one would have been sufficient to determine their genetic status."[18]

Genetic procedures have since improved to the extent that nowadays all that is needed for DNA analysis is a tiny piece from the end of an antenna. This is not as dreadful as it may seem because wētā frequently lose bits from the ends of their antennae over time anyway. Indeed, it is not uncommon to find adult wētā with less than half of one or both antennae. Removing a small piece of the antenna is certainly preferable to killing the insect. Losing part of an antenna is even less of a loss to a juvenile because it will regenerate the lost part at the next moult. Adults, however, cannot do that because they do not moult; they are the final stage in an insect's life.

The researchers at Victoria University were aware of the rare opportunity they had. They let Mary look after the insects until one of the males died naturally after almost four months in captivity. The researchers then killed the remaining male and female for genetic analysis, because they required samples from freshly killed insects. Mary, however, had recorded some of their behaviour and what they ate[19]. She realised that these wētā were mainly carnivorous, a discovery that was

17 Tony did not tell me this, but he did confess it to Sandy Bartle. The date, understandably, is long forgotten.

18 Letter to Gerry Rowan, Regional Conservator, 26/4/90; Department of Conservation file INS006.

19 I have never observed male tusked wētā fighting, but I have seen a film that Rod Morris and Paul Donovan (Natural History Unit, TVNZ) made of it. They made the film while Mary was looking after the insects at Victoria University. Males clasp each other's tusks or heads with their tusks and push and shove until either one wētā backs away and leaves or one gets flipped upside down.

ELECTROPHORESIS

Electrophoresis separates different protein molecules (and some other chemicals, including DNA and RNA) by size, shape, and electrical charge. Proteins from different species differ in these properties, and such differences reflect their genetic differences. Nowadays, of course, RNA and DNA analyses are used more frequently.

The first step in electrophoresis involves dissolving the proteins and treating them with a chemical that unfolds them and gives them a negative charge. The mixture is then pipetted into a narrow channel near one end of a sheet of gel. An electric field is applied across the gel, and the negatively charged proteins migrate towards the positive electrode. The gel acts as a molecular sieve, so smaller molecules move faster through it than larger ones. When the proteins are stained so they can be seen, they appear as a series of bands (like a barcode) spaced at different distances from each other. So, when proteins from different species are run side by side, their similarities and differences show up by how close or far apart the corresponding bands are. This indicates how closely related or unrelated the species are.

hugely important later when it came to rearing them in captivity. Unfortunately, the female never laid eggs, even though Mary found 234 mature eggs inside it when she dissected it. All three specimens (well, what is left of them) are now in the Museum of New Zealand. The researchers also stored some of the tissue samples from both wētā in a freezer, and this enabled them to obtain DNA 17 years later, in 2007. They showed that the three species of tusked wētā are broadly related to other wētā, but belong together in their own taxonomic sub-group, meaning that they are slightly distinct from other wētā.[20]

Phil Thomson was not alone in condemning the slaughter of both wētā by scientists. The Dominion and the Herald newspapers published an article (13 September 1998) describing the collection and subsequent killing of these wētā, which moved one reader to write that: "it seems a pity that three of these magnificent wetas have to be killed in the name of research." [21]

The next recorded visit to Middle Island with the specific goal of finding tusked wētā was made by George Gibbs (Victoria University of Wellington) and Peter Carter

20 Trewick and Morgan-Richards (2004).
21 J. Grant, letters to the editor, The Dominion, 28 September 1989.

(Department of Conservation) between October 26 and 27, 1989. They were part of a party led by Alison Cree that searched for and collected the last remaining tuatara on Stanley Island to protect them while rats and rabbits were being eradicated. The tuatara were held in zoos and at Victoria University and returned to Stanley Island in 1990 after the mammals had been successfully exterminated.

During the expedition to Stanley Island, George and Peter went over to Middle Island and spent approximately six hours searching over two nights. They found three half-grown tusked wētā, two females and a male, which they measured (body lengths 20–30 mm) and released. George agreed with Phil Thomson's earlier conclusion that tusked wētā were not common but cautioned that finding small numbers may not necessarily mean they are extremely rare because only a few might emerge on any one night. He recommended that "future translocations … to another island in the Mercury group should be regarded as the ultimate goal" and that this should be "done with captive-reared animals to preserve the endemic population of Middle Island as far as possible". The implication, of course, was that the wētā should only be translocated to a rodent-free island [22].

George advised that this necessitated some research on captive breeding and suggested that only a few juveniles should be removed for this. He also recommended that the smaller Northland tusked wētā, *Anisoura nicobarica* (which Tony Whitaker had known about), then known as *"Hemiandrus" monstrosus*, should also be brought into captivity because it is closely related and so might provide clues for learning more about the biology of tusked wētā on Middle Island.[23]

Jackie Davidson, a schoolteacher, provided most of what is known of the diet, behaviour and husbandry of the Northern tusked wētā. She found 13 within 13 months between February 1989 and September 1992 within 100 m of her home in Kohukohu, Hokianga. One was dead, three died soon after capture and four lived for up to 54 days in captivity. She also monitored three more in their burrows. Her observations are recorded in two detailed reports (illustrated with superb sketches) that she sent to Richard Parrish (Department of Conservation, Whangarei). [24]

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22 A translocation is the intentional transfer of an organism for conservation purposes. Korapuki Island and Double Island were mammal-free at the time.

23 Gibbs (1998).

24 Richard Parrish, copies in his personal communications file. Jackie's work was publicised in the *New Zealand Herald Sept.24*, 1992 (Rare weta coming out of its shell) and the *Northern News Dec. 30, 1993* (Tusked weta wanted for research).

Paul Barrett[25] made the only serious attempt to captive-breed Northland tusked wētā in 1993 when he worked at Wellington Zoo, but he only received one damaged juvenile female that died soon after it arrived and an adult male. The insects were rarely seen, and although efforts were made to catch more for him, no more were found, and Paul had to give up.

Researching a closely related common species illustrates one of the basic concepts in threatened species management and research. Closely related "surrogate" species are investigated in the hope they might provide clues to understanding the biology of the threatened species. This can speed up the investigation of the threatened species' biology and reduce the number of individuals required, thereby reducing the overall risk to the threatened species.

The recommendations in George's report largely agreed with the draft *Threatened Weta Recovery Plan* produced for the Department of Conservation by Mike Meads (DSIR Land Resources).[26] The Plan incorporated many of the ideas from an even earlier draft, *"Interim Recovery Plan for Tusked Weta"*, written by Phil Thomson.[27] Mike listed research as being urgently needed on the population status, including numbers and distribution, and on the biology, ecology and habitat requirements so that the species could be established on at least two other Mercury Islands. Mike also added that captive-breeding is urgently required and that "Pairs of wetas should be taken into captivity at the earliest opportunity for breeding." He was keen to do the captive breeding himself.

25 Paul Barrett was particularly successful at captive-breeding wētā (Barrett, 1991). A different Paul Barrett (from Massey University) is also associated with this project so I will include their institutions to avoid confusion.

26 Meads (1990).

27 Thomson (1991) but sent to Mike Meads before publication.

CHAPTER 3
RESEARCH

Mary McIntyre was the first to research the Mercury Islands tusked wētā and she provided most of the basic information about the biology and behavioural ecology, and documented their seasonal occurrence in 10 unpublished reports to the Department of Conservation. The summary that follows is taken mostly from McIntyre (1998 & 2001).

Initial observations

Mary's initial observations were made while she kept tusked wētā in captivity at Victoria University of Wellington until they were used to determine their taxonomic relationship with other wētā (Chapter 2). She realised they are "predators and scavengers and take little plant food" and reported that they dig ovoid chambers just beneath the surface of the soil. The openings are circular, and the wētā plug them with soil "apparently cemented with saliva." Juveniles can remain in their chambers for long periods, and adults can likewise stay in them for up to eight days.

She observed that the tusks are used for jousting, apparently to compete for chambers.[28] They are not used as pincers and are unlikely to be used for stabbing.[29] Mike Meads, who helped Mary on several of her field trips and also kept tusked wētā in captivity (Chapter 4), described the tusks as being "used for gripping, pushing and shoving, much as a stag uses his antlers." Bouts are won when a wētā flips the opponent over or pins it against something solid.[30]

Research on Middle Island

Bureaucracy

Mary became increasingly interested in tusked wētā while she kept them in captivity, so she applied for a permit to do field work on Middle Island to answer

28 Personal communication in Field and Deans (2001).
29 Chris Winks (1998) later reported that one female died from "... a hole in its side, possibly caused by a tusk or mandible ... the hole was the approximate diameter of a male tusk ..."
30 Meads (1990).

Diving petrel. Photo: Rob Chappell

some of the conservation management questions that Phil Thomson had identified: what were the habitat requirements of this wētā? Could 'scat' (faeces) analysis indicate what they ate on Middle Island? How large was the population? What was the population structure? Lastly, Mary was fascinated with their behaviour and wanted to investigate it further.

Her proposal (December 13, 1990), modified over several months to comply with the Department of Conservation's requirements, was subsequently approved after a convoluted process. The Department of Conservation was created in 1987, and the approval process was, at the time, incredibly bureaucratic because the procedure was still being developed. It involved scrutiny and approval by the "Waikato Conservancy, Auckland Conservancy (or at least individuals within it), Science and Research Division, the Threatened Species Unit, Protected Species Directorate, and the Animals Ethics Committee."[31]

Mary attended to all the varying concerns of these groups, including, as an example, the following: Middle Island is riddled with seabird burrows, and Phil Thomson (the Conservation Officer responsible for the Mercury Islands) was concerned that the birds might not nest until the following year if their burrows were collapsed by people walking about.[32] Mike Imber's solution (Department of Conservation) was to minimise damage by keeping to a narrow, marked pathway and immediately repairing any damage as much as possible. This would limit damage to a small proportion of the large numbers of burrows and so have a negligible effect on the overall population. He also noted that all the birds were common, widespread species.[33]

Then, after all this, the Hauraki Gulf Maritime Park Board, which managed the island, refused to issue the permit. The board had a research and management policy for Middle Island (June 20, 1990), which listed five legitimate purposes for visitation,

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31 Phil Thomson, 26 April 1990, letter to Gerry Rowan, Regional Conservator. Department of Conservation file INS006.
32 Phil Thomson: letter to Mike Imber, 8 January 1991. Department of Conservation file INS006.
33 Mike Imber: letter to Phil Thomson, 15 January 1991. Department of Conservation file INS006.

ADMINISTRATION OF THE MERCURY ISLANDS

The Mercury Islands, except for Great Mercury Island, which is privately owned, were added to the Hauraki Gulf Maritime Park in July 1970 and access was prohibited without a permit. Management of these islands was eventually transferred to the Department of Conservation in 1990 after the department was created in 1987. Permits (for scientific research) are now required to land on all the islands.

I originally assumed that all the Mercury Islands would have the same legal status but I was wrong. It is a mess! Double Island and Stanley Island are now Nature Reserves, the highest level of legal protection for reserve land in New Zealand (Gazette 2009: pages 1711, 1712) but Middle Island, Green Island and Korapuki Islands remain Scenic Reserves with secondary conditions of use as Wildlife Sanctuaries (1993 Gazette; Wildlife Act: pages 1311, 1377). Red Mercury Island is not mentioned in the 1993 Gazette and so remains a Nature Reserve administered as a Wildlife Sanctuary (Māori Purposes Act 1993).

The protected legal status of these islands has, of course, not deterred people from occasionally landing illegally on them (usually in summer). A marijuana crop was found on Red Mercury in 1983, and an old marijuana plot clearing together with associated rubbish was found there in 1987. Then an Auckland charter yacht operator began landing people on these islands without permits and continued to do so after being reminded that permits were required. Two people even took their dog onto Korapuki Island in January 1994.

one of which was that a proposal "for research will be declined unless it is clear that the objectives of the proposed work will assist with a clearly defined and accepted protection or restoration problem". Mary was unaware of this and had emphasised the research aspects, but she easily modified her proposal to satisfy this objective, and her permit was at long last issued. It had been a marathon. She made her first trip to Middle Island to study tusked wētā between March 23 and April 4, 1991.

Administration of the Mercury Islands (except for Great Mercury, which is privately owned) was eventually taken over by the Department of Conservation, so this bureaucratic hiccup never occurred again. Phil Thomson also wrote a management plan for the Mercury Islands, which sped up the approval of permits because the Conservator was only required to check that permits were aligned with the appropriate management plans before signing them off.

THE SOUNDS THAT WĒTĀ MAKE

The technical term for such sounds is stridulation. It is the noise insects make by rubbing parts of their body against each other – the chirping of crickets and katydids are well known examples.

Adult male tusked wētā make a rasping sound by opening and closing their tusks. The tusks have a series of annular swellings or ridges which catch against each other to produce the noise. The sound is like that made by pulling your fingernail along the ends of the teeth of a plastic comb. Juvenile males cannot make this sound because their tusks are either too small to cross over or, if they are large enough, they are smooth tasks and slide noiselessly over each other: females and younger males, of course, lack tusks.

Both sexes can make a hissing sound presumably for warning by rubbing the hind legs – which have tiny projections on the inner surfaces of their femurs – against tiny pegs and ridges on the abdominal plates (tergites) – so it is another form of stridulation. The insect makes this sound while rocking backwards and forwards energetically with all feet firmly on the ground (Ģuignion 2005).

Field work

Phil Thomson helped Mary during the first five days of her first field trip, and Liz Humphries (Department of Conservation) and Pat Miller, a volunteer, helped her during the last seven days. They established a search path that was used on all subsequent trips and marked the route by tying red marker tape and reflectors to trees. They found 18 tusked wētā, all in the South Basin where Ian Southey and Ewen Cameron had first camped in 1983. This surprised Mary because Ian told her that most of the wētā he saw were in the milk tree forests on the Northern and Central Plateaux.

Mary made 10 field trips to Middle Island over four years and completed her research there in April 1994. She spent 118 nights searching and found more than 239 tusked wētā.[34] The most she saw during a single night was at least 19, but she

34 “On this occasion I captured 19 weta in a short time and was aware of perhaps missing another 10. This brief weta “spree” finished abruptly as the arrival of daylight became detectable ...” (McIntyre, 1994b).

couldn't keep track of them all because she was trying to catch and measure as many as she could. She also sometimes found no tusked wētā during her searches.

She reported that most tusked wētā were seen on the ground, except for two males that were in a hollow 40 cm up a māhoe tree. They were also occasionally detected in the canopy after micro-transmitters were attached to them (see below). Adult males can make a characteristic rasping sound when disturbed, and Mary recounts hearing this when she grabbed some pōhutukawa foliage while ascending The Razorback, but she couldn't locate the insect despite an extensive and precarious search.

Mary described tusked wētā as occuring in three small patches "totalling about 0.2 ha." Most were seen in māhoe-wharangi forest in the Southern Basin (174) and under milk trees on the Central Plateau (64). The remainder were at the southern end of the Northern Plateau (12) and in the area below this down to the campsite (11), and on the access track (5). Mary also used a capture-mark-recapture technique in the autumn of 1994 and estimated there were "about 120 active mid-sized juvenile to adult weta on the island." [35]

Mary investigated the daily movements and the associated behaviour by glueing micro-transmitters[36] (about the "size of a large pea") onto the thoraxes of at least 16 "large" wētā and releasing them where she found them. She then tracked them using a receiver equipped with a directional antenna.[37] The wētā excavated chambers and rested ('roosting' is the term used nowadays – yes, even for insects) in them during the day. They didn't always emerge each night, but when they did, most remained on the ground while a few climbed up vegetation (some were even detected in the canopy as mentioned above).

Mary reported that the wētā moved 3.5–32 metres from their chambers. Females mostly stay close to where they emerged, whereas males can "roam" further afield. All returned underground before daylight, including the few that climbed up into foliage. Most excavated new chambers instead of returning to their previous ones.

35 The 95% confidence interval is 95–178. McIntyre (2001).

36 Grace Richards with help from Murray Potter pioneered the use of micro-transmitters for tracking wētā in 1991 (Richards 1994).

37 Mary has not documented her radio-tracking work except for brief mentions in her trip reports so the information is sketchy (McIntyre, 1992, 1993a, b.).

Mary noticed that wētā were not seen during the latter part of a night when "tuataras were out in abundance". She suggested "that the activity of tusked weta was tied in some way to that of tuatara"[38] and that this might be to avoid predation by tuatara, which are visual ambush hunters and readily eat wētā. She later confirmed that tusked wētā are most likely to be active on dark moonless nights and particularly after the new moon and a few days after rain.[39] This information allowed me to organise my trips to Middle Island to coincide with nights when the moon was mostly below the horizon. This information saved me a huge amount of time and effort and I am indebted to Mary for sharing this before she published it.

View north from the bay below our campsite. Photo: Leslie McKay

38 Mary McIntyre: letter to Phil Thomson, April 9, 1991. Department of Conservation file INS006.
39 McIntyre (2001).

CHAPTER 4

CAPTIVE-REARING

George Gibbs, Mike Meads and Phil Thomson independently realised in 1990/1992 that the Mercury Islands tusked wētā could easily go extinct and advised the Department of Conservation that the risk should be reduced by establishing populations on Double Island and Korapuki Island, which were, by then, mammal-free[40]. Their reports were read and initialled by the appropriate people, and filed, but nothing was done. Phil and Rob Chappell then took their concerns to Dave Towns, the Conservation Advisory Scientist in Auckland and, with Dave's support, convinced Theo Stephens, the Conservation Advisory Scientist for the Waikato Conservancy (which had geographical jurisdiction over the Mercury Islands) of the species' vulnerability and persuaded him to officially recommend that populations should be established on other mammal-free Mercury Islands. They also convinced Theo that this should be done using captive-bred insects.

Recruiting Theo made a difference: in those days, Conservation Advisory scientists had direct input into developing the Department of Conservation's strategies (the Department of Conservation bases its conservation management on the best available science), and Theo just happened to be supporting the charge to include all invertebrates within the wider responsibilities of the Department of Conservation. This was a fundamental change in mindset because the Department of Conservation had inherited a primary focus on birds from the Wildlife Service with a lesser interest in reptiles: only a few of the larger invertebrates merited a glance.[41] The vast numbers of other invertebrate species were relegated to the 'too hard basket'.

Theo prevailed and successfully got funding for captive-rearing after his first application failed (see 'Monitoring the environment' below). Four groups were interested in doing this, but Theo realised that allocating tusked wētā to all four could risk harming the small population on Middle Island. He decided to fund two groups that were going to try different methods of captive-rearing: Chris Winks and Graeme Ramsay planned to rear the insects under controlled laboratory conditions, and Mike Meads was going to rear them under natural conditions. Chris

40 Gibbs (1990); Meads (1990); Thomson (1991).

41 Richard Parrish and Kath Walker, for example, included large, threatened land snails in their work programmes.

and Graeme were chosen because they worked at Landcare Research in Auckland, where they could get help from Pritham Singh, a scientist who specialised in rearing insects. Mike specialised in invertebrate conservation at Ecology Division, Taita, Wellington and, as mentioned above, was keen to do the captive-rearing.

Mike Meads' attempts at captive-rearing

Mike had worked with threatened invertebrates for many years and considered himself the expert on invertebrate conservation in New Zealand (and I think he was).[42] He was fiercely critical of the Landcare approach. He wrote that *"controlled environments and manipulation* of eggs is not the correct approach at this stage, when there is insufficient data to inform us as to what environmental factors regulate pre-/post-nuptial behaviour, egg laying and hatching". [43] This seems quite a reasonable criticism, doesn't it?

Mike's philosophy was to try to rear tusked wētā under conditions close to those on Middle Island and to intervene as little as possible. He intended to maintain a breeding colony in a large cage and "grow … nymphs in separately constructed cages through to yearlings". To this end, he constructed a large insect-proof cage at his seaside home in Pukerua Bay by modifying a commercially available greenhouse (Ullrich Aluminium Shade Tunnel) and installing a water sprinkling system to keep the soil moist. He then got John Gumbley (Department of Conservation) and Mary McIntyre to collect about half a ton of soil (six large bags) from Middle Island in October 1992, which he spread over the ground in the cage. Lastly, he planted "species identical to those found on Middle Island" in the cage and got Mary to collect three pairs of large juveniles for him during her January and March field trips in 1993.

Mike inspected the cage periodically at night using a torch and saw the wētā on only six occasions. He hadn't seen them for some time by the end of 1993 and believed they had all died. So, he asked Mary to collect another two pairs, and she caught two subadult[44] females and one subadult male in March 1994, and an adult male on her next trip in May 1994.

42 His work at DSIR Ecology Division and Land Resources was largely focused on terrestrial invertebrates. By 1991, he had published 14 scientific papers, 19 unpublished reports, seven information pamphlets, and one book relating to invertebrate conservation. He also pioneered insect translocation in New Zealand (Meads and Moller, 1978; Sherley *et al*., 2010).

43 Mike Meads: letter to Rob McColl 26/11/94. Waikato Conservancy, Department of Conservation File INS006.

44 A subadult is the last juvenile stage before adult. The term is rarely used by entomologists but is commonly used by herpetologists.

Mike admitted he had a problem and wrote that: “I cannot estimate numbers without disturbing the whole colony”. This would have involved digging – hardly minimum essential interference – to locate the insects in their underground chambers. He also wrote that his “observations of behaviour and aspects of life history are few and far between and somewhat subjective”, but he did see two females laying eggs with their backs hunched over and their ovipositors (Latin: ovum = egg; positus = to place, put) thrust vertically into the soil. He also found eggs (which must have involved disturbing the soil), but these “were examined and found to be infertile”. He didn’t explain how he knew they were infertile, but the eggs are so impenetrably black that you cannot see if embryos are present or not.[45] Mike never reported seeing any small juveniles, and I do not know if he ever constructed separate cages for them.

By late 1995, Mike decided that his wētā had died out again because he had last seen them in January 1995. So, he applied for more wētā in November 1995 to try a third time. Chris and Graeme, meanwhile, had successfully reared some tusked wētā under artificial conditions, so Rob McColl, the Science Information and Liaison Manager in the Department of Conservation, who was responsible for overseeing such research, decided to stop removing wētā from Middle Island and did not give Mike the necessary permit.

Mike was incensed. When he eventually examined a small area of soil in his cage in February 1996, he unearthed one wētā “within a short burrow, and many burrow entrances”. He believed he had a self-maintaining population and suggested that the Department of Conservation “may see an advantage of releasing half on Double Island ...”. Nothing apparently came of this, and none of his wētā were released on any of the Mercury Islands.

Mike continued searching his cage at night without success until April 1996, when he was sure they had all died, so he decided to grow tomatoes in the cage and dug over the soil. Much to his surprise, he unearthed two large female tusked wētā that were very much alive. This wasn’t a breeding colony, so he was instructed to send them to Chris Winks in Auckland. Unfortunately, he included soil in their containers, and one wētā died in transit due to “dirt put in the container, which fell on the weta breaking bits off”.[46]

45 Meads (1994).
46 Chris Winks: letter to Phil Thomson 22/4/96: Department of Conservation file INS-006).

Chris Winks and Graeme Ramsay's successful captive-rearing

Chris and Graeme began captive-rearing tusked wētā in November 1993 after Mary collected two juvenile females for them in November 1993. Chris, who did most of the rearing (Graeme did the permit applications, provided advice and helped write up the results), initially housed them in separate large cages with plants (raised from seed collected from Middle Island) growing in a peat/pumice mixture. The cages were kept in a shaded outdoor insectary except in summer, when Chris thought it might become too hot for the insects and transferred them into a room kept at 20°C. The insects were then transferred to a "dedicated weta-rearing room" in 1995. This was provided with air circulation drawn from outside, cooling by air conditioning during summer and an automatic day/night lighting cycle.

Mary caught an adult male for Chris in March 1994, and he introduced it to each female in turn, which, by then, had become adults. Fifty-one eggs hatched in the cages, but Chris only found eight juveniles when he checked the cages later. He realised they were cannibalistic, so from then on, he kept the insects in separate containers. Any viable eggs that remained in the cages needed to be removed, so Chris sifted through the peat/pumice mixture and recovered 71 intact eggs, the remains of 27 eaten ones (the wētā dug chambers in the mixture and ate the eggs they exposed) and four infected by fungi. He inserted the intact eggs in moist perlite (crushed pumice) and 15 later hatched.

The combined 21 juvenile wētā had begun hatching 2.5 to 10 weeks after being laid, which surprised Chris and Graeme because this was much shorter than for other wētā species. [47] The last of these eggs hatched between 31 and 39 weeks after being laid, and by the time Mike Meads applied for more wētā for a third attempt at captive-rearing, Chris had 16 wētā ranging from two-thirds grown to sub-adult.[48] Fifteen of these eventually became adults, 15.5 to 22 months after hatching. Eight were females: two were deformed and died without laying eggs, and the other six laid a total of 31 eggs, but none hatched.[49] Chris and Graeme thought that something was probably lacking in their diet.

Chris received two more juvenile females from Middle Island in November 1994. One died while moulting, and the other developed into an adult, which laid 102 eggs

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47 Giant wētā eggs start hatching after 12 weeks to 11 months; ground wētā eggs start hatching after 8 weeks to 11 months (Stringer and Cary, 2001).

48 Winks and Ramsay (1998).

49 Winks and Ramsay (1998); Winks *et al.* (2002).

after being paired with a captive-reared male. Chris transferred the eggs into sterilised soil, but 98 died of fungal infection, and four hatched that developed into adults after 15.5 to 17.5 months. One died after 1.5 months while with a male and did not lay eggs, the others were still alive and had not laid eggs at the end of June 1998. They had lived for 3.5 and 5.5 months as adults. Chris published no further information about these insects or the juvenile female that Mike Meads sent him in April 1996.

Chris did more than develop a successful rearing method: he presented the wētā with a variety of plant and animal foods to find what they ate and quickly confirmed that Mary had correctly reported, in 1989, that tusked wētā are predominantly carnivorous. This explained their cannibalism. Chris also described a lot of the insect's behaviour relating to defence and aggression, burrowing, mating, egg-laying (oviposition) and moulting. He realised that the insects stopped eating "for several weeks" while they moulted in their underground chambers, and he used these non-emergences to document the number of moults the insects go through to become adults.

Chris was now confident he could breed large numbers of tusked wētā, so he applied for and got additional funding to rear more from the Department of Conservation. But he had a problem: by then, he only had one female. Rob Chappell, who had now become the Department of Conservation field officer responsible for the Mercury Islands, came to the rescue by opportunistically visiting Middle Island (in his own time) on dark moonless nights when it was calm enough to get ashore safely. Rob was the ideal person for this because he had helped Mary McIntyre on some of her field trips and had experience in searching for them.

Rob made nine trips to Middle Island before he took me there in September 1998 to start me off with my field work. He found two juvenile females in February 1998, which he caught and gave to Chris. Chris subsequently reared both females to adults and then kept them cool at about 10°C to extend their lives until he received a male. Rob only found one more female, though (in April 1998), which he left undisturbed. The insects were clearly less abundant than when either Ian Southey or Mary McIntyre did their field work. Haden Hewitt eventually found the male Chris Winks desperately needed in late November 1998 (Chapter 8).

Chris was lucky. Insects don't always survive being kept cool for extended periods, but the two females, fortunately, survived, mated with the male and laid 505 eggs of which 181 hatched.[50] Twelve of the juveniles died, and the others

50 A total of 44 eggs were eaten, 86 were infected with fungi, and 194 had no obvious cause of death. The females contained 935 fully developed eggs when they died (Winks, 2002).

View to the north from the Landing Bay on Middle Island. The campsite is around the point.
Photo: Rob Chappell

were successfully reared by Chris with help from Paul Barrett, who was working at Auckland Zoological Gardens. One hundred and thirty-two were released on Double Island and Red Mercury Island, and a further 15 (of 17 that hatched unexpectedly a year later) were released as half-grown juveniles at a second release site on Red Mercury Island in September 2002 [51] (these releases are described in Chapters 19 and 22). The wētā that were not released were used for research at Massey University (Chapters 15 and 16) and the University of Canterbury, and Chris kept some for further breeding, but they only produced a few infertile progeny.

When a decision was made later to captive-rear tusked wētā specifically for translocating onto additional rodent-free islands (Chapter 26), Chris, once again, needed new insects because the ones he had kept for breeding had almost died out.

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51 Two additional adult tusked wētā were released at the second release site on Red Mercury Island in March 2003 bringing the total there to 17. These wētā had been reared at Massey University and were released at the end of an investigation into their growth (described in Part 4).

By then, however, we were not finding any on Middle Island. We circumvented the problem by harvesting some of the progeny of the wētā we had previously released on Double Island.[52] These, fortunately, reproduced well in captivity and Chris, single handedly, reared 334 wētā for translocation in individual cages. This was a truly extraordinary effort by him. They were all released on Korapuki Island (100 wētā), on Stanley Island (100), on Ohinau Island (100) and Cuvier Island (34) in April 2008. These translocations are described in Part 5.

Assessing the rearing methods

What, then, were the relative advantages and disadvantages between Mike Meads' and Chris Winks and Graeme Ramsay's approaches to captive-breeding?

Mike's was the most likely to succeed quickly, but it failed because the insects were cannibalistic. He did not know this; otherwise, he would have reared them either separately or in a very large cage. He might also have reared more if he had supplied additional food or live prey, but he didn't because he was determined not to intervene.

A major disadvantage of Mike's approach, it seems to me, was that he didn't get any information about the biology of the wētā, so he couldn't improve his method. In contrast, Chris and Graeme's hands-on approach enabled them to make continual improvements, which they did. For example, Chris observed that the females sometimes ate the eggs, so he periodically provided fresh potting mix and transferred the old potting mix, together with the eggs, into separate containers.

The major advantage of Chris and Graeme's rearing procedure was that it could potentially produce large numbers of wētā (as it did) once they had a suitable method. It so happened that the first method they used to house and feed wētā worked well, and their captive-breeding programme became hugely successful.

Monitoring the environment

Almost nothing was known about the environmental conditions on Middle Island when Chris and Graeme, and Mike began captive-rearing. They needed basic information such as humidity, air and ground temperature, soil moisture and rainfall, and how these varied over time, so they could rear the insect under appropriate conditions, but this was almost completely lacking. Two early attempts were made to get some of this information, but both failed.

52 The releases (translocations) are described in Part 4.

The first was made by Phil Thomson. He realised that this information would be needed in future, so he applied to the Lotteries Grant Board in June 1993 for funds to purchase two meteorological recording stations. His application was unsuccessful. Then Mary McIntyre tried using temperature and humidity recorders that she borrowed, but these were only available for short periods. Unfortunately, the recorders were also plagued with so many problems that they either failed to record anything or most of the data was lost.

The lack of environmental data was, as you can appreciate, particularly concerning for Chris and Graeme, who were attempting to rear the insects under artificial conditions. What if, for example, all their wētā happened to die? Was it because their rearing conditions were unsuitable? How could they know? Their solution was to apply to the World Wildlife Fund for three meteorological data loggers.[53] They did this at the same time they applied to the Department of Conservation to fund the captive-rearing. To their dismay, they got the funds to purchase two data-loggers (they were set up on Middle Island and Double Island in 1994), but the Department of Conservation rejected their captive-rearing application. Theo Stephens was flabbergasted. He had lobbied hard for the funds to support both Chris's and Mike's rearing efforts because he considered their research to be the highest priority need for the Waikato Conservancy.[54]

It turned out that the Mercury Island tusked wētā had been incorrectly ranked as category B (Second Priority Species for Conservation Action) when Janice Molloy and Alison Davis prepared the first list of threatened species in 1992,[55] so all the available money went, quite understandably, to support more endangered species. Theo vigorously pointed out that tusked wētā had been incorrectly classified, and he eventually secured all the funding needed once the insect was reclassified as Category A, First Priority Species for Conservation Action.[56]

53 Meteorological data loggers can record different conditions depending on the sensors they are equipped with. Chris intended to put one data logger on Middle Island and the others on Double Island and Stanley Island because these islands seemed suitable for establishing additional populations of tusked wētā sometime in the future.

54 Theo Stephens: memo to Chris Robertson, 29/6/92. Department of Conservation file INS006.

55 Molloy and Davis (1992).

56 Molloy, Davis and Tyndall (1994).

PURE CONJECTURE

I think it was likely that some of the early visitors to Middle Island saw tusked wētā before Tony Whitaker discovered them in 1970, but they didn't realise what they were looking at. They would have recognised them as wētā and possibly even as ground wētā, as I would have if they lacked tusks.

This is exactly what happened with Raukumara tusked wētā. Large numbers of wētā were collected during a wide-ranging survey of the insect fauna of the East Coast region before Raukumara wētā were discovered in 1995. Every specimen that looked like a ground wētā was removed and preserved in the same large jar so someone could examine them later. But no one did until the Raukumara tusked wētā was discovered, and then entomologists took a closer look at these specimens. There amongst the ground wētā were some with tympanal organs: these were juvenile and adult female Raukumara tusked wētā, but, just by chance, none were large juvenile males or adult males, so none had tusks.

So why were they overlooked in the first place? It all comes down to your search image or gestalt. Almost all New Zealanders recognise a wētā, while entomologists can instantly distinguish, at a glance, a tree wētā from a ground wētā or a giant wētā or a cave wētā. They do this in much the same way as you can distinguish, say, a dog from a cat. You recognise them quickly without consciously ticking off the differences between them, and entomologists do much the same with most of the insects they are familiar with. So, tree wētā might differ from ground wētā in having – among other things – stouter legs with spines that look a bit like rose thorns, heads that project forward slightly, and darkened hind edges to their segments, which give them a striped appearance. But to entomologists, just a glimpse is sufficient to recognise what it is. The problem is that ground wētā and tusked wētā essentially have the same overall shape so if they lack tusks, you have to look more closely to differentiate them. The best distinguishing feature is that tusked wētā (and, as it happens, tree and giant wētā also) have the oval scars of tympanal organs on the tibiae of their front legs, whereas ground wētā lack them. This small detail is so easily overlooked, even by an entomologist giving the insect a cursory glance. Of course, things would have been very different if an entomologist happened to be researching ground wētā (none were) or, of course, if one of the specimens happened to be a male with tusks.

PART 2

MIDDLE ISLAND:
The Search for Tusked Wētā

Helema Flannegan and Ian Stringer searching at the top of The Cliff (September 2000). Photo: Malcolm Wood

CHAPTER 5
MAKING CAMP

Two months after Rob Chappell introduced me to Middle Island, I returned with Suzanne Bassett and Haden Hewitt to start my field work in earnest. Suzanne had recently completed her MSc on emu eggs and had helped me with other field work while Haden worked with me at Massey University.

I had camped on islands before, but this was the first time I was responsible for the preparation, and I was concerned that I had everything. We would have to do without if I did not. So, I overcompensated by packing every conceivable thing we might want, and we ended up with a huge amount of gear, far more than we would ever need. Rob Chappell was astonished when he saw it piled up on the wharf at Whitianga but didn't comment. It took him two trips to transfer it all to Middle Island.

Haden volunteered to stay on the Island after we unloaded the first lot of gear at the Landing Bay. I hoped he would have taken most of it to the campsite when we returned with the last load about midday, but he had only managed to take a couple of barrels around. I had seriously misjudged how long it takes to carry things around the headland and up to our camp.

The first 100 metres were an easy walk along a strip of bare soil about three metres wide that sloped steeply up against the base of a high cliff. The entrances of seabird burrows were everywhere, so we walked along the lower edge to avoid damaging them. To seaward, a wide expanse of round boulders, each a metre or so across, extended out into the water. The soil strip ended at a rock platform, which we climbed up onto and followed a narrow path that ran along the edge of the bush for about 30 metres before ending back on the rock platform. Boulders that had fallen from the cliffs then made our progress increasingly difficult as they became larger and more numerous the further we went. They ended around the headland at a huge pile of rocks, each three or more metres across, which we had to pick our way around, between or over. In places, we had to pass things up or down to each other. The rock pile ended at a slightly indented bay with rounded boulders up to a metre across and occasional large, irregularly shaped rocks scattered amongst them. The track up to the campsite began about 15 metres from the rock pile.

The three of us took about an hour to make our first trip to the campsite and return to the Landing Bay, and I realised that Haden had done well to get one load around by himself.

Rob had advised me to limit each container to about 15 kilograms, so they were easier to carry over rocks, and we appreciated his advice as the afternoon wore on. Most of our gear was in waterproof containers, mostly plastic barrels with wide screw-top lids – except for two gas bottles (for cooking), five 20-litre containers of water, and a solar panel for recharging our batteries. This panel was by far the most awkward item to carry. It was wrapped and taped up in plastic film and protected within a protective plywood box about one metre square, which frequently – and infuriatingly – kept catching and getting snagged on rocks.

Lugging things around the rocks set us wondering if there was an easier way. Our solution was to carry a load until you began to tire and then put it down in a prominent place and recover by scrambling back for the next load. This proved much easier and far less exhausting than carrying everything to the campsite in one go, and yet, we realised, we travelled the same distance overall. As you can imagine, lighter pieces were taken further than heavier ones, so it wasn't long before our gear became strewn higgledy-piggledy along the rocks.

It became obvious, after several hours, that we wouldn't get everything up to the campsite before dark, so we reorganised what remained at the Landing Bay and only took what was essential: the solar panel, most of our stuff, the food and one 20-litre container of water were already at the campsite. We needed the gas cooker and gas bottle, the tents and tarpaulins, the cooking utensils, and the torches and batteries[57] for searching at night. We intended to return to the Landing Bay each day with anything we had finished with, such as rubbish and dirty clothing, and bring back whatever else was needed as it was needed.

We left behind four 20-litre containers of fresh water, a spare gas bottle, two barrels, a large plastic box packed with spare equipment and clothing, and our swimming and snorkelling gear. This was all tied securely to bushes on a ledge near the northern end of the Landing Bay, where it was well hidden from passing boats. The Mercury Islands, except for Great Mercury Island, are protected by legislation and a permit is required to land, but we were concerned that someone might sneak ashore to investigate anything that was visible from the sea.

Setting up camp

It took us five and a half hours to get what we needed up to the campsite. I pitched my tent 33 m above the shoreline on a narrow ledge behind the wall of rocks that Ian Southey and his helpers had built in the early 1980s. Haden pitched his tent on

57 We used small lead-acid gel-cell batteries that weighed just under a kilogram. Each gave us three to four hours of light with our head torches.

Breakfast for Suzanne Bassett and Haden Hewitt under the kitchen fly. Photo: Ian Stringer

a lower site about 10 m below mine, and Suzanne took the third site, about 30 m further uphill. Loose soil had partially obliterated all three ledges, so we cleared this with a small folding spade. We thought the soil had probably rolled downhill from seabirds cleaning out their burrows, and we confirmed this later that night when we watched soil being ejected several metres out from a few burrow entrances.

We tied a small tarpaulin above the front of each tent so it extended about a metre out from the entrance. This was to shelter us as we crawled in or out if it rained. Lastly, we tied a large tarpaulin (about four-by-four metres) between trees alongside my tent to create a large communal shelter where we could use the gas stove. We draped the seaward side down and dug the lower edge into the ground to screen us from wind coming in from the sea: we hoped the island behind and the vegetation on either side would shelter us from those directions. Previous visitors had left some driftwood boards lying about, so we tied these together to form rough shelves for frequently used items. Everything else, including the food, was left packed in their original containers, and these were scattered about wherever we could find small, level areas where they would be safe from rolling downhill. I was terrified that our stove or our gas light[58] might get knocked over accidentally and start a fire, so we kept

58 Lighting at night was provided by an old-fashioned gaslight attached to our gas bottle. This was before LED lights and an incandescent light bulb would have required much bigger and heavier lead-acid batteries.

a barrel of seawater and a billy next to the fly for dousing in an emergency. It wouldn't do my reputation any good if we burned some of the island's vegetation.

The three of us then walked around the search route to familiarise ourselves with it in daylight. I was most grateful to find that Rob had installed a climbing rope along the Razorback. It was strung between the tops of waratah stanchions to create a rope 'handrail' like the one down The Cliff. I had assumed he wouldn't have had time to do this, so I had planned to get the others accustomed to the narrow Razorback (so they were less worried about walking along it without anything to hold onto) by sitting on it and watching the sunset. The idea still seemed attractive, so, in the late afternoon, I collected some cheese and biscuits, a cask of red wine and three plastic glasses and led the way up.[59] We made ourselves comfortable about halfway up with our legs dangling over the edge and snacked on camembert while very slowly sipping the single glass of wine we limited ourselves to.

It was a perfect evening. The island seemed to drowse in the warm, still air, and sunlight sparkled off a few patches out to sea where light breezes riffled the otherwise calm surface. A pair of kākāriki (red-crowned parakeets) occasionally flew in or out of their nest hole in the cliff below the Northern Plateau to our right, but nothing else moved. The only sounds were faint murmurings from the sea as it surged gently amongst the rocks far below.

The peacefulness gradually relaxed us, and our conversation became more and more desultory until there were only occasional quiet requests to pass the snacks. As the sun neared the Coromandel ranges in the west, more kākāriki arrived in the bushes immediately below us and flitted busily about, giving their chattering calls. Occasionally, one flew out from the island with rapid wingbeats, tail streaming behind, and flew quickly back. Three tūī also arrived and entertained us by flying, twisting and turning acrobatically, between the treetops, sometimes exuberantly chasing each other. It seemed they were enjoying themselves, and we certainly enjoyed watching them.

The birds slowly drifted away as the sun sank further behind the ranges. Individual bellbirds and tūī then began calling back and forth from widely scattered locations. Their calls became less and less frequent until the only sound was a faint swishing from the sea below. We reluctantly packed up and started back to camp in the gathering dusk. Once we entered the bush, we shuffled along slowly and carefully because it was much darker there and we had forgotten to bring our torches.

59 I paid for the wine: neither Massey University nor the Department of Conservation reimbursed purchases of alcohol. We also avoided bringing glass onto the island because it is heavy, can shatter, and adds weight when taken off the island.

CHAPTER 6
THE FIRST SEARCHES

Suzanne and Haden waiting their turns to climb up onto The Razorback. They are standing where diving petrels and flesh-footed shearwaters launch themselves westward from the cliff (towards the right in the picture). Photo: Ian Stringer

During dinner, we discussed how to organise the searches when only three people are allowed on the island at a time. Mary McIntyre and her helpers did single-person searches, but we decided to search in pairs with the person in front searching ahead and a few metres on either side, while the person behind searched as widely as possible and recorded the animals we saw in a waterproof field notebook. Recording everything, we hoped, would help keep us alert when few animals were about, because it involved telling each other where and what we saw to avoid counting things twice. Everyone, of course, would do the first search, as we were going to do, so I could explain how to identify the various reptiles and invertebrates and how to record what we saw in the field notebook.

We began searching at 10:30 when it was quite dark, eager to catch tusked wētā and confident we would do so. I had persuaded Suzanne and Haden to accompany me on this field trip by assuring them they would see lots of tuatara, a variety of skinks and geckoes, and numerous insects. I had also promised them that the experience would be so very different from anything they had experienced on the mainland, especially as innumerable seabirds arrive at night to nest in burrows. I suspect they thought I exaggerated, but they couldn't wait to find out.

RECORDING OBSERVATIONS IN THE FIELD

We recorded observations in small waterproof notebooks. We stopped wherever the path branched and took the temperature and relative humidity using digital instruments. We also recorded as much of the weather as we could at these junctions, such as the wind direction, if it was raining, and if we could see any stars. This gave me detailed information on how the weather changed during the night.

We recorded every animal we saw using abbreviated names to save space. These were listed in the order we found them, and additional sightings were added using tally marks (four short vertical lines with a diagonal slash through them for the fifth observation). Thus, for example, we wrote 'tut' for tuatara, 'cent' for centipede, 'LM' for large darkling beetles (*Mimopeus*), 'SM' for small darkling beetles (there were large and small species), and so on. This was much easier (and certainly much less pompous) to refer to *Lepidopteryx brounii* as a bark beetle and write 'BB' (for the entomologists among you, this is in the Family Trogossitidae, whereas true bark beetles are weevils in the Family Curculionidae). However, we always used the full names of animals when we were talking about them, except for tuatara, which became 'tuts'.

On later trips, after a small hut was lifted in by helicopter, the tuatara which lived around our camp became known as 'hut-tut'. We pronounced this as 'hutoot', much to the bewilderment of anyone who had not accompanied me to Middle Island. Such is jargon.

They weren't disappointed: they were astonished at the number of diving petrels that fell through the trees and disappeared into numerous burrows around us. Their mewing calls slowly increased into a loud cacophony as had happened during my introductory trip with Rob. Haden and I each had a bird fall on our heads, and we kept our heads shrugged between our shoulders afterwards in anticipation of more, but we were only hit once. However, the number of birds arriving diminished quite rapidly after an hour or so, and we forgot about being hit.

Our narrow torch beams only illuminated a small proportion of the birds as they fell, but we certainly heard light thumps as others landed around us. About half an hour after starting our search, we began seeing rows of up to five diving petrels perched on sloping tree trunks, presumably waiting to take off, even though dawn was hours away. All were asleep but quickly woke when we shone our torches at them. They made no effort to escape, even if we gently stroked them. Not so a blackbird we disturbed roosting on a branch. It immediately flew off in panic, making its alarm call as soon as it woke up. The only other birds we saw that night were several flesh-footed shearwaters and grey-faced petrels in the Southern Basin. We never saw these larger seabirds landing but presumed they also fell through the canopy.

Suzanne and Hayden were delighted to see tuatara – 26 of them – in their natural habitat. They were rapt and had to stop to admire and photograph the first ones we came across. We saw so many during the entire trip that they ended up hardly glancing at them: "Just another tut." I, on the other hand, was disappointed by the relative paucity of other animals compared with the abundance on my orientation trip. We saw three small geckos on tree trunks and six skinks, which quickly disappeared into the leaf litter. We were pleased to see that two were robust skinks, though. These were once widespread across the North Island but are now restricted to a few rat-free islands. They were the only skinks I could identify during this trip because of their size: they are the largest species around the North Island and can grow up to a length of 25 cm.

There were far fewer insects than on my first trip: we only counted six beetles, two small cave wētā, one giant centipede, and five small wētā. These could have been either ground wētā or juvenile tusked wētā because I couldn't tell which was which at this stage. I relied on George Gibbs' (Victoria University of Wellington) discovery that tusked wētā have tympanal organs on their front tibiae, whereas ground wētā lack them.[60] This is an unequivocal difference between the two species, but we couldn't see if tympanal organs were present or not using my 10x magnifying glass.

Tympanal organs (here I go with some technical information) are oval scars located just below the 'knees' (entomologists call this 'knee' the tibio-femoral joint) on either side of the tibiae of the front legs. They are visible in most photographs of tusked wētā. Each scar is a thin membrane that can be vibrated by pressure waves in air – what we perceive as sound – and the insect detects the vibrations with stretch receptors. There is an internal air sac immediately beneath the tympanum that allows it to vibrate: if the air sac were absent, then it would be replaced with the insect's blood[61] which would dampen any movement caused by sound waves.

Unfortunately, the air sacs in tusked wētā and ground wētā are in the same place, even though those in ground wētā are not associated with any external feature. The air sacs of both species appear as bubbles beneath the semi-transparent cuticle when examined with light bright enough to see clearly with a magnifying glass. The air sacs are also the same size as tympanal scars, so we couldn't be sure if scars were present or absent. All I could do was record all wētā the size of ground wētā as

60 Gibbs and Carter (1989).

61 Insects have an open circulatory system – they lack arteries, capillaries, and veins, so their organs are bathed in blood.

THE AUDITORY ORGANS OF GROUND WĒTĀ

So why do ground wētā, which lack tympanal organs, have air sacs in their tibiae? The air sacs form part of internal subgenual organs that detect sound transmitted though the leg from the ground. Subgenual organs are homologous with tympanal organs which detect vibrations transmitted through air. Both organs originated from the same ancestral organ but developed differently for detecting sound from different sources. For example, your arms, the wings of birds, the wings of bats, the forelegs of horses and the flippers of whales are all homologous.

"unidentified" wētā (any wētā larger than ground wētā would, of course, be tusked wētā).[62] This was so disappointing because the whole purpose was to find as many tusked wētā as possible to recognise their preferred habitat. I needed to be able to do this so I could choose a suitable habitat for releasing captive-bred tusked wētā on rat-free islands sometime in the future.

Why, then, did we see so few insects that night? The temperature (17°C) was suitable for insect activity, and the relative humidity (84%) seemed quite high. What was wrong? Insects risk dehydration if the air is too dry, so they usually respond to water vapour pressure deficit (WVPD). I couldn't measure this directly in the field – it depends on both the temperature and relative humidity, and I had to look up the saturated water vapour pressure (SWVP) in tables back in the laboratory.[63]

WVPD is a measure of how much water vapour the air can absorb, so it is in effect a measure of how 'drying' the air is. Insects are more active when the WVPD is low (less drying). It seemed that the WVPD that night was too high (too drying), so most wētā remained underground in their burrows.

Suzanne retired to her tent when we returned to camp at 12:45 am, and Haden and I took a short break before starting the last search at 1:30 am. The temperature and humidity didn't change appreciably during the night, and invertebrate numbers remained low – we only saw three more beetles, three small cave wētā, another giant centipede, and one small wētā. We finished at 3:30 am as diving petrels started

62 There were only two wētā species on Middle Island – cave wētā are present but are unrelated (classified in a different Family) and have a different body shape (morphology).

63 The WVPD varied form 2.9 – 3.1 mb that night.

TEMPERATUE, HUMIDITY AND INSECT ACTIVITY

Temperature is always important: insects cannot move about if it is too cold, and they risk dying of dehydration if it is too hot. Between these extremes, most insects respond to water vapour pressure deficit (WVPD – sometimes abbreviated to VPD) rather than directly to humidity. WVPD depends on both temperature and humidity: it is a measure of how much more water (in the form of water vapour) the air can potentially absorb – hence it indicates how drying the air is.

WVPD is simply the difference between the actual amount of water vapour present in the air and the maximum amount the air can hold – the saturated water vapour pressure (SWVP). Both are measured in units of pressure – here I'll use millibars (mb), but any unit will do. SWVP varies only with temperature (warm air can absorb more water than cold air). I had to look up the SWVP for the temperatures we recorded in published tables.

The actual amount of water vapour present is obtained from the relative humidity (RH%). Relative humidity is the percentage of water vapour pressure present in the air relative to the saturated water vapour pressure. Once I had these two values then I could calculate the water vapour pressure deficit as the difference between the saturated water vapour pressure and the actual water vapour pressure. This may seem complicated, but it is really very simple.

For example, the saturated vapour pressure at 18.4°C is 2.117 mb (obtained from tables), so if the relative humidity is 71.5% then the actual water vapour pressure is 2.117 x 71.5/100 = 1.514 mb, and the water vapour pressure deficit is 2.117 – 1.514 = 0.603 mb.

So, back to our first night. The temperature and humidity were within the range when we found tusked wētā later (15.9°C to 18.6°C; 75.3 RH% to 95.4 RH%) and the WVPD (2.35 mb to 3.44 mb) was mostly within the range when Mary McIntyre found 70% of her tusked wētā (less than 3.3 mb) so tusked wētā could have been active that night – we just didn't see any.

calling increasingly loudly from their burrows. It was so noisy that we thought it would be hard to sleep, but we fell asleep soon after crawling into our sleeping bags.[64] It had been a very long day and night: we were utterly exhausted!

64 We discovered later that more and more birds start calling towards the end of the night, and the noise reaches a crescendo just before dawn. The noise then fades surprisingly quickly as the birds move uphill to their traditional take-off points and leave. About half an hour of silence follows, then tūī and bellbirds begin their morning chorus.

The second day

Haden and I eventually woke sometime after 11 am. Suzanne had not been given any news when she made the scheduled safety call, so we decided to ring Rob Chappell as well in future, so we could at least get a weather report and keep him updated on our progress.

MORE ABOUT VAPOUR PRESSURE DEFICIT

Here are a few examples that demonstrate the relationship between relative humidity, saturated vapour pressure and vapour pressure deficit. (Note that I am using a different unit of pressure (the Pascal), so the values are different (from millibars) but they show the same effect).

Temperature (°C)	RH (%)	SWVP (Pa)	WVPD (Pa)
10	65	1228.1	429.8
	90	1228.1	122.8
20	65	2338.8	818.6
	90	2338.8	233.9
30	65	4245.5	1485.9
	90	4245.5	424.6

You can see that air can potentially hold or absorb more water (and have a greater drying effect) the lower the relative humidity and the higher the temperature. For example, air at 30°C with a relative humidity of 90% has almost the same capacity for absorbing additional water vapour as air at 10°C and a relative humidity of 65%.

You might well ask: so why not just use the difference between the observed relative humidity and 100% RH? In other words, say the RH is 70%, then why not use 100% - 70% = 30%. If you do, then 70% RH will always result in a 30% difference irrespective of the temperature, whereas WVPD accounts for the effect of temperature as indicated in the table.

After breakfast, we took our accumulated dirty dishes down to the cold sea and washed them – this necessitated using lots of detergent. We had left our dishes and cutlery scattered about on the ground after dinner, and much to our surprise, the remnants and smears of food were still on our plates in the morning. Tuatara weren't interested in it and, as there were no ants or rodents, everything was as we had left it.

The day was hot and sunny, so a swim seemed called for to wash off the exertions from the previous day and night. We clambered around to the Landing Bay to retrieve our masks and snorkels and retraced our steps until we were well away from the beach, where the receding tide had exposed a wide swathe of boulders slippery with algae. The sea was so chilly that we eased ourselves in slowly, but once in, we were rewarded with underwater visibility so clear that it seemed we could almost see to the opposite headland. Patches of sand were interspersed with rocks of all sizes and shapes. These were adorned with blotches of pink, encrusting coralline algae together with a fascinating array of encrusting invertebrates. Rocks near the surface had straps of brown algae growing densely, and small fish were everywhere, but none were large enough to encourage us to try fishing later. But it was so cold that we soon got out to dry off and warm up in the sun.

Hunger eventually drew us back to camp for a late lunch, and it was then that we really started noticing the flies. There had been none on the shore[65] but they were everywhere in the bush, an appropriate complement to the all-pervasive smell of guano. We were too busy to take much notice of them the first day, but now they pestered us. These were persistent flies that returned repeatedly and annoyingly to the same spot immediately after being waved away.

Chores

After lunch, we began nailing triangular orange track markers to the side of trees along the search route on the Central Plateau, ensuring that each marker was visible from the adjacent ones. We then stuck reflective tape to the markers using silver on the side leading towards camp and blue on the side leading away from camp. Very clever, we thought, but we needn't have bothered because the entire path was so short, and the markers were so close together that we could never have got lost.

When we reached the Southern Basin, we stopped marking and checked under the concrete tiles that Rob and I had installed earlier, but no tusked wētā were

65 An endemic mosquito – *Opifex fuscus* – breeds in brine pools along the New Zealand coast, but it seems to be absent from Middle Island. This is fortunate because its bite feels like being jabbed by a blunt hypodermic needle. There is no fresh water, other than a small fetid seepage, for the larvae of other mosquito species to live in.

under them. Next, we set up an oviposition tray near the Weta Bank. This was a shallow tray filled with fine damp white sand in which I hoped tusked wētā might lay their eggs when the ground dried out elsewhere. At the time, Chris Winks was trying to rear tusked wētā in captivity (Chapter 4) and needed an adult male, but he would have accepted eggs if we had found any, even if breeding from them would have taken much longer. Chris described the eggs as black, slightly curved, and about the size and shape of a grain of long-grained rice. I planned to recover them on later trips by sieving them from the sand.

The trays had small holes drilled about 3 cm below the top edges to allow rainwater to drain out and prevent the eggs from drowning. We then positioned a bottle of fresh water vertically into the sand with its opening buried near the bottom of the tray. I hoped this would keep the sand damp for longer. Lastly, we covered the tray with wire mesh to prevent blackbirds and seabirds from digging into it.

We called these trays oviposition trays because a female tusked wētā lays eggs through an ovipositor, a long, thin, blade-like appendage that projects from the end of the abdomen.[66] One student used to call them – half-jokingly – ovi*de*positors to emphasise their function. A female, as you can imagine, must hunch its abdomen so its ovipositor is directed vertically down before it can thrust it into the soil.

An oviposition tray containing sieved white beach sand. Wire pegs prevented seabirds from upending the tray by burrowing underneath, while wire mesh prevented blackbirds (common on Middle Island) from digging into the sand. Photo: Ian Stringer

66 Each ovipositor consists of four long valves arranged to form a tube through which eggs are laid. These valves are held together by a tongue and groove arrangement that allows them to slide back and forth independently to 'saw' the ovipositor into soil.

ATTRACTION TRIALS

Chris Winks, at Landcare Research in Auckland, was ready to begin a second attempt to captive-rear tusked wētā when I started my field work. However, by then he only had three females and desperately needed a male (Chapters 4 and 22). It occurred to me that the insects might be more easily caught if we could attract them to food. So, I brought peanut butter and tinned cat food (bacon and liver) – food that Chris had recommended – and six small squares of plywood (painted white so we could find them again) with me. This was not a carefully designed experiment: there was no randomisation nor any replication: it was just a rough and ready trial to see if the food attracted tusked wētā. We simply arranged the plywood squares 2–3 metres apart in a row along the eastern track on the Central Plateau, put dollops of the food on them and checked what was nearby or eating the food whenever we went past.

Small wētā congregated around the peanut butter and tuatara took a shine to both it and the cat food, so the food quickly disappeared, but no tusked wētā appeared. During the next two field trips, I presented the food on small white ceramic tiles, which were easier to clean each morning and protected the food within fine mesh cages, but again, no tusked wētā appeared. We realised, of course, that tusked wētā could easily have come and gone while we were absent because the food was only checked at long intervals, often several hours, when we passed by while searching.

The obvious solution was to use pitfall traps. I was given permission to use only three and I set them up during two later field trips. These trips coincided with colder weather, and we caught very few invertebrates in them, and, of course, no tusked wētā. I then gave up using food to attract tusked wētā and concentrated on searching.

We finally returned to camp at 3:30 pm, collecting, as we went, the flagging tape that Rob had originally used to mark the route and a lot of rubbish that previous visitors had discarded. Once back in camp, we spent the next hour and a half entering the information we had recorded the previous night into a little palm-top computer.[67] It clouded over while we were doing this, and light rain started about 4:30 pm, but the sun came out soon after, so we made our way up to The Razorback and relaxed with some wine and cheese.

67 I was extremely proud of this little gadget (it was well before electronic tablets). It had the advantage of being powered by AA batteries (I had brought along a good stock of these) so I didn't have to recharge it with our solar panel which provided just enough power to recharge the gel-cell batteries for the torches. I never took a laptop computer with me for the same reason – their batteries were only good for two to three hours use in those days.

Suzanne and Haden ascending The Razorback. Photo: Ian Stringer

CHAPTER 7

CALM BEFORE THE STORM

We didn't see any tusked wētā during the first four nights, and searching was uneventful until Haden and I returned to camp at the end of the fourth night. Flesh-foot shearwaters were taking off to the west when we reached the bottom of The Razorback at 5:20 am after completing the last search of the Northern Plateau. All the diving petrels had flown off by then, and dawn was lighting the sky in the east. There was just enough light to see by, so we turned off our torches, flattened our backs against the base of The Razorback, and watched.

The birds converged from the eastern slopes of the island and arrived in a single file. They then ran towards the cliff edge, flapping their wings energetically, and launched themselves off into space. Once airborne, they initially flew steeply downward, gaining speed before soaring gracefully away and disappearing into the gloom.

As each bird flew off the queue behind shuffled forward, the bird at the front then hesitated for a moment before leaving. This proceeded in an orderly fashion for some minutes until a bird jumped onto the bird ahead and tried to copulate with it. None of the birds behind tried to go around the pair, even though there was plenty of room to do so. Instead, they started yakking increasingly louder as more and more birds became stalled behind. The pair, however, separated after perhaps 30 seconds and flew off, and the queue re-commenced its orderly departure.

The flesh-footed shearwaters called as they made their way up to the departure area, although this wasn't nearly as loud as when they were banked up behind the copulating pair. The noise stayed at roughly the same loudness until the last few birds took off, and then it diminished surprisingly quickly because the silence below had been masked by the yakking of birds

Flesh-footed shearwater. Photo: Rob Chappell nearby. What intrigued us, though, was where all these shearwaters had come from? We saw none on the slope surrounding our campsite below The Razorback during the previous nights, so we concluded they must nest on the steeper areas to either side where we were forbidden to go. We left soon after the last bird departed and walked back to camp in almost complete silence except for faint sounds from the sea. It looked like it was going to be a good day.

Each night we started off brimming with enthusiasm, confident we would find tusked wētā, and were disappointed when we didn't. By the end of the fourth night, we were quite despondent: other invertebrates were out and about busily getting on with their lives – in total, we recorded four giant centipedes, 47 darkling beetles, and 37 small unidentified wētā. The number of small unidentified wētā also gave us hope that we might find some large tusked wētā, but we saw none. What were we doing wrong? All we could think of was that perhaps tusked wētā hid as soon as they detected light, so the next night we tried to avoid shining our torches more than a few metres ahead and concentrated our searches to either side. It didn't help, though: we still didn't see any tusked wētā.

We developed a routine during the first two days, which we followed during the next two: Suzanne got up at 7 am and rang Rob Chappell to get a weather forecast before he went to work, and then she rang the Thames Office of the Department of Conservation Office before 11 am to make our daily safety schedule call. We had breakfast after Haden and I woke up, then wrote up our observations from the previous night while everything was still fresh in our memories. We also did this first because there were fewer flies in the morning – more and more appeared as the day warmed up. Next, we went down to the sea, washed the dishes, had a swim, and sunbathed until the unrelenting sun drove us back into the bush. After a late lunch, we continued attaching track markers along the search route and numbering them. We also surveyed the route using a hand-held sighting compass, an inclinometer, and a long tape measure so I could map the tracks when I got back home. This allowed us to quickly record accurate positions of any tusked wētā we found by simply measuring its distance and direction from the closest marker.

When we were tired of track work, we either retired to our tents to read, or sat at the base of The Razorback enjoying the view of the islands and the Coromandel ranges to the west or went down to the seashore and poked about in rock pools. The only memorable thing for me occurred on the third day after we had finished our swim. I decided it was time I shaved, so I found a suitable pool with a low rock where I could sit and lean forward over the water. Bits of crab and empty carapaces from several

WHEN NATURE CALLS …

The usual procedure on offshore islands is to make a latrine by digging a deep hole, then positioning an upended bucket with the bottom cut out over it and attaching a standard toilet seat on top. At the end of the trip, or when full, the hole is covered over with the excavated soil. We couldn't use this system on Middle Island because the soil is turned over too quickly by burrowing seabirds, and this would risk introducing weeds such as tomato, cucumber, and pumpkin. The seeds of these plants pass unharmed through the human gut and thrive in the rich fertiliser they are deposited in.

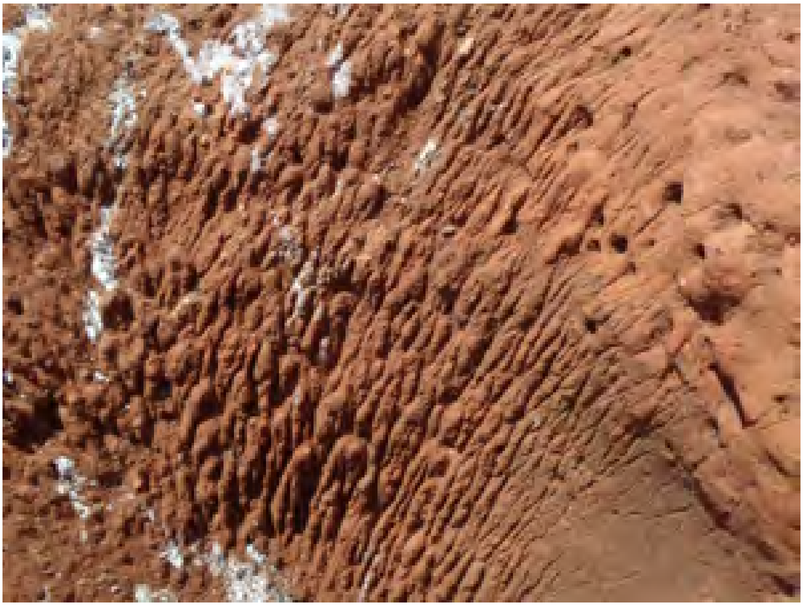
Another option used on some islands is to erect a small toilet shed with a bucket (the 'honey bucket') positioned under the toilet seat. When nearly full, the bucket is sealed with a lid and rowed well out to sea and emptied. But it's not always possible to get a boat off Middle Island safely, and even if you could get off in rough weather, imagine taking the lid off while being tossed about, and the contents of the bucket are sloshing around. You would likely get splashed or worse. This is not a good option.

Our solution was to find a suitable place on the rocks and relieve ourselves directly into the sea. There was, of course, a ritual associated with this: we left a plastic bag containing toilet paper and a tube of saltwater soap under a rock cairn at the bottom of the track up to the campsite. The rule was to go around the rocks to the north only after picking up the toilet paper bag and taking it with you. If the bag was not there, then you waited until someone returned with it. Everyone could go south at any time – this led back to the Landing Bay – except when someone was having a shower, but I'll explain about that later.

Lisa Sinclair elegantly explained this in a poem that she dashed off after we had returned to the mainland after the fifth field trip.

It's not the threat of getting wet
That makes the moment last
It's when you know that crabs below
Await to break their fast

When looking down, did cause to frown
The crabs all looked aghast
T'was plain to see all crabs did flee
When a poo went floating past



Grooves in the rock at the base of The Razorback made by the claws of numerous diving petrels as they fluttered up to the top to take off. Most diving petrels left from the base of The Razorback and departed in a wide swath (giving the impression of a moving carpet) as they ran towards the cliff edge and took flight. Flesh-footed shearwaters also did running take-offs but formed an orderly line and waited for their turns. Photo: Rob Chappell

species littered the bottom of the pool, and I idly tried to recall their specific names. This was something I always did: it was a legacy of having to memorise the specific names of everything on the seashore when I was a second-year student at Auckland University many years ago. As it turned out, the shaving cream didn't lather in seawater, so I had to scrape the stubble off. I was so engrossed trying to remember the names of the various crabs that the significance of their remnants only dawned on me when I had almost finished. I quickly cleaned up and went searching for the octopus. There it was, neatly tucked into a small cavity under the very rock I had sat on.

The weather stayed warm, sunny, and calm during the four days, so we migrated up to The Razorback in the evenings with our wine and cheese as we had done on the first day. We enjoyed ending the day this way so much that these evening wine and cheese sessions are now a regular highlight on all my field trips whenever the weather is suitable.

A warning

On the fifth morning, Rob told Suzanne that a 45-knot easterly and rain was forecast for the next two days, and by the time Hayden and I awoke, a strong wind was blowing in off the sea. We decided to check that everything at the Landing Bay was secure, but we were too late: when we got down to the shore, waves were splashing right up to the highest boulders on the headland, so they would have been breaking right over the lower rocks further around. All we could do was hope we had secured our gear well.

Back at camp, we retightened the tarpaulins and then started off to mark the route on the Northern Plateau and survey it, but the wind was so strong that we decided not to risk climbing The Razorback and returned to camp. All we did that day was enter all the survey data from the previous day into my palm-top computer before retiring to our tents – it was more comfortable lying on our beds than sitting on the ground under the flapping tarpaulin. It was only 7 pm.

Hayden and I got up at midnight and searched the Central Plateau and Southern Basin in light rain that was being blown horizontally by a strong easterly. At The Cliff, the wind was being deflected upwards, carrying the rain up with it and onto my glasses, making it difficult to see clearly. The path down to the Southern Basin was by then very slippery, and the rope 'handrail' had absorbed water and stretched so it now drooped onto the ground between the waratah stanchions. We still held onto it, though, lifting it off the ground as we went, in the hope it would arrest us if we slipped (we never did). We returned to camp at 2:20 am after searching the Southern Basin and Central Plateau and took a break to eat sardine sandwiches for what passed as dinner.

We finished later that night by searching the Northern Plateau. The base of The Razorback was fully exposed to the strong wind, and the light rain stung our faces. The path up was surprisingly only slightly wet. It seemed that most of the wind and rain were blasting up the cliff and over the top of the dense hedge of Pōhutukawa trees along the eastern side. Even so, we still had to exercise great care coming back down because the path had become a little bit slippery and the rope 'handrail' had stretched – like the one down The Cliff – and now dangled in a series of loops down the western side of the cliff where it would be of little help if we went over.

There were very few seabirds that night, but we did count 41 tuatara, two small geckos, two of the large Duvaucel's geckos, and 32 small unidentified wētā. Other insects seemed to be as abundant as on previous searches, but once again – disappointingly – there was no sign of tusked wētā.

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The sea was now making a continuous loud thundering, and it seemed much louder and closer once we retired to our tents. The thrashing and creaking of trees above us also seemed far worse than during the day. Haden, who was nearest the sea, confessed later that he was terrified because the waves seemed to be crashing just beneath him. Even so, we all managed some fitful sleep until dawn provided the relief of being able to see what was happening around us.

AERIAL TOPDRESSING

When Māori discovered New Zealand, they would have found vast colonies of nesting seabirds on both the offshore islands and on the mainland. The birds weren't spread evenly but were in colonies sprinkled on hill tops and mountains – often many kilometres inland – where steep slopes or cliffs afforded places where they could take off. The birds arrived and departed at night to avoid birds of prey and released guano rich in nitrogen, phosphorus, and trace elements while flying overland, just as they do today on Middle Island. These nutrients accumulated over millennia to create fertile soils that supported a highly diverse rainforest. This fertiliser also kick-started farming, much to the delight of Europeans when they arrived in numbers in the 1860s. The colonists, of course, had to first clear the land, which they did mostly by felling the forest and burning it. They did so much of this that the skies were often dark with smoke for many days in summer during the 1880s and early 1900s. The colonists then replaced the forest with exotic grasses and introduced herbivores to graze it. They also brought their carnivorous pets and later introduced predators to control the rabbits they had introduced for sport and food when these reached plague proportions. Rats also arrived by hitch-hiking with both Māori and Europeans. The result was that much of the native fauna disappeared along with almost all the seabird colonies on the mainland.

Most scientists at the time realised what was happening but were content with the situation because the prevailing wisdom at the time was that the native flora and fauna would inevitably succumb to the more 'highly developed' European forms anyway. They thought this was simply the way nature works, so it was pointless trying to stop it. This attitude regrettably survived into the early 1900s with disastrous results for New Zealand's original biodiversity.

The original nutrients didn't last forever, though, so more fertiliser was eventually needed. Seabird droppings were again used, but this time in the form of superphosphate mined from deep deposits of guano on Nauru Island. In some areas of New Zealand, it was even spread from the air again.

CHAPTER 8
DRENCHED BUT TRIUMPHANT

Suzanne got up briefly at 7 am on Monday to make the safety calls and was warned by Rob that the rain and wind would continue for at least another 24 hours. We stayed in our sleeping bags until midday, listening to a continuous and tremendously loud booming as huge waves thundered in below us. We, of course, had to venture down when we got up to gawp at the spectacle while keeping a wary eye on the sea. Waves arrived from the north and southeast, the latter being refracted around the south end of Stanley Island. Occasionally, they combined to form enormous breakers that surged a few metres right up amongst the shrubs along the shore, while we quickly retreated up the track in front of them. Our rock cairn at the bottom of the track had disappeared together with our dishwashing gear, and the plastic bag with toilet paper and saltwater soap, which had been under it.

After a late breakfast, we continued to mark and survey more of the search route. Light rain continued for most of the day, but the wind became so strong that gusts ripped sheets of spray off the sea and flung it up through the trees past our campsite. Fine spray swirled behind our cooking fly and dampened our clothing and parkas. Everything plastic and metal became coated with a fine film of seawater. Droplets accumulated on the underside of the fly and dripped onto the ground, slowly turning it to mud, so we were obliged to stand instead of sitting. We were careful to keep our tents zipped up to prevent spray from getting in, while entering or leaving our tents became an exercise in ensuring that no mud from our boots and waterproof over-trousers entered with us.

Heavy rain started at 2:30, so we retired into my tent and spent half an hour entering data. Suzanne and Hayden then dispersed to their tents to read, but they eventually reconvened in my tent again, where we played cards until dinner time.

It continued to pour with rain that night, and it blew a real gale [68] but despite this, we decided to do one search. The path was now extremely slippery, even though only a thin topmost layer of soil was wet. Each time we took a step, this thin layer of

68 Wind gusts up to 156 km/hr were recorded on Tiritiri Matangi Island that Saturday.

mud peeled off the ground and stuck under our boots, leaving a dry footprint behind. These layers quickly built up into thick cohesive masses that couldn't be shaken off, so walking (without slipping) became increasingly difficult. Our progress became extremely slow because we had to stop every 10 to 15 metres and prise off as much mud as we could with sticks. When we finally reached the Central Plateau, I decided enough was enough – we were focusing entirely on walking instead of searching, so we retraced our steps back to camp. We had to negotiate the steep path down with extreme care, but even so, we inevitably slid over innumerable times.

Once back at camp, we dug steps to Suzanne and Haden's tents to make it safer for them and strung some spare rope alongside the steps to help Suzanne get up and down, but she still had difficulty doing so. Haden managed much better because he didn't have as far to go, and his path was not as steep. He also had more trees to hold onto along the way.

We all managed to get some fitful sleep that night, even though the roar from the sea seemed very much louder and closer than the previous night. The sounds of trees thrashing above us and creaking in the wind also seemed much louder. We were all greatly relieved when daylight returned.

The storm reaches a climax

The waves were huge when we got up on Sunday morning. Some now broke right over the tops of the highest rocks on the headland between us and the Landing Bay and splashed well into the edge of the bush above them. They also surged a few metres amongst the bushes up the path to our campsite more frequently than before. At one point, I was returning from the shore and had gone some metres uphill, where I thought it was safe, when I suddenly found myself waist-deep in foaming seawater. I quickly looked behind me to see if more was coming and saw that the bushes a short way below me were completely submerged. After that, we agreed only to go down to the shore if necessary, and while there, to constantly watch the sea and be prepared to sprint back up the path at a moment's notice.

Our equipment at the Landing Bay had probably been lost or destroyed. From then on, we used our fresh water strictly for drinking, just in case we were marooned on the island for some days. Consequently, we had to wash our dishes in the sea, and this became quite tricky. One of us would dart in with a bucket during a lull while the others looked out for unexpectedly large waves. Going to the toilet was similarly fraught, so we made it a rule to remove our trousers and underpants when halfway down the path before venturing further: we didn't want them around our ankles tripping us up if we had to make a mad dash to safety, and, of course, we constantly watched the sea.

We spent most of that wet and windy day reading or playing cards in my tent. We were damp and a bit bored, but it was warm, so we weren't miserable. However, we had been unable to wash ourselves for two days and were grimy with mud from slipping over repeatedly. At one stage, while we were playing cards in my tent, Suzanne noticed a rivulet of water running across the floor. We quickly vacated and shrugged into our parkas, now clammy inside with saltwater spray that had penetrated everything. Suzanne and Haden went to see to their tents while I checked mine. Fortunately, the leak was easily fixed: guy ropes to the outer fly had worked loose in the wind, exposing the inner tent material, which was not waterproof.

I climbed up to the saddle at 7:30 pm and rang Rob to see if we could telephone him each evening instead of making the safety call to the Department of Conservation office before 11 am. He agreed and then warned me that a gale warning was still active, although the wind was forecast to go northerly and diminish to 15 knots. Suzanne, however, was pleased because she could be freed to help search later at night.

View south from below the campsite with Rob Chappell in the distance. Huge waves broke over the highest rocks on the headland in the storm during the second field trip. Photo: Lesley McKay

That night, Suzanne and I got up at 3:37 am and searched the Central Plateau, accompanied by a constant thundering from waves in the Landing Bay below. The wind had moderated, and we were surrounded by a heavy, damp mist. The rain had penetrated deeply into the soil, transforming it into deep, soft mud that no longer accumulated under our boots, so our progress was now much easier and faster. We decided not to risk going down The Cliff because it seemed too slippery, but we did climb up to the Northern Plateau and search there until 5:10 am. We saw numerous tuatara, but very few seabirds, and no insects.

Going up the Razorback was easy, but coming down was quite a different matter. It was so slippery that we had to edge our way very gingerly along, grasping the ends of Pōhutukawa branches on our left and holding onto the slack climbing rope on our right. But we eventually arrived safely at the bottom at 5:25 am and stood for a while recovering, while watching an occasional bird take off. Once we had calmed down, we slid back to the campsite and crawled into our damp sleeping bags.

Bright dappled patches of sunshine on our tents woke us all around 10 am the next morning. The waves had reduced so much that Haden and I risked scrambling around to the Landing Bay to check what had become of our gear while Suzanne stayed behind to call Rob. The strip of soil along the base of the cliff near the Landing Bay that had previously provided an easy pathway had completely vanished, and boulders now extended right up to the cliff. Dozens of bedraggled and forlorn-looking diving petrel chicks were scattered everywhere. We rock-hopped across to the ledge where our spare gear had been. All that remained was a single smashed plastic bin containing several of Haden's clothes, now filthy; the spare gas cylinder, which had somehow emptied; various small heavy tools; and four 20-litre plastic water containers. Two still contained freshwater, but the others had been punctured and were partly full of seawater. Everything else had gone, although we did find one of Suzanne's socks when we searched the beach later. Her sock, together with scattered fragments from the plastic containers that had disappeared, was embedded in a thick wrack of seaweed that covered the entire beach. We also found one of Suzanne's pullovers jammed into a crevice during the next field trip, and a snorkelling mask washed up (minus the glass) nine months later.

When we returned to camp, Suzanne told us that Rob, who lived in Coromandel, had moved the dinghy to Mercury Bay Sea Safaris in Whitianga, so the owner-operator, Rod Ray, could collect us in his glass-bottom boat as soon as the sea allowed. We had a late breakfast, then walked over to the Southern Basin where we set up two more oviposition trays, one with soil from Middle Island, and one with sterilised potting mix. Lastly, we surveyed the short track back up to the base of

The Cliff and the remaining section on the saddle. We still had to survey the track up from the campsite, The Cliff itself and The Razorback.

That night, we went to bed about 8 pm after dinner and got up at 1:15 am to do what we hoped would be the last search of the trip. By now, we were quite disheartened because we hadn't found a single tusked wētā, and we felt we were wasting our time searching for them. We had also had enough of the mud and our damp clothes. We just wanted warm showers, dry clothes, and civilisation.

Pandemonium

We started along the eastern path of the Central Plateau at 1:40 am and went down The Cliff into the Southern Basin at 2:10. I led, followed by Suzanne and then Haden. We squeezed between a pair of trees that marked the start of the Weta Bank and were passing a large, prominent rock on our right when Haden yelled excitedly, "What about this?" There, on top of the rock, was a large wētā with big tusks. We decided it was an adult because of its size and large tusks.[69] Suzanne and I had been concentrating on the ground in front and to either side, so it was fortunate that Haden was looking elsewhere.

This was the male Chris Winks needed for his breeding programme, so we didn't want it to escape. Where was the plastic bag for capturing tusked wētā with? I found my camera and hurriedly photographed it, but I must have fumbled in my haste and excitement because the colour slide was blurred. This was before digital cameras allowed you to check photographs on site.

We were frantic because we had no idea what the wētā might do. This was the first one I had seen in the wild. Mary McIntyre had told me they usually freeze for a while, and when they do jump, they can leap up to about two metres, so I hoped it would stay still until we were ready to catch it. I dreaded pursuing it across the surrounding ground riddled with seabird burrows. Someone eventually found the transparent plastic bag, and I carefully placed it over the wētā, making sure it didn't touch the antennae while the others watched anxiously. To our complete amazement, the wētā started walking and effortlessly ripped a hole in the bag by simply opening and closing its tusks and calmly walked out. The bag didn't even slow it down. I immediately bunched up the bag and used it to gently pin the wētā against the rock while the others began a desperate search for the two-litre ice cream container we were going to use to transport it to the mainland.

69 It turned out to be an unusually large subadult.

As soon as we found this, we carefully ushered it in and added some leaf litter. It was a huge relief to get the lid closed, and we just stood there for some time recounting the adventure excitedly to each other. It had certainly been exhilarating!

We eventually collected our belongings that were strewn everywhere, repacked our backpacks and searched the rest of the Southern Basin.

With lifted spirits and renewed confidence, we searched back along the western track of the Central Plateau, then Suzanne and I searched the Northern Plateau while Hayden took his prize triumphantly back to camp. All three of us then did another quick final search of the eastern track of the Central Plateau from 3:45 to 4:07, followed by a second (and thorough) search of the Southern Basin, but finished empty-handed at 4:45 am. It was getting distinctly lighter in the east by then, and the seabirds were noticeably louder. Some were also starting to congregate around a huge Pōhutukawa tree that they take off from at the bottom of The Cliff. We did a quick search of the eastern track of the Central Plateau on our way back to camp and retired to bed at 5:05 am.[70]

A tricky departure

The sea had moderated so much when we got up at 9 am that the largest breakers were now not much more than a metre high. They seemed to arrive in threes, followed by a spell of smaller waves, so we decided we could get off in a dinghy if we timed our departures to coincide with the lulls. So, with some relief, I rang Rod Ray and arranged for him to pick us up at 1 pm.

A bank of rain was moving in from the north, so we hurriedly packed up camp to get everything down to the rocks before the track became slippery. There was, of course, less to take back because much of the food had been eaten. We also had permission to leave behind the 20-litre container with the remainder of our fresh water; two barrels containing our tents; a large, sealed plastic box containing the tarpaulins and their ropes; the cooking utensils; some spare tinned food; and our folding shovel. We hurriedly left as soon as these containers were tied securely to tree trunks at the campsite, but we needn't have rushed because only a few spits of rain fell. The waves were even noticeably smaller by the time we got everything down onto the rocks, so I rang Rod again and asked for a 2 pm pickup, anticipating that the sea would have become even calmer by then.

70 The water vapour pressure deficit was 2.4 mb and the temperature was 16.8°C when the tusked wētā was found.

The tide was out when we got everything to the Landing Bay at 11 am in readiness to depart. We realised it would have been hazardous if we had left straight away because we would have had to negotiate a wide expanse of slippery, rounded boulders. These were liberally covered with a dark red encrusting algae – *Apophloea sinclairii* – aptly called 'dried blood algae', which is extremely slippery when wet. Furthermore, sea urchins lurked amongst the kelp between the boulders, ready to skewer us with their spines should we slip onto them. We congratulated ourselves on making the correct call to delay our departure for an hour.

As we sunbathed on the gravel beach during that hot and sunny early afternoon, we watched with growing consternation as the waves slowly began getting bigger. By the time Rod arrived, they were so big that landing a dinghy through them was, to say the least, marginal.

Fortunately, Rod had brought Alain, a Frenchman from a visiting yacht, to row the dinghy back and forth. Rod and Alain stood on the stern for a long time looking at the surf before Alain, to our immense relief, got into his wetsuit and bravely rowed in. The dinghy became completely swamped in the surf when he tried to back it in with the bow facing the waves. Waves continued to break over it while we frantically bailed, but we eventually got it light enough to drag it further up the shore where we turned it over and emptied it. We then loaded it up just out of reach of the waves and waited for a lull. While we waited, we had a hurried discussion about how best to land in future. The tide had come in so far that the slippery boulders were submerged, and the waves were breaking onto gravel where the beach was steepest. Our strategy was for Alain to wait for a set of smaller waves and then quickly row in, bow first. We would wait, waist-deep in the sea, and run the dinghy with him still in it up onto the beach as far and as fast as we could. This worked well because the dinghy only took a little water over its transom and remained light enough for us to drag it easily up the shore once Alain jumped off.

Alain took three loads out to the waiting boat, arriving and departing successfully during periods of relative calm. Suzanne then departed, perched on a pile of gear in the stern, looking seaward. They were about 25 metres out when Haden and I noticed a huge rogue wave forming beyond them. We yelled as loudly as we could and gesticulated wildly to try to warn them, but Alain was preoccupied with rowing, and they couldn't hear us above the noise of waves crashing onto the surrounding rocks. Eventually, Suzanne pointed seaward, and Alain looked around and immediately began rowing desperately fast, making strokes every few seconds. We watched with our hearts seemingly in our mouths as the dinghy slowly went up the face of this huge wave and crested over just as it began to curl. Relief just flooded through us. Haden and I just looked at each other and said "*swim*?" at the same time. Neither of us fancied a trip like that. We each grabbed a black garbage bag full of rubbish, fortunately all that was left on the beach, and swam awkwardly out to the boat 300 metres away.

The trip back to Whitianga was surprisingly easy because the surface of the sea was relatively smooth, although we went over huge, lazy, widely spaced swells. As we entered shallower water near Whitianga, these swells produced a considerable lift, which we found a bit disturbing and quite exhilarating, but Rod took it all with equanimity. We even watched a yacht leave the estuary and then turn back hastily after cresting a few of these waves. Once ashore, we saw that the surf had washed right over the road along the waterfront, leaving drifts of sand both on the road and in adjoining gardens.

Rod kindly offered us the luxury of showers at his home before we hit the road. Suzanne commented on how her shower water turned a muddy red, and this also happened for both Hayden and me, even though we had swum out to the boat. I noticed my shower water still ran slightly red the next day, and traces of red were even present when I showered the day after that, so the mud must have been deeply ingrained into my hair and pores.

The exchange

After cleaning up, we drove to Coromandel and gave the wētā to Rob Chappell, who then drove to The Castle Café at Maramarua – roughly halfway between Coromandel and Auckland – and waited for Chris Winks to arrive from Auckland to take possession of it. This was the arrangement for exchanging all the wētā Rob had previously caught. Rob would telephone Chris (and wake him) as soon as he caught a wētā and give him the approximate time he hoped to arrive at the café. Rob then returned to the mainland as fast as he could and drove to the café. Meanwhile, Chris drove from Auckland, timing his arrival to coincide roughly with Rob's. These exchanges had usually occurred before dawn or soon afterwards, depending on when the insects had been caught during the night (the café opened early for truck drivers).

On this occasion, Rob was at the café during the day, and the proprietor's curiosity finally got the better of him. Why, he asked, was Rob nursing a two-litre ice cream container, and why had he waited for someone so very early in the morning on previous occasions? It all seemed a bit suspiciously cloak-and-dagger. Rob explained that he had an extremely rare tusked wētā and was waiting to give it to the person who was going to breed from it. The proprietor naturally wanted to see such a special insect. Rob obliged. He gingerly lifted a corner of the lid, and the wētā immediately leapt out and took off across the floor, vigorously pursued by Rob. It bit Rob's hand, drawing blood, while he was (very gently) capturing it – Rob was only too aware of how special this critically endangered insect was, and Chris desperately needed it undamaged for breeding with his two females. The proprietor was suitably entertained and "thought the whole thing was a great joke," but he did commend Rob on the care he had taken to avoid damaging the insect as he gently unfastened its jaws from his hand.

Adult female tusked wētā in its chamber after the roof was broken away.
Photo: Ian Stringer

ISLAND BIOSECURITY

The Department of Conservation has strict rules to ensure that visitors to islands do not introduce foreign animals or plants. All clothing must be freshly laundered and thoroughly checked for such things as invertebrates and seeds. Footwear and tent gear must be cleaned using a strong sterilising detergent. When you arrive at a Department of Conservation office, everything is taken into a clean room, which is then sealed. You then unpack it all, and a Department of Conservation officer checks it thoroughly. If a 'weeder' is available, they do the check, and they seldom fail to find something you missed. 'Weeders', as the name implies, remove weeds from offshore islands, so it's in their best interests to ensure no additional plants are introduced. When they have finished, you pack everything into clean plastic barrels or plastic bins and chilly bins, which are then sealed and made watertight. These containers are only opened again when you are on the island.

When the Department of Conservation later provided a small relocatable hut on Middle Island, I had a wooden box made for keeping vegetables fresh. It looked a bit like an old-fashioned meat safe with sides of fine gauze that prevented invertebrates from escaping from food, such as lettuces and cabbages. We were always amazed at how many slugs emerged from such vegetables, especially when you rarely find them when eating at home. We always dutifully carried slugs down to the sea and squashed them in seawater in case they contained fertile eggs, which might survive if the slugs were squashed on land.

CHAPTER 9

DISASTER THEN SUCCESS

Megan McLean and Marieke Lettink helped during my third visit to Middle Island in April 1999. Megan had helped me numerous times on other projects, and Marieke was an enthusiastic reptile specialist from Canterbury. She wanted to visit Middle Island because 10 species of lizards occur there, an unusually high number for such a small island.

Bad weather delayed us in Coromandel for three days before Rod Ray took us to Middle Island. We motored over a lazy 1–1.5 metre swell and were entertained for some time by a pod of dolphins that surfed along on our bow wave and cavorted about nearby. Small waves were lapping the beach when we arrived at the Landing Bay, so we were able to disembark easily and quickly. The remains of 30 diving petrel chicks were scattered over the gravel, and we found dozens more as we carried our gear around the rocks. There were even three dead chicks on the path up to the campsite. All had died after their nests were destroyed in the November storm.

The taupata and karo bushes that fringe the coast below the campsite had lost most of their leaves – presumably from being drenched with saltwater spray – and a thick layer of dead leaves now covered the ground, whereas, previously, the steep hill up to the campsite had only had a scattering of dry leaves. We found later that the tall trees higher up the island had also lost many leaves, so the leaf litter under them was much deeper than previously. The canopy was still intact, though, so they hadn't been affected as severely as the bushes lower down.

It took seven hours to set up camp after we landed at 11:30 am, even though we had left some of the equipment from the previous trip in containers tied to trees at the campsite. We also left anything we didn't immediately need (in containers tied to trees) at the Landing Bay, just as we had done during the November field trip. This time, though, I was determined to bring everything to the campsite at the first hint of an impending storm.

After a very late lunch, Megan and Marieke decided they could easily familiarise themselves with the search route at night and were insistent that it was more important to have a leisurely wine and cheese on The Razorback: it had been a strenuous day. We sat chatting until the sunset had almost faded, and then, in the gathering dusk, returned to the campsite and retired to our beds for a short sleep.

We all arose at 10 pm, cooked and ate dinner, and then did two full searches, starting at 11:30 pm and finishing at 5:30 am, with a break between for hot coffee. The island seemed dry, and there were far fewer seabirds than on my two previous trips – we only saw three flesh-footed shearwaters, two sooty-faced shearwaters, and about a dozen diving petrels. As a result, it was much quieter at dawn when the birds left the island, so we had no difficulty going to sleep.

We counted 47 tuatara, much to Megan and Marieka's delight, but saw few lizards. There were fewer insects than I had seen on previous trips, except for numerous cave wētā, and we only found three of the small wētā we wanted.[71] I had been unable to identify tusked wētā from similar-sized ground wētā during the previous field trip using a 10x magnification hand-lens to see if tympanal organs were present (tusked wētā) or absent (ground wētā), so I had armed myself with two new ways to distinguish between them. One was the method Mary McIntyre used during her field study in the early 1980s (Chapter 3), and the second was to identify the species using multivariate statistics.

Mary identified the wētā by the colour of their ocelli. Ocelli are three small accessory eyes located between the large compound eyes (they can be seen in most photographs of the head). She explained that they are orange in tusked wētā and pale cream-coloured in ground wētā.[72] So we caught the three wētā we found during the first night and examined them back at camp. All three had pale cream-coloured ocelli, so we were satisfied they were ground wētā.

I included multivariate statistics as a backup in case I couldn't find a way to identify the species either by sight or by using a magnifying glass. The methods I used (Principal Component Analysis and Canonical Variate Analysis) were developed for separating similar objects – in our case, species – from slight differences in measurements or proportions.[73] Identifications are made by comparing measurements with specimens that have been positively identified. So we took 11 measurements from each of the three small wētā: the lengths and widths of the head and pronotum (a shield-like

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71 I use the word wētā in a general sense to refer to the 'true' wētā – tree wētā, ground wētā, tusked wētā and giant wētā (they are all in the Family Anastostomatide). Cave wētā are quite different insects (in the Family Rhaphidophoridae) and look quite different from other wētā, but we are stuck with the common name 'cave wētā' so I use both words to distinguish them from 'true' wētā.

72 McIntyre (1991).

73 I had also recently completed a course on multivariate statistics and was keen to try out some of the analyses.

structure on the thorax behind the head), and the lengths of various parts of each leg and of the cerci (cerci are a pair of short tapered sensory appendages that project from the end of the abdomen – a bit like stout hind-facing antennae). The disadvantage of using this method was that I couldn't identify the species there and then: I had to wait until I could take the same measurements from insects that were positively identified as either tusked wētā or ground wētā before I could do the analysis.

Adult female Mercury Islands tusked wētā. Note the ovipositor and lack of tusks. Photo: Kahori Nakagawa

Using statistical methods might seem clever, but it turned out to be a waste of time because we never found enough juvenile tusked wētā on Middle Island to get the comparative data we needed. There was more to it, though, as I'll explain in Chapter 14.

After measuring small wētā, we always released them where we caught them. We caught them in numbered vials and marked where we found them with white numbered plastic plant tags. We also painted a small spot of white Twink® behind their heads before releasing them so we could ignore them if we saw them again.

Why go to this trouble? Well, ground wētā dig vertical holes that are often slightly J-shaped, and they return repeatedly to these burrows after foraging. Furthermore, adult females lay their eggs on the walls of their burrows (they only have small, stumpy ovipositors, so they cannot thrust them into the soil) and look after the juveniles until they have grown through several moults. So, there is much more to these humble little insects than you might expect: they show both homing behaviour and some parental care. We felt they deserved the extra consideration of returning them to where they lived and giving them the chance to find their burrows again. We hoped they did because they would probably be at greater risk of predation until they dug new retreats.

Thursday was devoted to mapping The Cliff and The Razorback and clearing a path through patches of inkweed so we could see where to place our feet. Then, at 7:30 pm, we started searching together from the Southern Basin to the Northern Plateau. I led, diligently searching the first few metres ahead. As we emerged from the low bushes at the start of the Northern Plateau, there was a shout from behind:

"I've just stepped on a wētā."

I spun around and, sure enough, one of the women[74] lifted her boot to reveal an adult female tusked wētā. I flung myself down and pinned it gently to the ground before it could jump, while the others hastily unpacked a two-litre plastic ice cream container to capture it in. To our dismay, some of its gut and reproductive organs had burst through the end of its abdomen, but it still seemed strong and energetic, so we decided to take it back with us and check it the next day.

"How did you know you had stood on it?" I asked.

"I could feel it kicking."

"What? Through the sole of your boot?"

"Yep."

It amazed us that the kick was felt through the sturdy soles of a tramping boot.

This was my fault. The wētā must have been right in front of me, and yet I missed it. So, I took the blame when I rang Rob Chappell the next morning and confessed. But how could I have not seen it? It seemed inconceivable. The insect was large, and I had been carefully and methodically searching the area immediately in front of me.[75] I now believe it was probably hiding amongst the deep layer of karaka leaves that cloaked that part of the route.

I arrived at this explanation much later, when tusked wētā were common on Red Mercury Island after we translocated them there in 2000.[76] I watched an adult female through a night scope equipped with infrared light as it walked along a stream bank, and it immediately took cover under leaf litter as soon as the faintest flicker of light reached it, as someone approached with a torch. Everything clicked

74 Some people really wanted to know who it was, but she will forever remain anonymous.

75 Mary McIntyre also stood on a tusked wētā by mistake during her fifth field trip (January 1993). "It was apparently in a small depression under some leaf litter ... and was found later ... with the abdomen split open." This was one of 28 tusked wētā she found during 14 nights of searching. (Letter to Phil Thomson, 28 January 1993). We had worse luck: ours was only the second tusked wētā we found.

76 This is described in Part 4 below.

SURGERY ON INSECTS

This is surprisingly easy if you happen to have a supply of carbon dioxide (usually in a gas cylinder) to use as an anaesthetic, some phenylthiourea powder, and an antibiotic powder, such as streptomycin. (Carbon dioxide is an anaesthetic for insects, but high concentrations will kill birds or mammals.) After surgery, you simply dust phenylthiourea and streptomycin onto the wound and pull the edges of the cuticle together. Insect blood clots quite well and usually seals the wound. If it doesn't, then you can use beeswax, warmed just enough to melt it (about 60° C) to hold the edges together. Beeswax is ideal because it adheres well to a thin protective layer of wax that coats the outside of the insect cuticle.

What follows is technical, so you might want to skip it! Phenylthiourea inhibits the production of diphenols, which bind proteins (and polypeptides) together by forming chemical links between them. Diphenols are normally produced by insects to harden the cuticle after moulting – this is a chemical process akin to tanning leather: hardening after moulting is not caused by the cuticle drying out! Unfortunately, diphenols are also produced when the cuticle is damaged, and if the damage is large, then so much diphenol can be produced that it can flood inwards and cause proteins in the blood and tissues to harden into solid masses. This is what probably caused the progressive paralysis that afflicted the tusked wētā that was stood on: the internal organs just started solidifying, starting from the damaged rear end.

when I remembered this third field trip. I realised that the wētā we stood on had probably been actively walking about but had dived under cover when our torchlight inadvertently reached it. This seemed likely because we had been stooped down while negotiating the low vegetation at the beginning of the Northern Plateau, so we would have shone our torches erratically in all directions.

Once we had recovered from the shock of damaging such an extremely rare insect, we completed the search and returned, dejectedly, to camp at 10:30 pm. The wētā had resorbed most of its eviscerated organs the next morning, but it died that evening from a slow, progressive paralysis that started in its hind legs. There was nothing we could do because we were unprepared for such an eventuality: I had been so confident that such an accident would be impossible when the lead person searched ahead carefully.

First tusked wētā found (by Haden Hewitt) during my field trips to Middle Island. This out-of-focus photograph is a copy of a colour slide taken in haste (well, everyone makes mistakes).
Photo: Ian Stringer

About midnight, Megan and I started a second search after Marieke had gone to bed. Soon after we descended into the Southern Basin, we caught a small wētā with pale orange ocelli. The colour seemed to be similar, as far as we could remember, as the ocelli on the female we had damaged, but we needed to confirm this when we took it back to the campsite to measure it.

While we were examining the wētā in its vial, I noticed at the edge of my vision, patches of faint, dappled moonlight, and mentioned this to Megan. She diplomatically reminded me there was no moon that night – even the stars were hidden by clouds: it was pitch black. We switched off our lights and found ourselves in an enchanted, magical glade. Small white lights were scattered over the ground around us, some single, others clustered densely together, on a jet-black background. It was fascinating and enthralling – as amazing as visiting the Glow Worm Grotto at Waitomo.[77]

77 This was the third time I had seen bioluminescent fungi in the bush at night. Both previous occasions were in the forest at Erua near National Park while helping students estimate the number of freshwater crayfish in a small stream using capture-mark-release-recapture. They located the nocturnal crayfish by their eye-shine. On both occasions, it had rained for some days previously.

We were standing well in from the lower edge of a slope shaped roughly like a wide shallow basin tipped well up onto its side (hence the name Southern Basin). Behind us, the pinpricks of light were scattered over a wide flat slope that ended where the ground fell away steeply towards the cliffs encircling the Landing Bay. We turned on our lights briefly and discovered that the glow came from the stalks of small grey bioluminescent toadstools sprouting from numerous sticks and twigs lying about. Occasionally, the broken end of a stick also glowed, presumably from fungal hyphae within.[78]

The sight was so entrancing that we spent some time admiring it before we turned our lights back on again and reluctantly resumed searching. We had only gone a few metres when an adult male tusked wētā suddenly began leaping ahead of us. One hind leg was missing[79] but it still led us on an energetic chase before we caught it. Chris Winks no longer needed a male for breeding, so we measured various body parts and let it go where we had first seen it. Amazingly, we didn't break through into any bird burrows during the chase. We also felt so much better having caught a tusked wētā without damaging it.

Overall, we did 12 full searches during the five nights we were on the island and found eight species of insects, one more than during the previous trip. Most insects were also more abundant than previously, especially small darkling beetles, which had increased from an average of four per search previously to an incredible 160 per search, and cave wētā, which had increased from 1.6 per search to 9.6 per search. The only insect that showed a reduction in numbers was the small wētā we were interested in: we counted 42 of these at an average of 5.2 per search during my second trip, whereas we saw 14 at an average of 1.4 per search this time. But we were delighted to have identified one of these small wētā as a juvenile tusked wētā from the orange colour of its ocelli.

78 Brett Robertson described these fungi on Middle Island as "a delightful tiny pin-sized sort that luminesced after the rain and put on a glow-worm type light show" (Anonymous, 1993).

79 Mary McIntyre reported finding adult tusked wētā with damaged or missing appendages. This was most frequent in spring when the "few adults encountered at this time ... seem to be near-spent" (McIntyre 2001).

The path down The Cliff. The poles and chain were installed in October 1999, replacing the original rope strung between waratahs (a bent waratah is visible by the first pole).
Photo: Kahori Nakagawa

View of the Landing Bay inlet from the top of The Cliff with the Kuaka at anchor.
Photo: Ian Stringer

CHAPTER 10
HOME SWEET HOME

Russell Clague of Mahurangi Charters looked bemused when he arrived at the Whangapoua wharf at 9 am on Friday, June 18, 1999, to take us to Middle Island for my fourth field trip. Piled on the wharf were three plastic chairs and two mattresses in addition to the usual assortment of plastic barrels, chilly-bins, gas and water containers, and other paraphernalia that he normally expected. Two leaf rakes particularly amused and intrigued him until I explained we had accidentally stepped on a wētā during the last trip, so we were going to keep the track swept to prevent it happening again. Packed into our barrels were also three new solar showers because it was now winter, and showering with warm salt water was preferable to swimming in the cold sea. Rob had told me he had put a hut on Middle Island (dropped in by helicopter) and warned me to keep it secret because huts elsewhere on the Mercury Islands had been ransacked. It was obvious to Russell that there was a hut on the island, and he also cautioned us to keep it secret.

We were greatly relieved to find we could unload directly onto the rocks below the campsite. Even so, it took us a good hour to ferry everything ashore. Once this was accomplished, Russell invited us back aboard for coffee and delicious muffins his wife had kindly baked for us.

My companions were Richard Parrish and Avi Holzapfel. Both worked for the Department of Conservation: Avi chaired the Mercury Island Tusked Weta Recovery meetings, and Richard and I had worked together for many years on giant flax snails (*Placostylus* species) in the Far North. Richard also taught me a lot about camping and working on offshore islands while I helped him with his work. Both had come as volunteers after I had regaled them with embellished stories from previous trips. I suspected Avi didn't believe that tusked wētā were as difficult to find as I had made them out to be because they are so big. He was keen to see for himself.

It's hard to describe how pleased I was to see the hut when we climbed up with our first load, but neither Richard nor Avi thought there was anything special about it: it was just another small hut as far as they were concerned. But neither had camped on the island before, nor had they dealt with the steeply sloping campsite or the mud when it

View into the Middle Island hut from the deck (from the south-eastern door) showing the cooking area with shelving behind. The 'back door' (facing north) with its window is visible behind Esta Chappell. Additional shelving and the edge of the bunk are to her right. Photo: Rob Chappell

rained. Cooking had also been awkward, and even sitting on the ground became uncomfortable after several days.

The hut was situated where we had set up the kitchen fly previously. We now had shelter from the weather, a level wooden floor, and a bunk where two of us could sleep. A small plywood deck to the south covered the area where I had previously pitched my tent, and steps from this now lead to the track leading down to the sea. One door, at the south-east corner of the hut, opened onto the deck while a second door at the opposite corner opened onto the sloping hillside to the north. Both doors had small glass windows that admitted the only light when the hut was closed. Two large unglazed window openings along the front provided a partial view of the sea through the trees. They could be closed with shutters at night or when the hut was unoccupied.

We set up our camp stove and gas light on a wide shelf beneath the windows and dumped most of the gear on the floor between the rear door and the bunk on the western wall. This was indeed luxury compared with camping. We now had protection from storms and a sheltered environment for cooking. Even more importantly, we could leave a lot more gear behind in future. From then on, when we left the island, we only had to take our personal kits, empty water containers, the gas cylinder, the chilly bins, the rechargeable batteries, and all the rubbish we had generated. Bliss!

The first thing we did was tie a rope between trees above the front of the hut and stretch the large tarpaulin previously used as the kitchen fly between this rope and the trees behind to create a roof over the deck. Next, we hung one of the small tarpaulins (previously used to cover a tent) in front of the deck to screen it from the sea. This created an outside shelter where we could put on and remove wet and muddy gear when it rained. We also hoped the screen would hide our doorway when it was open at night. It would otherwise be seen as a bright oblong opening and advertise that a hut was there to anyone in a boat. We also kept the windows well shuttered at night for the same reason. Light would be seen through the screen, but we hoped it would look like a tent lit from inside.

I set up my tent at the top site while Avi and Richard chose to sleep in the hut. All our gear was up at the hut by early afternoon, so after a late lunch, I led them around the search route, raking leaves as we went and clearing a way through the occasional patches of inkweed. We finished in the late afternoon and retired to the Razorback with some wine and nibbles to enjoy the last of the sunshine.

The three of us did two full searches that first night, starting at 8:15 pm. Richard took the opportunity, while we searched, to show us how to differentiate between the two geckos we were seeing. Pacific geckos grow to a body length (snout-to-vent) of about 100 mm, whereas Duvaucel's geckos grow up to 150 mm. So, large geckos were Duvaucel's geckos, but I wanted to know how to distinguish their juveniles from Pacific geckos. The easiest way, Richard explained, is to look at their toes. The lamellar pads of Duvaucel's occupy less than two-thirds of the toe length, and the ends of the toes are long and slender and curve elegantly upward before the tips reach the ground. In contrast, the lamellar pads of Pacific geckos occupy more than two-thirds of the length of their toes, and the short toe ends go straight to the ground. This was all good to know, but it didn't help me identify them from a distance. I was certainly not going to approach every gecko to identify it because doing so would cause considerable unnecessary damage to bird burrows.

Duvaucel's gecko. Note how the toes curve beyond the lamellar pads. Photo: Kahori Nakagawa

An explosion of curses from behind caused Richard and me to turn around quickly. There was Avi, way off the path and a long way behind us, diligently clearing out a couple of seabird burrows. We were on the eastern path of the Central Plateau, and Avi had fallen behind while searching extremely thoroughly (I suspected he was checking that we had not missed any tusked wētā). He decided to catch up when he realised how far back he was, looked up, saw a reflector on a track marker shining in front of him, and went directly towards it, not realising the marker was on the western path right across the plateau. He soon stepped into a burrow, staggered back out, and straight into another burrow. Avi did the same thing twice more before Richard and I made sure he stayed close to us.

We eventually finished the search at 10:40 pm, made coffee, and then searched from midnight until 2:35 am. We were disappointed we didn't see any tusked wētā because the night seemed ideal – it was warm and humid, and numerous small wētā and other invertebrates were out and about. I was, of course, also secretly pleased that Avi didn't find any tusked wētā we had missed.

The next morning, I was awakened at 10 am by sunlight on my tent and was greeted by Avi, who had packed a collapsible fishing rod, proudly carrying a large snapper up from the shore. He later cooked it for our breakfast – fresh and delicious. Avi went fishing each night after we finished searching and again each morning before Richard and I awoke. It seemed like he never slept. Richard survived two nights in the hut before he pitched a tent on the lower campsite because Avi disturbed him too much, preparing to go fishing or returning late. Richard was also tired of being startled awake by diving petrels flying into the sides of the hut.

The first time this happened, we were sitting in the hut at dusk, eating our dinner. Suddenly, there was a loud bang, and we exclaimed in unison, *"What was that?"* We rushed outside and checked around the hut. A diving petrel was on the ground behind the hut, recovering from being stunned. We couldn't believe such a small bird had made such a loud noise. Surely something larger, like a flesh-footed shearwater, had crashed into the hut, but we couldn't find anything else.

Six or eight of these bangs occurred randomly throughout the night, although most occurred during the first few hours of darkness. Richard didn't avoid being disturbed by birds by sleeping in a tent, though, because he was woken occasionally by one scrabbling incessantly on the side of his tent. They never moved around the tent because, I surmised, the tent blocked the way they always went to their traditional take-off points, and they didn't deviate from it because it was too dark to see an alternative route. When a bird began scrabbling, there was nothing else for it but to get out of your sleeping bag, unzip the tent, reach around and pick the bird up (they never tried to escape), and release it on the other side of the tent.

That Saturday, we had fish for lunch and fish for dinner, and fish on Sunday for breakfast, lunch, *and* dinner. Then I called a stop because we had lots of other food, and I was reluctant to carry it all back with us at the end of the trip.

Four days later, when Richard and Avi left, Avi took a chilly bin containing the fillets of three snapper and a kahawai. We had only done a single search the previous night, so we could get a good night's sleep before getting up early to prepare for their departure. Not Avi, though! He had gone fishing again before dawn.

We usually completed our various chores by mid-afternoon and then, if it was fine, climbed up to the base of the Razorback to sit with our backs against the cliff reading or dozing in the sun. On Wednesday, we had been there for some considerable time when Richard decided he was too hot and returned to the hut. Soon after he left, Avi and I noticed a large whale approaching from the north. We yelled to Richard, knowing he would be interested (he was responsible for responding to whale strandings in Northland), but he failed to reappear. Neither Avi nor I knew much about whales, so we couldn't identify it. It approached the island obliquely, swimming quite slowly until it came close to a float marking a crayfish-pot, about 300 metres from the rocks below us. It then suddenly turned around and sped back towards the open ocean, leaving a long wake of churning foam. We assumed it had contacted the rope and taken fright.

Back at the hut, we razzed Richard for not coming up to identify the whale for us, but he swore he never heard our shouts. How could he not have when the island was so quiet? I couldn't help suggesting that the thought of having to scrabble back up to us had brought on some 'selective deafness', but he vehemently denied this.

Halfway through the trip, Avi and Richard were relieved by Paul Barrett[80] from Massey University and Glenice Hull, who lived locally. Both helped at short notice after two Department of Conservation hunters who were rostered to help me had pulled out at the last minute. One of Rob's conditions for allowing me onto Middle Island was that I always had to include a Department of Conservation field worker, but this never eventuated. The Department of Conservation minders he had arranged for the second and third trips had also pulled out, but I had sufficient time to find additional volunteers to replace them. This time, though, Paul was the only replacement I could find at short notice, so Rob persuaded Glenice, who had done a lot of voluntary work for the Department of Conservation in Thames, to help. Rob never again mentioned Department of Conservation minders, which led me to surmise that perhaps Avi and Richard had put in a good word for me and had convinced him that I was not the liability he imagined I might be. Department of Conservation personnel accompanied me on many of my subsequent field trips, but they all came as volunteers – as did Avi and Richard – keen to see the island and its fauna at night.

We had fine weather for most of the entire field trip, except for light rain during the night of Monday 21st and the following day, then seven hours of steady rain on Friday 25th, and heavy rain between 10 and 11 pm on Saturday 26th, so some searching was done while it was quite wet. Fortunately, the soil quickly turned to mud and didn't build up under our boots as it had done during my second visit to the island.

We also kept the paths raked. While doing this during the daytime on Sunday, we noticed that a morepork was following us, silently gliding from tree to tree. We subsequently looked for it whenever we raked the path and often saw it following us both during this and subsequent trips. I expected other birds to mob it, but they never did. These owls often eat wētā larger than about 20 mm long[81] so we realised there was yet another predator for tusked wētā to avoid on the island.

Overall, we spent 11 nights on the island and did 23 searches, totalling 54 hours and 37 minutes. We found 38 small wētā, but none were large enough to be tusked wētā. Nine had orange ocelli, so we identified them as tusked wētā until we started finding others with ocelli of every intermediate colour between orange and cream. There was no clear cutoff point between tusked wētā and ground wētā, so I classified them all as 'unidentified wētā' with the proviso that nine with the brightest orange ocelli *might* be tusked wētā.

80 This is a different Paul Barrett from the one that helped Chris Winks captive-rear tusked wētā (Chapter 4).
81 e.g., Haw and Clout (1999).

We took all the small wētā we found back to the hut and measured them, as we had done during the previous trip, to get comparative data for identifying them later using multivariate statistics. Every insect was then released where we had first seen them. Thwis, however, reduced our valuable search time quite considerably.

Birds recorded on Middle Island (18–24 June 1999) by Richard Parrish.

Australasian gannet	A few seen passing the island.
Australasian harrier	Up to two seen cruising over the island most days.
Bellbird	Only one or two heard / seen.
Black backed gull	One or two around beach.
Blackbird	Common.
Blue penguin	One or two heard calling on shore most nights.
Caspian tern	One seen on three days flying close to island.
Chaffinch	Common.
Diving petrel	Hundreds arrive at night; very vocal. No eggs in burrows.
Dunnock	Uncommon. Two heard in full breeding song.
Fantail	One or two seen; not common.
Grey faced petrel	Two heard on 18th. None seen on ground.
Grey warbler	One of two seen and heard; not common.
Kingfisher	Scarce. One was seen around the shore occasionally.
Little Shearwater	Up to 20 were seen on surface every night.
Morepork	One heard on summit areas every night.
New Zealand pigeon	One or two seen each day. One disturbed on two nights.
Pied shag	Seen frequently offshore. One or two roosting on rocks.
Red billed gull	A couple seen roosting on rocks.
Red crowned parakeet	The most common forest bird. Probably ca. 100 present.
Silvereye	Second most common forest bird: in flocks of ca. 20.
Starling	A few mainly around the cliffs at the Landing Bay.
Welcome swallow	Frequently up to six seen hawking around the island.

Improving our situation

There was nowhere to store anything in the hut, so we left everything in the barrels because of the limited floor space. We needed shelving, so I measured up the walls and got Jens Jorgenson to make prefabricated flat packs in the workshop at Massey University, and I installed them on the next field trip. These shelves made a huge difference – suddenly, we had open floor space and room to sit on chairs inside when the weather was inclement.

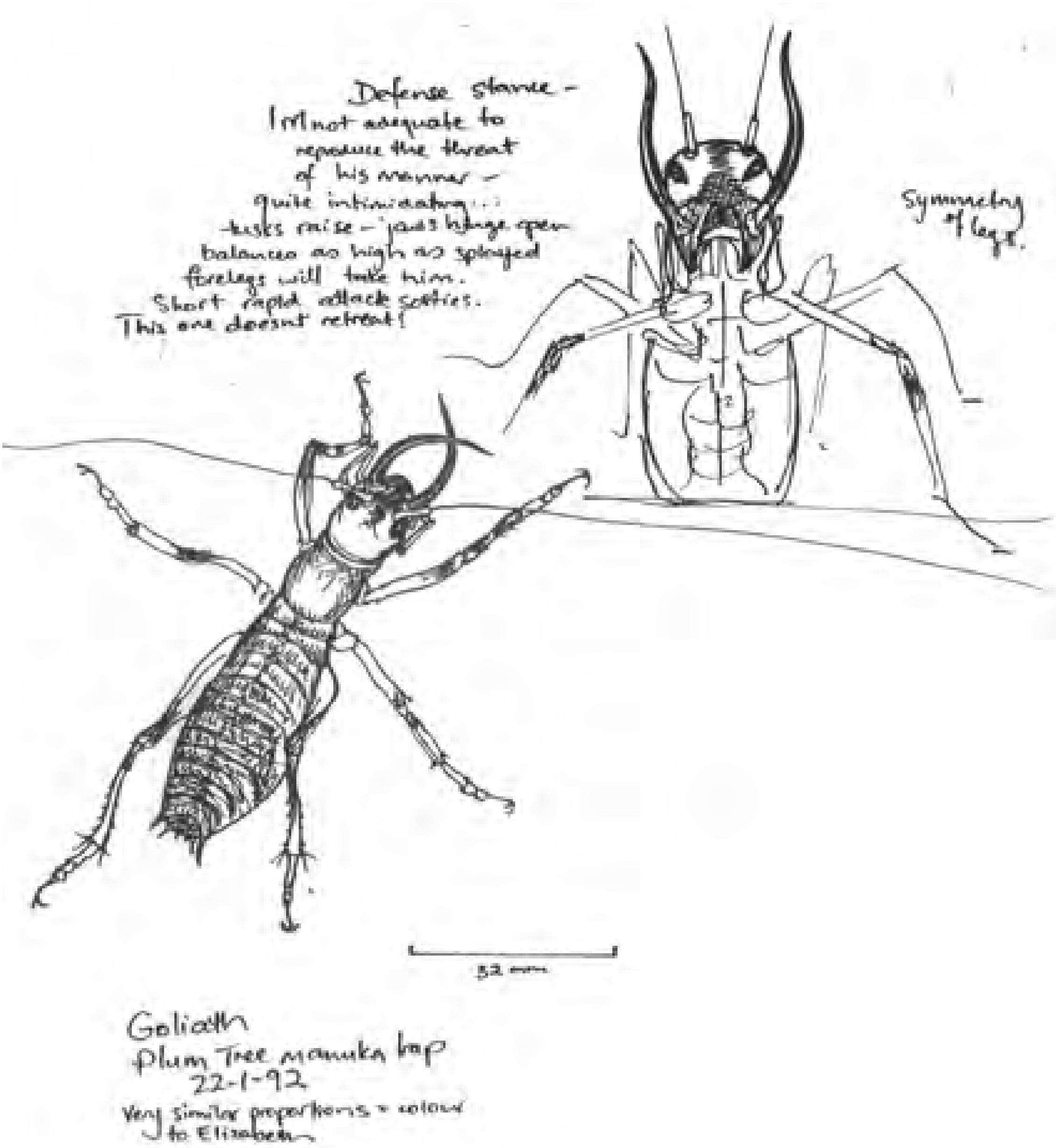
We completed stringing ropes up all the steep slopes we had to negotiate by the end of this fourth field trip. Rope now stretched from the seashore to the hut and from the hut right up to the Saddle. We even fastened a rope between the top stanchion on The Razorback and a tree on the edge of the Northern Plateau to make it safer to step down onto The Razorback when it was wet. All these ropes certainly helped us pull ourselves uphill, but they didn't prevent us from slipping when going downhill after rain. They did, at least, arrest us from going too far. We also completed mapping the entire path by surveying the 33 m from the hut down to the shoreline, and we removed more rubbish left by previous visitors that had become buried and then unearthed by seabirds digging burrows.

A significant improvement was made by Paul during the second half of this fourth field trip. Whenever he was tired of sitting in the sun, he progressively dug steps up to the hut and paved them with huge flat rocks that he lugged up from the shore. These steps made it much easier to go up and down, especially when it was wet. They lasted for years, although we had to clear off loose soil that had accumulated on them each time we visited the island. Paul also helped carry rocks up to my upper campsite one day to weigh down the edge of the tarpaulin over my tent after the wind the previous night had started to rip it. So, at the end of that fourth trip, we had a good set of steps up to the hut, ropes up every steep section of the track, and we had a hut to shelter in. We also had shelving on the fifth field trip.

Suzanne Bassett and I made the last improvement to the hut during my tenth visit to the island by painting the inside plywood walls white. This reflected light from the small gas lamp we used for lighting and made it very much brighter and more cheerful. We ended up with a very comfortable, if small, hut.

There is no longer a hut on Middle Island – it was lifted off by helicopter in November 2008 after I finished working there. This was just as well because the rock wall that Ian Southey and his helpers had built back in 1983, together with the platform on which the hut had rested, were completely carried away and destroyed by a landslide in 2017. I only hope that 'hut-tut.' the tame tuatara that lived near the hut, had survived.

The landslide of September 2017 destroyed the area where the hut and lower campsite had been. The upper tent site was unaffected. Photo: Rob Chappell



Two field sketches by Jackie Davidson of ‘Goliath,’ an adult male Northland tusked wētā. (Jackie gave names to six of the 13 wētā she observed – see Chapter 2 for more details). Goliath was “aggressive” and is shown in the threat posture. The scale is the body length of 32 mm.
(From a letter to Richard Parrish, January 6, 1992.)

CHAPTER 11

AN IDENTITY CRISIS

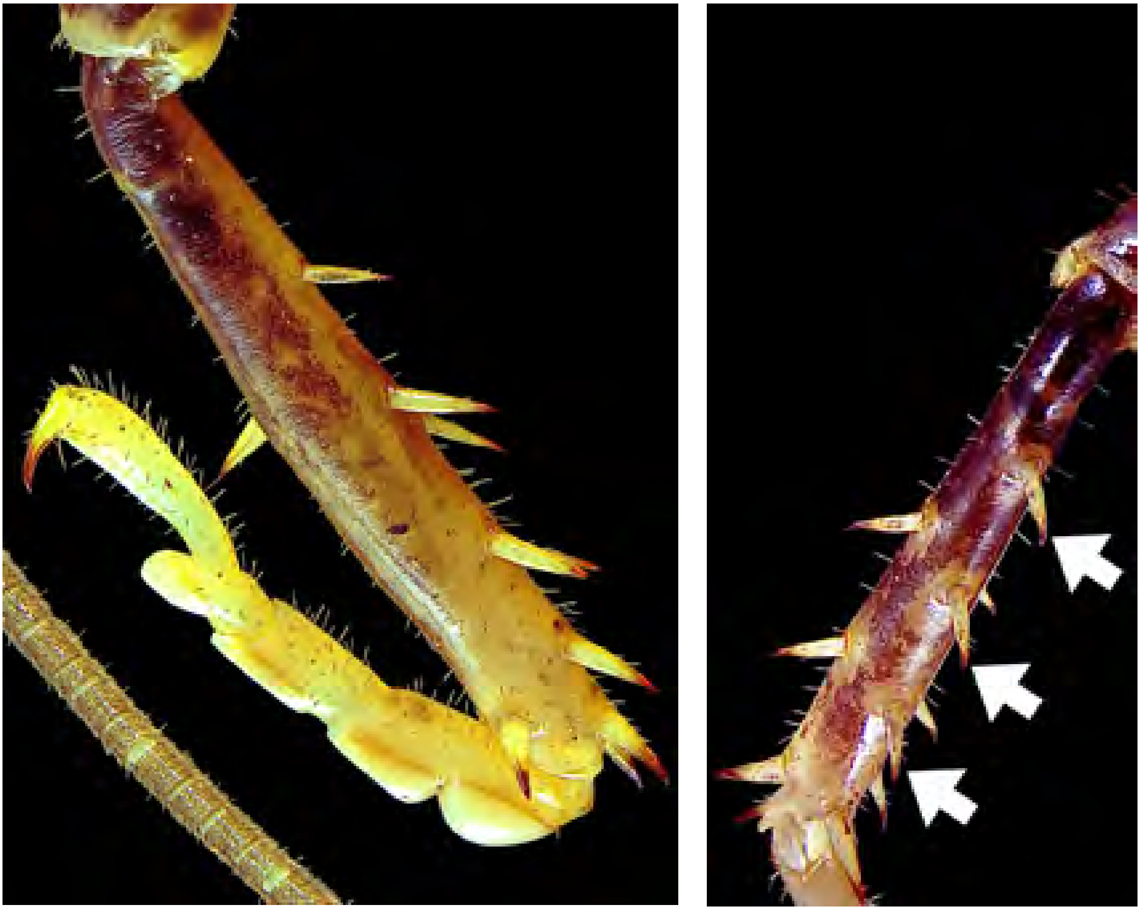
This is a technical chapter explaining how I found a practicable way to distinguish juvenile tusked wētā from ground wētā in the field. If this does not interest you, accept that we can now identify the wētā and skip to the next chapter – you don't need to know any of this to follow later chapters.

We quickly tired of taking small wētā back and forth to the hut to measure them, and it reduced our searching time considerably, especially when we found numerous wētā. Ideally, I needed an easily seen anatomical feature that enabled me to distinguish between the insects in the field.

Finding how to identify tusked wētā

I began by searching insect collections for preserved specimens of both species that had been formally identified by taxonomists and found what I wanted in the collection in the Museum of New Zealand, Te Papa Tongarewa, in Wellington. They had three adult tusked wētā, a half-grown juvenile tusked wētā, and the only specimen that I could locate of a ground wētā from Middle Island. Te Papa courageously let me loose on their fragile specimens and I pored over them, comparing them structure by structure. The only difference I could find that was easily seen was the number of spines on their middle tibiae. So, if you ignore the bunch of spines where the tibia joins the foot (the tarsus), then ground wētā have three spines along the posterior outer edge of their middle tibiae, whereas tusked wētā have two. There are other spines elsewhere on the middle tibia of both species, which can confuse you, so you have to know what to look for.[82]

82 The convention for describing an insect leg is with the leg stretched straight out from the body. Thus, what I have termed the posterior-outer tibial spines are, using the correct anatomical terminology, the posterior-dorsal tibial spines. But it is easier to visualise what the 'posterior outer' edge is when the leg is in the normal flexed standing position, so I'll continue to use this.



Fore tibia (left) and mid tibia (right) of a ground wētā from Red Mercury Island. Note the lack of a tympanal scar on the fore tibia (it is below the 'knee' of a tusked wētā). The mid-tibia is a view of the outward-facing surface (when the leg is in the normal resting position relative to the body) with the front (anterior) to the left and the back (posterior) to the right. The arrows indicate the three posterior-outer spines that differentiate ground wētā from tusked wētā (ignore the spines at the junction with the foot (tarsus), which is flexed back (posteriorly). Both species have two spines on the anterio-outer edge of the mid tibia, so it is easy to make a mistake. Photos: David Roscoe

These spines were exactly what I needed. They are visible to the unaided eye if the insect is larger than about 1.5 cm long, or by using a hand lens if they are smaller. It takes practice to identify these spines in the field, though. They are best seen by kneeling in front of the wētā and slightly to one side. In most cases, both species of wētā conveniently freeze for 10 seconds or so when illuminated, which is just enough time to identify the insect. If the insect jumps before you finish, it is likely to jump again, so it is best to catch it in a glass vial and identify it in that.

I now had a potential way to distinguish tusked wētā from ground wētā, but I had only examined four tusked wētā and a single ground wētā. I needed to know if this difference holds for all wētā on Middle Island? I knew that the number of spines on the legs of some species of ground wētā can vary from individual to individual and that related insects can hatch with fewer leg spines and add more as they moult.[83] If the wētā on Middle Island did this, then our only option was to use a microscope to identify the tympanic scar. I needed to check.

So, are tibial spines a reliable character for identifying wētā?

The tusked wētā I examined were those we reared in the laboratory at Massey University (Part 3), which I observed as they grew. All those with body lengths of 4.6 mm or longer had these two identifying spines on their middle legs, but newly hatched juveniles sometimes had only one and acquired the second spine during the first two moults. Newly hatched juveniles also lacked tympanal organs, and these also appeared during the first two moults. These changes are described in more detail in Chapters 15 and 16.

We didn't rear ground wētā, but they probably also hatch with fewer spines and add more as they grow. This means that it's likely we wouldn't be able to identify very small wētā. It so happened, though, that we only found three of these during the entire study, and we were luckily able to identify them by other means. One was a tiny hatchling that was a tusked wētā because it was in a small ovoid chamber just under the surface of the ground; one was a ground wētā because it was in a J-shaped burrow; and the last one had the three identifying spines of a ground wētā.

Once we had a hut on Middle Island, I started taking a dissecting microscope with us because it would be protected from mud and rain, and we had a stable base for using use it on. So, we captured as many wētā as we could during the fifth trip to Middle Island and took them back to the hut (in individually numbered vials) where we first identified them under the microscope (presence or absence of tympanal scars) and then counted the posterior-outer tibial spines on the middle legs. We then painted a small white spot behind each of their heads so we could avoid catching them again, then released them back where we had found them.

As it turned out, every wētā we examined under the microscope lacked tympanal scars and all had the three posterior-outer tibial spines of ground wētā so I was confident we could quickly identify them.

83 Stringer (2006).

ANATOMY OF AN INSECT LEG
– continue only if you are game!

The hardest thing about biology, in this case entomology, is learning the language – the terminology. So, let's see how difficult this is with insect legs. Many parts have the same names as the leg bones in humans, even though, in insects, the skeleton is an external cuticle. Thus, the insect's foot is the tarsus, followed by the tibia (shin) and the femur (thigh). The next two parts are short and have new names – the trochanter and, where the base of the leg attaches to the thorax, the coxa. In humans, trochanters are bulges at the top of the femur where muscles attach, whereas coxa is borrowed from the Latin word for hip.

So, why do these extra sections exist in insects? Insect leg joints usually work like hinges, so each joint only bends in one plane. This allows the part further from the joint to be moved with precision by only two antagonistic muscles: an extensor that extends the structure, and a flexor that folds it back. If these joints could bend in any direction, then more muscles would be required to prevent the leg from wobbling, and the leg would have to be thicker to accommodate the extra muscles. Such joints do occur at the base of the leg in some insects, enabling the leg to be swung in any direction. Here, the additional muscles are accommodated within the thorax. However, in many insects, this joint is a hinge that swings the leg forward or backward (anterior and posterior). The next joint, the coxo-trochanteral joint, works at right angles to the thorax and swings the leg up and down (dorsal and ventral). The trochanter is usually fused with the femur, and the femoro-tibial joint extends or folds the leg back. These three joints allow the foot (the tarsus) to be placed firmly and precisely anywhere. Next time you find the cast cuticle of a crab on a beach (or you are lucky to be eating crayfish), move a leg about, and you will see exactly how these joints allow the tip of the leg to be moved. Note that Crustacea have more leg joints than insects (but let's not go there).

Finally, the tarsus is a single segment that is subdivided into up to five sections (tarsomeres) and a terminal part with a pair of claws. This allows the tarsus to flex and fit onto the substrate. The (four) tarsomeres of wētā also have inflated pads (euplantae) that make their footprints distinctive (Chapter 27).

Now, if you are still game, let's go a little further with the terminology. An insect's body, as you know, comprises a head, a thorax, and an abdomen. These are the same names as in human anatomy, but in insects, the thorax and abdomen are differentiated, and the abdomen is segmented.

The head is formed from six embryonic segments, each of which bears a pair of embryonic appendages. These develop into the antennae and the various mouthparts. These six segments fuse into a rigid head capsule that provides a strong base for muscles to work the mouthparts. The thorax has three segments, each with a pair of legs, and the abdomen has several more – nine abdominal ones are visible in tusked wētā. The embryonic appendages of the abdomen disappear except for those on the last segments, which can develop into cerci and reproductive structures (such as the ovipositor of tusked wētā).

Entomologists name the three thoracic segments using the prefixes 'pro-', 'meso-', and 'meta-' derived from Greek words meaning, respectively, 'before or in front of', 'middle', and 'after or beyond'. Thus, the three thoracic segments are the prothorax, mesothorax, and metathorax, and these prefixes also apply to parts of the appropriate legs. So, the tympanal organs are on the protibiae, and the spines that distinguish tusked wētā from ground wētā are on the mesotibiae.

There are only two new words to remember – trochanter and coxa – and you can forget them anyway because I will never mention them again. So that wasn't too difficult, was it?

Adult male Northland tusked wētā, Anisoura nicobarica, *(body length about 20 mm). Photographed at Jackie Davidson's home in Kohukohu, Hokianga in 1990 (more information in Chapter 2). Photo: George Gibbs*

Adult male Raukumara tusked wētā, Motuweta riparia *from the Waioeka Gorge (body length about 37 mm). Photo: Jay McCartney*

CHAPTER 12

AN ABUNDANCE

Small pale flowers and petals of taupata shrubs (*Coprosma repens*) were sprinkled over the ground when Yvette Cottam (Massey University), Jarn Godfrey (a student at Massey University), and I climbed up to the hut at the start of the sixth field trip. Above the hut, the New Zealand ambush vine (*Sicyos mawhai*) bore numerous small white flowers, and both the Central and Northern Plateaux were strewn with light-coloured greyish-green flowers and newly fallen leaves from large-leafed milk trees (*Streblis banksii*). This species forms the entire forest canopy on the flat to gently sloping ground on top of these plateaux except for a small karaka grove (*Corynocarpus laevigatus*) at the start of the Northern Plateau. Even these karaka trees bore small greenish flowers. Yvette, a keen botanist, pointed out other plants with inconspicuous flowers that were blooming – wharangi (*Melicope turnata*), māhoe (*Melicytus ramiflorus*), and coastal māhoe (*Melicytus novae-zelandiae*). I wouldn't have taken much notice of them otherwise. But even I couldn't fail to notice the deep blue medium-sized flowers of the few poroporo plants (*Solanum aviculae*) we passed, or the green upright spikes of densely packed tiny flowers on kawakawa bushes (*Piper excelsum*).

Most of the ground-cover vegetation on Middle Island – such as ferns, poroporo, and kawakawa – is so sparse that the forest floor is usually visible for up to 15 m or more. Dense patches of inkweed (*Phytolacca octandra*) grow wherever there were gaps in the canopy, and we pulled these introduced weeds out wherever they obscured the path – we certainly didn't want to step on another tusked wētā! We hung each plant upside down on nearby branches to prevent it from taking root, as Megan Mclean had done during the third field trip (Chapter 9), because it seemed so effective.

Sicyos mawhai*: ambush vine or native cucumber. Photo: Rob Chappell*

Yvette and Jarn were delighted that the morepork followed us, gliding silently from tree to tree, while we raked the path, as it had done during the previous trip. Regurgitated pellets at the upper campsite where I pitched my tent indicated that it probably roosted there. A few tuatara were basking in patches of sunlight, and Yvette and Jarn were both excited to see them in the wild for the first time and pleased they could photograph them in daylight.

We saw an emaciated tuatara near the southern end of the Central Plateau during the previous field trip, 22 days earlier (Chapter 17), and this was still in the same place. It was originally covered in soil, so it may have been imprisoned in a collapsed bird burrow. It walked away energetically as we approached but collapsed onto the ground after a few metres. We argued passionately about whether or not we should try to help it, perhaps by offering it some watered-down honey, and eventually agreed – reluctantly – that we should not interfere. It died three days later, and we felt dreadful for not having done something for it.

Once back at the hut, we finished organising the campsite and set up the solar charger and solar showers on the rocks above the high tide mark. This was our last chore, so, as it was late afternoon, we went up to The Razorback – as was now the custom – and relaxed with a glass of wine and some cheese and crackers to watch the sunset.

"It pinged off!" exclaimed Yvette as a small wētā suddenly jumped and vanished from our torch beams. I had been showing them how to locate the spines on the middle legs to identify the insects, so we had spent longer than usual looking at them. We found and captured it easily enough in a vial and measured it later. From then on, Yvette called all small wētā "pingers," and the name seemed so appropriate that we soon followed suit.

We found 65 small wētā during the seven nights we were on the island. All were identified as ground wētā from their leg spines, but we still took 51 of them back to the hut where we measured them. The next day we confirmed their identities under the microscope. We did this the following day rather than the same night (so we had more time for searching) and released them soon after it got dark, exactly where we had caught them, using numbered vials and tags as previously, in case they could find their holes again after a day's absence. Well, you never know.

This was the field trip when I started noticing how few insects were attracted to the spotlights mounted on our heads. Clouds of insects are often attracted to light in mainland forests, particularly if you are near water. They can plague you so much that you may have to hold the spotlight well away from your head. Even then, the insects can be so numerous that you sometimes have to wear a mosquito net over your head to keep them out of your eyes and nose. We had none of this on Middle Island, only the occasional moth or other insect to wave off, so our hands were free for writing in a notebook or holding on to trees to pull ourselves up steep slopes.

Light rain fell for short periods on most days, and there was a real downpour during the afternoon of the sixth day, so much so that surface water flowed around the hut. Fortunately, it dried up before nightfall, so the soil didn't adhere to and build up under our shoes, making it difficult to walk, as had happened during the second field trip in November 1998 (Chapter 8).

The rain increased the humidity at night[84] which encouraged invertebrate activity. We saw a greater variety than on previous trips, even though the nights were cool (13°C to 15°C). Many species were also amongst the most abundant I had seen (see text box "Abundance"), but there were few seabirds.[85]

The damp conditions seemed to have encouraged a wide variety of toadstools and other fungi, including two spectacular basket fungi (*Ileodictyon cibarius*). They looked like hollow balls, about 5 cm or so in diameter, fashioned from a single layer of thick white fungal strands surrounding large irregular holes.[86] We had been asked to look out for *Favolashia thwaitesii*, a newly self-introduced bright orange fungus, and reported that it was abundant everywhere on rotting sticks and branches.

When we returned to the hut on Wednesday night, Yvette noticed glowing patches out to sea so we went down to the rocks to gawp at the sight. At any one time, about 20 small bright white patches were visible. Some were close enough to see that each patch was a myriad of individual tiny, brilliant lights that lit up together for a few seconds. Different patches lit up briefly here and there, giving the impression of a broad, glittering ever changing mosaic drifting slowly past the island with the current.

84 The relative humidity was mostly 95%RH or higher (95%RH was the maximum our equipment could detect).

85 The water vapour pressure deficit (WVPD), a measure of how drying the air is, was correspondingly very low with WVPDs of 0.08 mb to 0.52 mb and one outlier of 1.68 mb. Such low values are known to encourage activity in many insects. Mary McIntyre (1991) reported finding 70% of adult tusked wētā when the WVPD was less than 3.3 mb, and all were found when the WVPD was less than 4.4 mb.

86 Joe Bennet described these as "a spherical lattice, like a soccer ball with the panels removed" ('Taking the fun out of fungi': Manawatu Standard 16/8/2023).

Wine and cheese on the Razorback with Yvette Cottam and Jarn Godfrey during the sixth field trip. The view is to the west with Green Island in the distance. The mainland beyond is hidden by haze. Photo: Ian Stringer

We saw the same thing the next night and, now alert to it, we also saw areas of these glowing patches in the Landing Bay (from The Cliff) and over much of the sea to the west of the island (from The Razorback).

Searching during the sixth night was magic: we were in dense fog, so our torches no longer functioned as spotlights because the mist dispersed and reflected the light, creating a glowing cloud that enveloped us. Trees and bushes emerged gradually and eerily out of the whiteness as we progressed. When we reached the Saddle, we noticed bioluminescent toadstools scattered sparsely down Sicyos Gully past the hut. Later, during our last search in the Southern Basin, bioluminescent fungi were so abundant that Yvette and Jarn were as enthralled as I was when I first saw them during the previous field trip (Chapter 9).

Overall, we did nine full searches on the island and 30 hours and 42 minutes searching. We were extremely disappointed we didn't find any tusked wētā, especially after our hopes were raised by finding more ground wētā than on the previous field trips.

AN ABUNDANCE

We saw many more animals at night during this, my sixth trip to Middle Island, than on previous visits. Many of our sightings were, of course, repeats because we couldn't identify individuals. This was particularly so with many of the tuatara because we saw them in the same places repeatedly over several nights, and we counted them each time we saw them. So, the counts for individual searches were accurate, whereas those for the whole night, where we included all the sightings, were inflated.

I've included the more commonly seen animals in the table below (together with the Family classification of the invertebrates) so you can see how abundant they were at a glance. We saw more species than I've listed, though. For example, I've left out 19 tiny beetles because I couldn't recognise what family they belonged to – I would have had to collect some to identify them back in the laboratory, but I didn't have a permit to do that.

Animal (Family)	Number sighted	Average (per night)	Minimum-Maximum per search
Ground weta (Anastostomatidae)	65	9.3	5 - 14
Cave weta (Rhaphidophoridae)	46	6.6	0 - 14
Large *Mimopeus* beetles (Tenebrionidae)	575	82.4	15 - 131
Small *Mimopeus* beetles (Tenebrionidae)	55	7.9	1 - 28
Chrysopeplus species (Tenebrionidae)	413	59.0	27 - 86
Ground beetles (Carabidae)	24	3.4	0 - 9
Longhorn beetles (Cerambycidae)	37	5.3	0 - 13
Weevils (Curculionidae)	193	27.6	0 - 113
Giant centipedes (Scolopendridae)	26	3.7	1 - 9
Tuatara	243	34.7	23 - 51
Skinks	7	1.0	0 - 1
Geckos	64	9.1	2 - 15
Little shearwater	218	31.1	19 - 43
Flesh-footed shearwater	124	17.7	5 - 27

Other insects seen less often included five small native cockroaches (Blattodea), two large coastal earwigs (*Anisolabrus littorea:* Dermaptera), a stick insect (*Clitarchus* sp.: Phasmatidae), a spider wasp (Sphecidae), and 28 bristle-tails (*Nesomachilus* sp., Archaeognatha). Bristle-tails are amongst the earliest insects to have appeared on earth: they have never had wings (i.e., they are primitively wingless), whereas wētā and other wingless insects have developed from winged ancestors.

We frequently saw two types of spiders on the ground but didn't count them. Small *Aparua* were quite numerous and usually lurked just inside the entrances to their vertical burrows with their legs fanned out over the ground, waiting in ambush. Large *Cambridgea* were seen less frequently, mostly hanging in the entrances to seabird burrows and only occasionally running over the ground.

Saturday, our last day, dawned warm and fine, and Jarn woke us at 6:30 am with coffee. We washed all the dishes in fresh water, packed up, and closed the hut. All we had to take back were barrels of personal gear, the chilly-bins and gas bottle, and an empty water container. There was too much surge to depart safely from the rocks below the hut, so we carried everything around to the Landing Bay and awaited Russel Clague's boat.

Russel arrived at the appointed time of 9:30 with Blue as his deckhand. Blue was a local crayfish fisherman who had been the deckhand on my previous two field trips. His main role was to row the dinghy over to us. On this occasion, the sea was so calm that I stayed in the dinghy ready to row while Yvette, in a wetsuit,[87] held the bow into the waves, as Jarn loaded up. It took two trips to get everything safely aboard Russel's boat before I took Jarn off the island. Yvette, however, took the opportunity to swim out to Russel's boat.

Once aboard, we breakfasted on bacon and onion muffins – kindly baked by Russel's wife – while Yvette tried her luck at fishing and caught a small rock cod which she promptly released. Then it was up anchor, and we headed back to Whangapoua while Blue entertained us with stories about his experiences at sea. Most days, we had swum out to a couple of his buoys close to shore, so we gave him an account of how many crayfish had been in his craypots each day. We assured him that we never dived down to raid them. He must have believed us because – quite unexpectedly – he generously gave us two crayfish when we arrived back at the Whangapoua wharf.

87 The sea always seemed cold, so I encouraged volunteers to bring lightweight neoprene wetsuits – the sort that surfers often wear – to keep warm.

CHAPTER 13

NOTICEABLY BARE

Our field trips usually lasted about a week, except for two trips of nine and 10 nights. These long field trips, however, included less effective searching time at the beginning and end because the dark periods of the night, when tusked wētā are most active, were reduced. For example, the first and last quarter moons occur respectively about a week after and a week before the new moon, and the moon is up for about half the night. So, only half the time is good for searching.

The fourth field trip (Chapter 10) was the first long one, and this chapter is an account of the second long one.

All the volunteers were women: Megan Mclean and Kathy Lake helped for the first seven days, then Suzanne Bassett and Miranda Oliff relieved them when Rob replenished the food and water. Suzanne and Megan had previously helped on the second and third field trips, respectively, while Kathy and Miranda wanted to experience what New Zealand was like before humans arrived. Kathy worked with me at Massey University, and Miranda was a student there.

We left Whitianga at 10:55 am in Russell Clague's charter boat and disembarked below the campsite at about 11:30. Russell, as usual, invited us back aboard for coffee and muffins after all our gear was ashore. We then carried everything up to the hut and erected our tents. By then, it was 4 pm, so we took a break from unpacking and stacking the shelves by walking in a leisurely fashion over the search path, raking it as we went.

Shortly after returning to the hut, there was a sudden burst of loud squeals from the women: they had discovered the chocolate. So, we had wine and ... *chocolate* ... on the Razorback that evening. They both assured me that women "*search so much better after eating chocolate*." My assurances that cheese was surely a better match to wine fell on deaf ears.

The first search

After dinner (a delicious pasta-based meal prepared by Megan), we searched together from 10 pm to 1:30 am with a short coffee break around midnight. This, as with all first searches, took longer than usual while I showed Kathy how to identify the animals and record them in the notebook. Megan already knew what to do, so she lagged behind and concentrated on searching.

The night was warm and humid, and the island was bursting with life. Large numbers of diving petrels were dropping through the canopy and disappearing down burrows. Fewer flesh-footed shearwaters, much larger than diving petrels, also appeared, and we saw some little shearwaters (also called allied shearwaters) that are halfway in size between diving petrels and flesh-footed shearwaters. Lots of tuatara were about – that fabulous ancient reptile you hear about in lectures or read about in books, but never expect to see in their natural habitat, so Kathy was delighted to see them in the wild for the first time. A variety of skinks and insects were in abundance. It was enough to distract anyone interested in wildlife from searching, as indeed both women were.

Routine tasks

The next day, we took some spare gear and water to the Landing Bay and discovered that a recent landslide had come down near the beach. All the vegetation that had clung to the cliff had been scoured off, and frighteningly large pale-coloured chunks of rock were scattered about on the black rock platform we were on. The remains of bits of trees and bushes were everywhere. Large cracks in parts of the cliff indicated that it was still unstable, so we hurried past this area whenever we passed by.

Later that day, we checked the paving stones and oviposition trays in the Southern Basin. There, in the sand of one of the oviposition trays, was a tiny wētā. Much excited, we carried it back to the hut, but it proved to be a ground wētā when I examined it under the microscope. Quite disappointing.

Photo opportunities

We noticed that the tuatara, which resided in a burrow about five metres to the south of our deck – the 'hut-tut' – now ignored us and no longer withdrew into its burrow when we moved about. Previously, before there was a hut, we often found it wandering about at night, inspecting what we had scattered about on the ground.

CHOOSING WHEN TO GO ON FIELD TRIPS

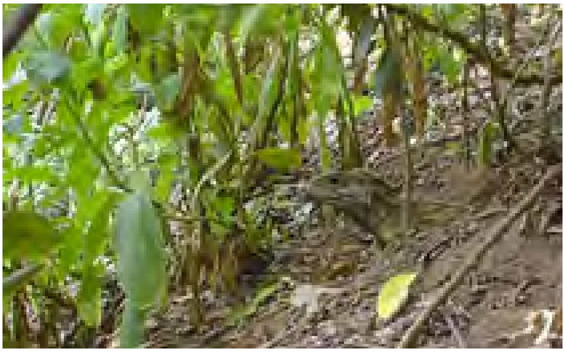
Recall that Mary McIntyre, who did the first field research on tusked wētā, reported that she found most of them during moonless periods of the night. Such periods vary from night to night depending on the times of moonset and moonrise and the times of sunset and sunrise.

The longest moonless periods at night occur at the new moon, so I planned the field trips to coincide with them. However, I also preferred to arrange the trips so they included more nights before the new moon than after it because the moonless period starts at the beginning of the night before the new moon whereas the moonless period is at the end of the night after the new moon. So, before the new moon, we could begin searching as soon as it was dark enough and then stop when the moon rose. After the new moon, we had to wait during the first part of the night until the moon set. This meant we had to try to get some sleep beforehand – usually when it was still daylight – which was difficult to do even when we were tired.

The time available for searching, of course, also varies with seasonal changes in day/night length. In addition, the moonlight that is available each night around the time of the new moon diminishes as the crescent moon wanes before the new moon and then increases again after the new moon as the crescent moon waxes.

The table below is an example using the tenth visit to Middle Island (January 24 to 28, 2001). It gives the times of sunrise, moonrise, sunset, and moonset, together with the length of time (hours:minutes) when the sun is below the horizon (night) and when both the sun and moon are below the horizon (darkest part of the night). Twilight, of course, reduces the search time but I have ignored this for simplicity. Note that the longest potential period of full darkness (sun and moon absent in the table below) occurred at the full moon (January 24) whereas it is about half this when the moon is in the last quarter (January 17) and about two thirds as long when the moon is in the first quarter (January 31).

Date (Jan. 2001)	Moon set	Sun set	Moon set	Duration of night	Moonless period of night (hours:minutes)	Moon rise	Sun rise	Moon rise
17	14:09	10:41		9:38	4:25	1:06	6:19	
19	16:10	10:40		9:42	5:30	2:10	6:22	
21	18:05	10:39		9:45	6:45	3:24	6:24	
23	19:47	10:38		9:48	8:16	4:54	6:26	
24		10:38	20:31	9:49	9:24	5:45	6:27	
25		10:37	21:10	9:51	9:18		6:28	6:39
27		10:36	22:17	9:54	8:13		6:30	8:31
29		10:34	23:14	9:58	7:18		6:32	10:25
31		10:33	12:11	10:03	6:24		6:35	12:21



‘Hut-tut.’ *This tuatara lived in a bird burrow by the hut. Photo: Kahori Nakagawa*

Whitaker’s Skink. It was semi-tame and lived on the opposite side of the hut from ‘hut-tut’. Photo: Ian Stringer

It became increasingly used to us during the trips, perhaps because we never tried to catch it. We surmised that it had probably been getting used to humans since the 1980s, when the campsite began being used. Now it often walked over the deck in the early evening while we were sitting, waiting for it to get dark enough to start searching. Hut-tut even clambered over our feet occasionally, much to our amusement and pleasure. Well, not many people have had a wild tuatara scramble nonplussed over their feet!

We became quite fond of hut-tut and felt quite protective of her. So, when Rob mentioned that he was going to help remove 60 tuatara from Middle Island in October 2003 for release on Tiritiri Matangi Island, I asked him to please leave hut-tut alone. He readily agreed, and we enjoyed her quiet company until I finished my fieldwork there in 2006. I hope she survived the landslide that destroyed the area in September 2017 (Chapter 10).

During this field trip, we noticed that a Whitaker’s skink occasionally emerged from a bird burrow a few metres to the north of the hut and basked whenever there were patches of sunlight nearby. Previously, during the fourth field trip, Richard Parrish mentioned that it occasionally flitted quickly back into its burrow. We managed to photograph it then by shutting the door and viewing it through the window, but now it allowed us to move about by the hut, although it would retreat bit by bit if we approached it. We usually saw other Whitaker’s skinks around dusk, but these were flighty and very hard to photograph, so we were pleased this one had become somewhat tame. They are beautiful skinks, so we appreciated being able to watch and photograph this one.

Personal hygiene

I always encouraged volunteers to avoid sweating by taking their time when walking about, and particularly when climbing steep areas. The exception, of course, was when we hurried to get our gear around to the Landing Bay before leaving the island, but then we had the luxury of warm, fresh-water showers to look forward to on the mainland. The searches at night took on average two hours and 40 minutes, and, as our route was only 624 metres long, we walked at a speed of just under a quarter of a kilometre per hour. This is dawdling when you consider that you can easily walk faster than four kilometres per hour. It wasn't arduous, but it was time-consuming because our searches were thorough and so were necessarily slow.

The sea was too cold for swimming during this field trip, so we showered with warm seawater. Each evening, we filled three solar showers and left them on a huge smooth black rock well above the high-water mark, and the water was always warm by the time we got up the next day. Sometimes we even had to add cold water when it was sunny to avoid being scalded. The showers were used by attaching them to a rope draped over a huge overhanging boulder. We had to use a special soap that lathered in saltwater, although hair shampoo seemed to work well. And, of course, we always kept an eye out for passing boats.

Saturday, after searching for five long nights

Megan went down for the first shower and remained there for ages. Eventually, Cathy and I started shouting for her to come back up so we could have our showers. There was no response for so long that Cathy decided to go down to see what the problem was. Just as she was about to leave, Megan exploded up the track, wrapped in her towel, flushed with embarrassment, and squirming with humiliation. She explained breathlessly that she had decided to dry off in the sun for a few minutes because it was such a beautiful, warm day. So, she laid her towel over the huge rock we heated our solar showers on and lay down, spread-eagled on her back. We often sunbathed on this rock after swimming because of its smooth surface. It also faced seaward with just enough tilt for us to look out to sea without having to lift our heads. You can guess what happened. The sun was bright: Megan shut her eyes. The day was warm: she relaxed. She was tired after spending a long night searching; she fell asleep.

Our shouts finally woke her, and she dreamily admired a large yacht ghosting silently past, close in. Suddenly, she realised she was as big to the men lining the railings admiring her as they were to her: she grabbed the ends of her towel, wrapped it quickly around herself, jumped off the rock, and ran for it, over the boulders and back up the track out of sight.

It was Cathy's turn to shower next, and she waited for Megan to get dressed and then went down with her to collect her clothes and toiletries. Just as they reached the rocks, a small boat sped around the headland and anchored in front of them. It looked like the men aboard were going to fish, so Cathy and Megan returned to the hut.

"That was quick," I said.

And just as I said this, we heard another boat arriving. More and more boats materialised – we glimpsed them through the trees and could hear people talking. Kathy and I realised we had to wait until dark before we could have our showers.

From then on, during the remainder of that weekend, boats anchored nearby to fish, a cray-fishing boat moored in the bay each lunch and dinner time, and a dive charter boat stayed for what seemed hours. An endless procession of small craft also motored slowly and aimlessly back and forth all day. Before this weekend, we rarely saw boats between Middle Island and nearby Stanley Island, but now there was seldom a moment when there was not at least one in sight … with the heads of every male aboard turned shoreward. Showering in the dark was not a problem, but waiting until night before we could go to the toilet was.

The level of scrutiny made us reluctant to go down to the shore, so we either mooched around the hut, occasionally peeping through the foliage at the hopeful voyeurs below, or went up to the base of The Razorback to laze or read books in the sunshine.

About mid-afternoon on Sunday, we ran out of clean dishes and cutlery, so we went down to wash them. A fission of excitement went around the boats as we emerged onto the rocks, followed by silence. What did they expect us to do? Strip off and dance about! We hoped they would get bored watching us doing such a menial task and go away, but no, they continued staring intently at us. So, we sat on the big flat rock when we finished and stared belligerently back at them. It didn't work, though: they continued staring at us, secure in the knowledge that they were the audience, and we were monkeys in a zoo. We eventually gave up and retreated out of sight. Russell Clague explained everything at the end of the trip when he took us off the island: a call had gone over the marine radio that a naked woman had been spotted on Middle Island.

The changeover

On Monday, two days later, it was time for Megan and Cathy to leave the island – disappointed at not having found a tusked wētā. All the boats had gone, presumably because their occupants had returned to work. The weather had changed, though:

the sun was still shining, but a brisk, cold south-westerly wind was pushing large waves ahead of it, and it was far too rough to embark below the campsite, so we started off to the Landing Bay. Cathy and Megan only had to carry a barrel of personal gear each, while I took an empty chilly bin stuffed with rubbish. Megan got gently ribbed as we passed the rock she had sunbathed on, and this developed into general good-humoured banter.

We stopped briefly before we rounded the headland and watched the waves exploding onto the rocks there. It looked like they might get soaked getting into the boat, so I suggested they might have to get into swimming togs. But it was much calmer when we got around the corner and into the lee of the southern headland across from the Landing Bay, so I began looking for a suitable place where Rob could bring the boat ashore: none of us wanted to carry everything to the Landing Bay if we could avoid it. We soon came to a wide channel through the rocks where the sea was almost flat calm. It looked ideal to me, so I stopped and put down the chilly bin. Both women immediately began rummaging in their barrels and disappeared behind large rocks. I assumed they were changing into warmer clothes, but both reappeared wearing bikinis.

We stood at the head of the channel while I desperately tried to divert their attention from the tiny wavelets lapping lazily at our feet. I began by revisiting a topic we had discussed several times during the trip – why hadn't we seen any tusked wētā? We had searched for over 13 hours: had they died out or had none emerged, and if so, why had they not? This was a good ploy because they had strong views, which led to vigorous debate. Fortunately, it was soon cut short when the *Kuaka* rounded the southern headland with spray flying as she pounded into the backs of the waves that were marching across the entrance to the bay. Rob, Suzanne, and Miranda were hunkered down behind the windscreen, puffed up under layers of warm clothing and parkas. Only their eyes and the tops of their heads were exposed to the elements. Suzanne told me later that as soon as Rob saw us, he turned to them and said, '*You appear to be a bit overdressed.*'

Rob, wearing an enormous grin, nosed the *Kuaka* right up to the rocks at our feet and exercised great tact and uncharacteristic self-restraint by not commenting. I grabbed the bow to hold the gently rocking boat steady while Cathy and Megan went around to the port side to unload. Suzanne jumped off to help while Rob remained at the helm, and Miranda stayed aboard to hand things back and forth. Then just as they started unloading, there was a giggle, a muttered comment, followed by laughing, and they began splashing me. Rob and Suzanne shouted encouragement (the traitors) while Miranda, who hardly knew me, watched with a bemused grin. I was soon drenched, trapped as I was steadying the bow, but the hilarity eventually subsided, and disembarking and loading were quickly accomplished.

Rob, ever the gentleman, advised Cathy and Megan to get dressed again because the wind had been cold on the trip over. They, of course, had to retrieve their barrels from the boat first, so we had to be extra careful not to get them muddled up with Suzanne and Miranda's barrels. The barrels were identical, so it would be easy to make such a mistake. But I needn't have worried because Suzanne and Miranda confirmed which barrels were theirs by opening and stowing their parkas and some of their outer clothing in them.

Miranda must have wondered what she had gotten herself into. She was the girlfriend of an MSc student in the Ecology Department and she was so keen to help that her boyfriend had asked on her behalf. Miranda was one of four undergraduates who volunteered: the others, Melissa Thompson, Mark Fraser, and Matthew Low, all asked if they could help during laboratory classes. (I'll recount their experiences in later chapters.)

We finally waved Rob, Cathy, and Megan off, and I led the way back to the campsite, because by then I knew the easiest ways to get around the rocks. As soon as we arrived at the hut, Suzanne and Miranda went off to their tents to unpack and sort out their bedding while I changed into dry clothes and made fresh coffee. Later that afternoon, I familiarised Miranda with the search route, and we finished the day with wine and cheese on The Razorback. We had dinner soon after dark, and then the three of us did a three-hour search from 9:40 and then went to bed: we were just too tired to do a second search.

We only managed four more searches during the next three nights. It began to rain heavily while we were searching on Tuesday night, so much so that the sticky, glutinous mud made it so difficult to walk that we abandoned the second search. However, the island dried out enough to do two searches on Wednesday night, and we all did one final search on Thursday night before departing on Friday morning. We spent 16 hours and 22 minutes searching during the last three nights without finding a tusked wētā.

A little shearwater (sometimes called an allied shearwater). Photo: Rob Chappell

CHAPTER 14

AT LONG LAST

We captured the last tusked wētā found on Middle Island in late January 2001, two years after finding a pair in April 1999. Our failure to find these insects during the intervening period had not been for want of trying: we had spent 45 nights and 234 hours searching fruitlessly for them during moonless nights.

Grant Blackwell and Phillip Eades accompanied me on my tenth field trip to Middle Island. Grant had taken time off from his PhD research,[88] and Phillip was a visitor from England who had appeared at my office door at Massey University, offering to volunteer for field work. I was setting up a large research project in National Park near Horopito and asked him if three or so weeks of work in a mature podocarp forest suited him. It did, and he quickly became a valued and highly effective member of the team, so I took him to Middle Island as a thank-you before he returned home. Middle Island is a glimpse of what New Zealand was like before humans arrived, so it was an exceptional treat for him, as it would be for anyone interested in natural history.

Getting our gear around from the Landing Bay was even less of a chore now because Rob Chappell had modified an old tramping pack frame for strapping on heavy water containers and the gas bottle so they could be carried on our backs. This time it only took two trips to get everything up to the hut from the Landing Bay, and we accomplished this in one and a half hours.

Setting up camp was now a doddle: all we had to do was pitch our tents and stretch the tarpaulins over the deck to form an outside shelter. I began by pulling the tents and tarpaulins out from where they were stowed under the lower bunk, while Grant and Phillip began unpacking the barrel of dry food. Suddenly, a large centipede emerged from a fold in a tarpaulin and ran quickly towards me. I backed away rapidly, knocked over a barrel, and yelled, *"Look out!"* Grant and Phillip immediately scrambled backwards, causing another barrel to go flying, and a few moments of chaos followed because our retreats were hampered by gear spread about over the

88 Blackwell (2000).

floor – we had put things down anywhere as soon as we got them into the hut. Our initial escape reactions to the sudden appearance of a long, thin animal wriggling like a snake soon abated when we realised that it wasn't moving very fast, although it certainly seemed to be when we first saw it. We tried to usher it out the door using the chilly bin and the water container to block its path, but it kept trying to turn back away from the light. It was only when Grant handed me a chopping board that I was able to flick it out the door.

The centipede could have entered through the ventilation slots[89] low down on one of the walls, or it could have squeezed under the door. I already knew they could get under the door because a large centipede fell onto the floor in front of me on a previous trip when I opened the door after returning from a search. It had squeezed its way up between the door and the door jamb, so big centipedes can obviously get through narrow gaps. Centipedes are also good at climbing, which was why I never slept on the bunk: I preferred a tent (ours had built-in ground sheets) because they were completely sealed when the entrances were zipped up.

The remainder of that first day was spent familiarising Grant and Phillip with the search path and sweeping it clear of leaves. We also clipped off any vegetation that could brush against us at night. Rob had originally advised me to make the paths easier to walk along by 'judiciously' trimming the vegetation, but we only removed foliage that we had to push through during the first few field trips. It was only after finding centipedes amongst the outer foliage of low branches that we resumed clearing away anything that could contact us at night.

All the centipedes we saw on foliage were positioned as if they had stopped walking along a branch, so their rear ends faced back the way they had come. The last pair of legs, which are longer than the others, were directed rearwards and raised ready to grasp anything that blundered into them. This could be a gecko, for example, climbing up to begin its nightly hunt for insects. The fronts of these centipedes were all turned around so their heads faced backwards, ready to strike anything clasped by their rear legs. The poison fangs are the first pair of legs that have been modified into formidable, swollen structures beneath the head.

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Later that afternoon, we checked the concrete paving slabs in the Southern Basin, but no tusked wētā were under them. We also sieved the sand in the two oviposition

89 Ventilation slots were provided to prevent carbon monoxide poisoning if we cooked while the windows and doors were shut.

trays and found a tiny wētā, but it turned out disappointingly to be a ground wētā when we examined it under the microscope. It was late evening when we finished, so we climbed up to the Razor Back and relaxed with wine and cheese.

That night, all three of us began searching about an hour after the sun had set. It was completely dark except for starlight filtering through the trees. There were no diving petrels – they had finished nesting – but there were more flesh-footed shearwaters than we had seen previously, although they were not as abundant as the diving petrels had been. We counted 44 tuatara, seven geckos, 12 skinks, three giant centipedes, and numerous insects, including 75 darkling beetles and 20 ground wētā. We ended the search at 1 am and went to bed. Moonrise was still two and a half hours away, so there was time to do a second search, but we were exhausted.

Our only chore for the following days was writing up the previous night's searches, so we had lots of free time. It was summer, and the next four days were calm and sunny with only some sparse, wispy cirrus clouds overhead. It was also pleasantly warm with temperatures of up to 24°C, so, as you can imagine, we spent much of our time reading and sunbathing on the rocks below camp. Now and then, we also went snorkelling to cool off.

During one of these snorkels, we saw a huge stingray with a large gash on one of its wings. It was resting in a shallow area within an irregular semicircle of large rocks, and we floated on the surface at the narrow entrance, discussing what could have caused the injury – we knew that orca in the area specialise in eating stingrays, but we couldn't imagine how one could have made a single long slash. Propellers make a series of diagonal slashes, so that seemed an unlikely explanation. Suddenly, without warning, the stingray swam straight at us so fast we couldn't get out of its way, but – much to our enormous relief – it passed harmlessly beneath us and disappeared rapidly into the ocean behind.

Searching during the next four nights was uneventful. We did seven full searches and spent over 22 hours fruitlessly looking for tusked wētā. Lots of insects were out, and darkling beetles were particularly common: we counted a total of 228 *Chrysopeplus*[90] and 163 large *Mimopeus*. We also saw 172 ground wētā and 50 cave wētā, as well as 27 giant centipedes, more than we had ever seen before.

90 A small brown darkling beetle flecked with light patches.

We awoke to light showers on the fifth day, so we spent the morning in the hut or sitting under the tarpaulin on the deck. The ground only got slightly wet and dried out completely during the afternoon, so we migrated down to the rocks to read, sunbathe, and occasionally snorkel as if we were on vacation. Our two full searches that night produced no tusked wētā, even though we saw numerous other insects and reptiles.

By the seventh night, our last night on the island, we were thoroughly dejected, and I was resigned that this would be – yet again – another unproductive field trip. Phillip and Grant were still keen to do two full searches, so Phillip and I searched from 9:55 pm until just after midnight, then woke Grant, and he continued searching with Phillip. I went to bed. I knew they were wasting their time.

Then ...
"String! ***String! Wakeup String! WAKEUP, IAN!"***
*"Urrrgg ****** off!"*
"We got one! WE GOT ONE."

I had to see it. I quickly wriggled out of my sleeping bag, unzipped the tent to be met by two beaming faces. Sure enough, they had an adult female. To say we were thrilled is an understatement. They also had to answer my endless questions: Where exactly had they found it? Was it hard to catch? Did they damage many bird burrows? ...

Grant found the wētā at 3:27 am in the Southern Basin, near the large rock at the "Weta Bank", and they caught it easily. Elated, they cut the search short and returned to camp because they were tired, and they decided that they had now earned some rest. Dawn was about one and a half hours away, so they would only get a short sleep before bright sunlight would awaken them.

In hindsight, I should have known better. There had been some light rain earlier in the morning, but the island had completely dried out, and the ground was dusty. Even the air felt parched. But ground wētā were so abundant that night.[91] We counted a total of 171, almost as many in total as we had seen during the previous four nights so I should have realised the conditions were probably favourable for tusked wētā as well.

91 Ground wētā often occurred in clusters and then we had to identify as many as quickly as possible before the others began jumping. We ignored those that did jump because chasing them could cause more to start jumping and we could damage bird burrows. Overall, only 9% escaped and were recorded as 'unidentified wētā.'

We took the tusked wētā with us when we left the island, as requested by the Mercury Island Tusked Weta Recovery Group, and Rob Chappell handed it over to Chris Winks for captive breeding later that day. This was the last tusked wētā ever seen or detected on Middle Island (see Part 5). It unfortunately turned out to be an infertile female.

After Grant caught this last wētā, I organised seven further field trips to Middle Island and spent 97 hours searching before I gave up in February 2006. Each time we returned without finding tusked wētā, I thought it increasingly likely they had died out. Rob, however, couldn't believe they had and did a further nine single-night searches, usually by himself, until he finally stopped in May 2016. He reasoned that they might still survive on Middle Island because they are so difficult to find. He pointed out that we didn't find any during the six field trips after finding two in April 1999, and yet some must have been present because Grant found one two years later. We now know that some tusked wētā eggs delay hatching for a year, so the wētā Grant caught could have hatched in 2000 (see text box "Diapause: an escape in time" in Chapter 22), and we didn't find it until it was an adult.

Ouch

Both Rob and I developed swollen knees during the later field trips, caused, I suppose, by relentlessly going down steep slopes. As the trips progressed, bending our legs became increasingly painful, and the swelling took longer to subside after returning home. I eventually went to the doctor, who told me it was degenerative.

"Will it get better?" I asked.

"No."

Fortunately, he was wrong. The swelling eventually disappeared after the last field trip. Rob was less fortunate because he worked on the Mercury Islands and ended up using a brace on one knee for a long time.

Slippery rocks

The tide was out when Rob Chappell, his daughter Esta and I were getting ashore at the Landing Bay on Middle Island in January 2006 and the inevitable happened. Rob inadvertently stepped on a patch of 'dried blood algae' encrusting the top of a boulder and, as it was wet and therefore extremely slippery, his foot slid off into the kelp between the boulders and onto a sea urchin hidden beneath. A spine penetrated the side of his left diving booty and broke off in his foot.

Esta Chappell extracting a sea urchin spine from the side of her father's foot. Photo: Ian Stringer

What to do? It was embedded in thick skin on the side of his foot and didn't seem to have gone far into the flesh beneath but we knew it would fester if left there. Rob was sure it would be relatively easy to remove but couldn't reach it. None of us wanted to return to Whitianga and wait . . . and wait . . . and wait to see a doctor. We had already postponed the field trip because of bad weather and didn't want any further delays. So, Esta and I both volunteered to remove the spine. All of us had extracted sea urchin spines from our own feet in the past. Rob wisely chose Esta to do it. I think he realised she would be gentler than me.

We sterilised a needle over the gas stove, then Esta pinched the skin on either side of the spine to numb the pain and proceeded to pick away at the hardened skin around the spine. Rob, meanwhile, writhed about trying to see what she was doing while giving lots of advice which Esta ignored. Once she exposed most of the spine she began to very carefully extract it. This was the delicate part because these spines are brittle and the tip could easily break off. If it did then we might have had to return to Whitianga, but the spine slipped out intact so she dabbed antiseptic on the hole and covered it with a sticking plaster. The wound healed with no complications.

There are “Lies, damn lies and statistics” [92]

I’ll finish Part 2 by returning to the problem of identifying how many juvenile tusked wētā were found during the second to fourth field trips. Recall that the 10x magnifying lens we used during the second field trip was not powerful enough to distinguish tympanal organs of tusked wētā from subgenual organs of ground wētā (Chapter 6). Then, during the third and fourth field trips, I relied on the colour of the ocelli (orange for tusked wētā, pale cream for ground wētā) until we found wētā with ocelli of intermediate colours, so I stopped using this method because it was too subjective (Chapter 10).

Fortunately – or so I thought at the time – I had a backup plan that involved using multivariate statistics that should enable me to identify the species from measurements of 11 body parts. However, the identifications could only be done after we had collected comparable measurements from insects that were positively identified as either tusked wētā or ground wētā. We got measurements from lots of ground wētā, but we didn’t find any juvenile tusked wētā after the fifth field trip (when we took a binocular microscope with us to identify the wētā we caught), so I had no comparable measurements for the analyses. I did have measurements from captive-reared tusked wētā, but I couldn’t use them because all the wētā were the progeny of two females and one male, so the data were biased (highly correlated). It’s like assuming that measurements from the children of two families are representative of all children when they are not. So, any analysis I might do would be meaningless: as statisticians say, “garbage in, garbage out.”

We will never know, for certain, how many juvenile tusked wētā were amongst the small wētā we caught during the second to fourth field trips, but we know for certain that every small wētā we found after that was a ground wētā.[93] It is possible that we might have caught a small tusked wētā during the third trip, and we might have caught nine during the fourth field trip because their ocelli were distinctly orange.[94] I, however, take a conservative approach in such situations and believe that we simply don’t know if we found any juvenile tusked wētā during those trips.

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92 Attribution uncertain. Wikipedia gives several sources.

93 740 ground wētā were caught between the sixth and last field trips (October 1999 to February 2006).

94 Fourteen small wētā were caught during the third field trip, 38 during the fourth field trip, and three during the fifth field trip.

PART 3

CAPTIVE-REARING:
A Laboratory Study

The following two chapters are technical so skip to Part 4 if you are not interested in captive-rearing.

Liz Grant with a juvenile male tusked wētā. The developing tusks are small conical knobs projecting from the front of the mandibles. Photo: Ian Stringer

CHAPTER 15

GETTING SORTED

The suspense and anticipation were palpable. Chris Winks at Landcare Research Ltd in Auckland had telephoned the day before:

"I'm sending your wētā by overnight courier today. There are 21 of them and all hatched over the past 17 days."

Everything was ready. Liz Grant and Hamish Mack had carefully prepared individual containers to house the wētā, the temperature-controlled room where the insects would be kept had been thoroughly cleaned, and we had the food Chris told us they ate. All that was missing were the wētā. Our eagerness was mixed with some trepidation, though: these were special insects.

All through the following morning – Wednesday, December 29, 1999 – we pestered the departmental secretary with *"Has a parcel arrived for us yet"?* It arrived soon after lunch, decorated with labels: LIVE ANIMALS, FRAGILE, THIS WAY UP. We quickly carried it into a laboratory and opened it. Inside were 21 small individual containers, which we opened one by one. We carefully extracted the tiny wētā from the fine Vermiculite™ (exfoliated weathered mica) they had buried themselves in and released them into their new containers.

The next day, we checked if any had emerged to eat overnight. We hoped that the wētā would create small depressions or piles of Vermiculite™ when they came out and dug back in, but we couldn't see any. We then realised that the insects were too small to create visible disturbances. I knew Chris kept the eggs in damp Vermiculate™, so how did he know when they hatched? I telephoned him:

"Easy," he said. *"I sprinkle a thin layer of fine Perlite [crushed white pumice] over the surface so tiny bits of brown Vermiculite™ get pushed up onto the surface when they emerge."*

Brilliant!

So why rear tusked wētā?

By mid-1999, I realised I would probably get few, if any, scientific publications from the fieldwork on Middle Island, simply because we were finding so few tusked wētā. Yet, it was 'publish or perish' if I wanted to continue my employment at Massey University. My solution was to rear some in the laboratory and describe their growth and life cycle: I could certainly publish that. The idea was feasible because Chris had already developed an excellent method of captive-rearing them. Another advantage of captive-rearing is that I would learn an awful lot about the habits and behaviour of the insect, much more than I could expect from fieldwork alone. This was especially so with tusked wētā because they are so secretive. I advanced the idea at a Mercury Islands Tusked Weta Recovery Group meeting, and everyone approved.

Yet more paperwork!

More paperwork was required for rearing the insects in captivity. You just cannot seem to avoid it! Mercury Islands tusked wētā were, at the time, classified as 'Category A: Highest Priority Species for Conservation Action' by the Department of Conservation[95] so I needed an additional permit to rear them in captivity. I already had permits to land on the Mercury Islands, and a permit to 'handle and hold' protected wildlife; now I needed an *Authority to obtain and have in possession absolutely protected wildlife under the Wildlife Act 1953*. This – to my utter amazement – was obtained for me (as were the previous permits) by members of the Mercury Islands Tusked Weta Recovery Group. Once again, I was flabbergasted! This had never happened before during my entire working life: I had always done all the paperwork myself. The Recovery Group had freed me up again to research, unhindered by bureaucracy.

I received the permit in September 1999, and we were cleared for action.

Taking care of tusked wētā

But I have digressed, so back to rearing. We – well, mostly Liz and Hamish – kept the insects in a temperature-controlled room set at 16–18 °C with 14 hours of light and 8 hours of darkness. These were average conditions during the warmer months on Middle Island. Each wētā was housed in its plastic food container. These were equipped with transparent lids with large holes covered with fine stainless-steel

95 Molloy, Davis, and Tisdall (1994).

mesh for ventilation. We used 7-litre containers initially, then 28-litre ones and finally 44-litre containers as the insects grew larger. Each container was provided with a layer of fine Vermiculite™, which we kept moist by sprinkling with tap water as required. The wētā excavated rounded cavities within this and sealed over the entrances with a thin layer of chewed Vermiculite™ mixed with saliva.

As the wētā grew into large juveniles and adults, we also increased the depth of the Vermiculite™ to a maximum of about 10 cm. Food and water were provided in small dishes, which we kept clean and free of mould. The food usually consisted of a mixture of tropical fish food, commercial hen food, oatmeal, ground corn and dry Lucerne. We replaced this twice a week and occasionally provided fresh plantain or *Coprosma* leaves. Once the wētā were half-grown, we also gave them each three live mealworms a week.[96]

Obtaining the information we needed

This was simple: we measured the insects periodically to find how long they lived, how many times they moulted and how much larger they got after each moult. We started by measuring their heads, pronota,[97] the femurs of the middle legs, the tibiae, and the femurs of the fore- and hind-legs, their cerci,[98] and their body lengths and weights. Some anatomical features are missing in newly hatched wētā and start developing later, so we began measuring these when they appeared: the ovipositors of females, the tusks of males, and the tympanal organs[99] and the spines on the middle femur that are so important for distinguishing tusked wētā from ground wētā (explained in Chapter 11).

These anatomical parts – except for body length – were measured because they are hard and rigid, so their dimensions don't change until they moult. We recorded body length and weight, even though they vary enormously, in case a large weight reduction relative to body length might indicate that the insect had become diseased or something else was wrong with it.

We aimed to minimise the number of times we measured the insects in case this stressed them and affected their development,[100] so we tried to do this once

96 Full details are published in Stringer, Mack, Grant, and Winks (2006).
97 The pronotum is the saddle-shaped plate covering the first thoracic segment.
98 These are short tapering sensory appendages at the end of the abdomen. They function as posterior antennae.
99 Tympanal organs are auditory organs. They are oval, drum-like scars located on either side of the front tibiae and are visible in many of the photographs of tusked wētā including the frontispiece.
100 Overall, we dug up and checked each insect on average 118 times.

between each moult. We recognised when the insects were moulting because they remained in their underground chambers for several weeks without eating, so every time we replaced the food, we recorded if any of the old food had been consumed: if it was uneaten for more than two weeks, we assumed the insect was moulting. We then usually waited until they began eating again before we dug them up to measure them.

The results were recorded in a spreadsheet that allowed us to see at a glance when the insects had not eaten. This didn't always work out, though, because wētā occasionally remained in their chambers without doing anything for so long that we dug them up in case they had died and often found they hadn't moulted. We also measured all the insects periodically in case we missed a moult, but we rarely did.

WETA	Gender	Date hatched	22-Dec-99	24-Dec-99	14-Jan-00	17-Jan-00	18-Jan-00	28/01/2000	4-Feb-00	15-Feb-00	18-Feb-00	22-Feb-00	28-Feb-00	3-Mar-00	6-Mar-00	10-Mar-00	13-Mar-00	16-Mar-00	21-Mar-00	22-Mar-00	24-Mar-00	27-Mar-00
132	Male	12/11/1999	NO	yes	yes			no		no	yes	yes	no	yes	moulted	yes	yes	yes	yes	.	no	no
133	Female	12/11/1999	no	yes	no			yes		no	no	yes	no	no	.	yes	yes	yes	yes	moulted	no	no
134	Female	12/11/1999	NO	yes	no			yes		yes	yes	no	yes	no	.	yes	yes	no	yes	no moult	yes	no
135	Male	13/11/1999	no			yes		no		yes	yes	no	yes	yes	no moult	no	no	no	no	.	yes	yes
137	Female	13/11/1999	NO	yes	no			yes		no	yes	no	yes	yes	no moult	yes	no	no	no	.	no	no
138	Male	13/11/1999	yes		yes			no		yes	yes	yes	yes	yes	no moult	yes	no	no	no	.	no	yes
139	Female	14/11/1999	yes					no		yes	no	yes	yes	no	.	yes	no	no	yes	moulted	no	yes
146	Female	17/11/1999	yes	yes	no			no		no	no	yes	no	yes	no moult	no	no	no	yes	moulted	yes	no
147	Female	17/11/1999	no	yes				no		no	yes	no	yes	yes	no moult	no	no	yes	yes	moulted	no	no
151	Male	21/11/1999					no	yes		no	no	no	no	yes	moulted	yes	yes	yes	yes	.	yes	no
158	Female	22/11/1999			yes			yes		yes	no	no	yes	no	.	yes	no	no	yes	moulted	no	no

Screenshot of part of an Excel spreadsheet showing when each wētā had eaten (Yes, highlighted in red) or not eaten (No), and the dates when we dug them up to confirm if they had moulted (green) or had not moulted (blue). Identification numbers were assigned by Chris Winks

Measuring tusked wētā

Measuring our captive-reared tusked wētā was easy when they were larger than 15 mm long because we could do this while gently holding them. Our wētā were docile and seldom moved or struggled, and we never got bitten. You will almost certainly get bitten if you pick up a wild tusked wētā, though.[101] Their bite hurts: these insects have powerful jaws!

101 We always wore thin gloves (rubber or plastic) when handling wild tusked wētā because they seemed to treat these as part of their inanimate environment and never tried to bite through them.

MOULTING
Here's an Executive Summary

First, the cuticle – this is what is shed: it is the insect's external skeleton – the exoskeleton. It completely envelops the insect and is infolded to line the foregut, midgut, the end of the reproductive tract, and the tracheae (through which the insect respires). The only openings through the cuticle are microscopic pores that allow the chemical sense organs to savour the smells and tastes of the environment. A thin layer of wax on the outside of the cuticle almost completely prevents water loss (or gain if the insect is aquatic).

Moulting begins when the insect produces a new soft cuticle beneath the old one. The new cuticle has all the features of the insect's next life stage, although it is usually ¼ to ⅖ larger, so it is pleated and wrinkled to fit within the old cuticle. When the new cuticle is almost complete, the old cuticle usually splits along the back, and the insect wriggles, squirms, and slides out, leaving the old cuticle as an empty husk called an exuviae*. The exuviae retains every feature of the original stage in exquisite detail, including the internal linings and everything attached to it – leg bands, painted numbers, anything glued on – is shed with the old cuticle.

Many insects hang from something, so gravity helps them slip out of the exuviae. Once out, they swallow air (or water if aquatic) and inflate to their new size. Chemicals produced beneath the new cuticle stiffen parts that will become hard (the process is akin to tanning leather), but these chemicals are not produced in the joints, so they remain flexible. More cuticle is also added for a while as hardening takes place. Finally, most insects with chewing mouthparts eat some of the old cuticle to recycle the protein in it before they walk or fly off. Magic!

Well, as the saying goes, that's it in a nutshell.

**Exuviae is both singular and plural.*

Occasionally, a captive wētā would rear up and adopt the defensive/threat display, and then we left it alone until the next time we checked the cages. This display consists of raising the front of the body, lifting and spreading the front legs and opening the jaws widely. Sometimes a wētā will also rock back and forth jerkily and periodically lunge forward as if about to bite. If they are really 'annoyed,' they also produce a rasping-hissing noise or a series of loud, sharp, rapid clicks (entomologists call these noises stridulations).[102]

102 See the text box "The sounds that tusked wētā make" in Chapter 3.

Measuring the length of the pronotum of a tusked wētā with callipers. This wētā is in its underground chamber on Red Mercury Island (March 2003). Photo: Ian Stringer

Wētā number 164 behaved differently from the others in that she invariably assumed the defensive/threat display whenever I came within a few metres, but she remained perfectly calm whenever Liz or Hamish handled her. We have no idea why she reacted like that, but Liz and Hamish had to remember to warn me to stay away before they picked her up in case they got bitten by mistake. Liz named her Xena, from the film *Xena: The Warrior Princess*. She was the only wētā we named: the others just went by the identification numbers that Chris Winks assigned to them when they hatched.

The defensive/threat behaviour was described in detail by Cassandra Guignion, a student at the University of Canterbury, in her M.Sc. thesis. She reported that stridulation is produced by a series of pegs on the inner surface of the hind femur when rubbed against a series of pegs and ridges on the abdomen. The defensive/threat display is quite effective against humans because it is perfectly evident that the wētā will bite if given the chance, so most people pull back and leave the insect alone.

There was, however, one very unpleasant aspect to handling captive wētā: they occasionally produced a surprisingly large volume of black, semi-liquid faeces[103] with an unbelievably repulsive stench that quickly permeated throughout the laboratory. If one defecated while interested bystanders were watching us measure our insects, as they often did, then they invariably gasped, swore and scuttled off muttering something like *"Oh, that's* ***bad!****"* Cassandra identified dimethylsulfide $(CH_3)_2S$, as the main component of the odour.[104]

103 Most insects produce dry poo – entomologists call it frass – to conserve water.
104 Giugnion (2005).

Measuring small juvenile wētā

Small wētā were easily damaged by handling, so we restrained them very gently using what we called a 'wētā crush' (named after cattle crushes that farmers use to restrain cows). Our usual 'wētā crush' consisted of two pieces of plastic pipe that fitted one inside the other. A clear disc of Perspex™ was glued to one end of the outer pipe to form a window, and a plug of soft foam was attached to the end of the inner tube to create a plunger. The wētā were measured after softly sandwiching them between the window and the foam. We never had to jam them against the window because they relaxed and usually stayed still when they were so restrained. Biologists call this response thigmotaxis: it is a common reaction amongst insects living in holes or crevices.

We used an even smaller 'wētā crush' for measuring the smallest tusked wētā. This was made by cutting off the end of a plastic hypodermic and attaching soft foam to the end of the plunger. A microscope slide coverslip was attached to the cut end of the syringe by first dipping the end of the syringe into molten wax. The wax glued the coverslip on so lightly that the coverslip fell off well before the insect could be squashed. This meant we had to be extremely gentle when pushing the plunger in.

These crushes certainly made it easy to measure small wētā without damaging them, but they tested our patience because the insects had to be oriented correctly before each part was measured. This usually involved pulling the plunger partway out several times and waiting until the wētā moved into a suitable position.

A juvenile tusked wētā in the large 'crush' before being measured under a dissecting microscope. Photo: Ian Stringer

Once in the crush, we measured the insects using a dissecting microscope equipped with an eyepiece micrometer graticule, which superimposes an engraved scale over the object being viewed. The part being

THERE ARE ALWAYS EXCEPTIONS

The few insects that do moult as adults are silverfish, bristletails and their kin, and mayflies. Silverfish and bristletails are primitive wingless insects that are classified together in the Subclass Apterygota: the name is derived from ancient Greek, meaning: a, without; pterygon, wing. They moult repeatedly as adults, whereas adult mayflies do have wings and moult once as adults.

Mayflies belong in the Family Ephemeroptera (Greek: ephemeros, lasting for a day; pterygon, wing). The adults emerge from water (trout fishermen call this stage a 'dun' because the wings are dull-coloured) and fly to nearby vegetation where they moult once more into the second and final adult stage. These have transparent wings (fishermen refer to these as 'spinners'). This is the stage that you commonly see flying above water searching for mates. Mayfly adults don't eat and only live for a few hours, hence the Family name Ephemeroptera.

measured, of course, must be completely in focus; otherwise, the measurement is inaccurate (the object lies at an angle from you if part of it is out of focus), and we achieved this by tilting the crush this way and that as required.

Lastly, we rarely measured adults more than once because the adult is the last stage of an insect's life cycle, and so, as with most insects, adult tusked wētā never moult. We, of course, had to check adult females occasionally if they had not eaten for some time in case they had died, and this involved opening their chambers. Adult males, on the other hand, didn't excavate cavities (their tusks get in the way when trying to dig), so we provided them with upended plastic two-litre ice-cream containers. Each had an arched entrance cut into one side, so we simply lifted the containers to check on the males.

CHAPTER 16

GROWTH AND DEVELOPMENT

Growing by moulting

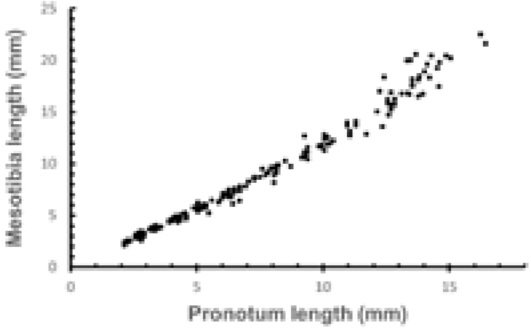
First, some terminology. Entomologists use the general term 'instar' to refer to all the growth stages. Tusked wētā therefore grow by moulting through a series of juvenile instars (also called nymphs) until they reach the adult instar. The adult is the reproductive stage: it does not moult, and the insect dies after reproducing. Entomologists also use the term stadium (plural: stadia) to refer to the time or period between moults. I use both terms in the interests of brevity – they save me from repeatedly writing "the stage between moults" or "the time between moults".

Determining how many moults a tusked wētā undergoes as it grows is not as simple as it may seem when the insects are nocturnal and roost underground during the day. We started by graphing pronotum length against mesotibial (tibia on the second leg) length as the insects grew. This produced a scatter diagram showing clusters of data points that indicated different stadia. However, the clusters began overlapping at the 6th instar and progressively merged after that, making it increasingly harder to distinguish between later instars.

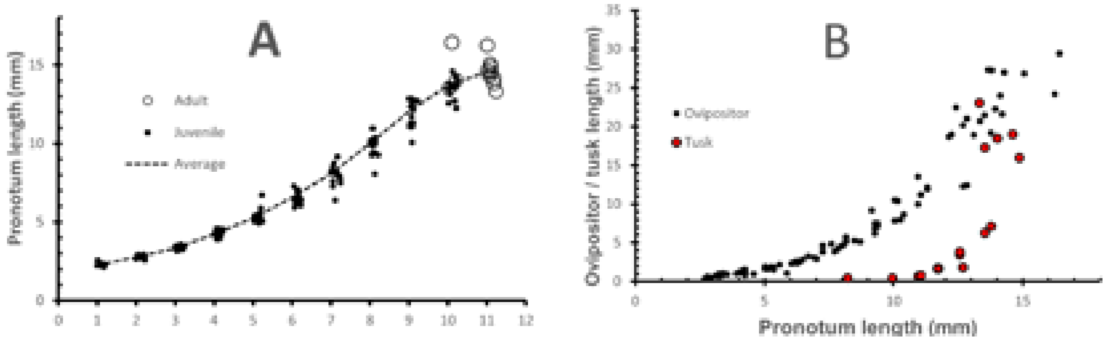
A captive female tusked wētā moulting in its chamber (in fine Vermiculite™). The head is to the left, and the insect is lying on its left side. Photo: Ian Stringer

We overcame this by following each wētā individually and by comparing each of their successive measurements. On average, the wētā enlarged about 25% at each moult[105] and we used this information to keep track of the instars as each wētā

105 Mathematicians call this a geometrical progression. Things get increasingly larger when they increase geometrically. For example, a tusked wētā would grow larger than a human (21.8 m) if it moulted 24 times after hatching (the average body length at hatchling is 10 mm). In other words, it would only require 13 additional moults. The tusks, however, increase by 350% at each moult, and average about 20 mm long in adults. Thus, they would only require a further five moults to grow longer (3.7 m) than an elephant's tusks (which are 1.4–2.5 m long).



Relationship between pronotum length and mesotibia length. Note that the first four or five instars cluster well, whereas measurements of later instars blur into neighbouring clusters



Growth of tusked wētā. ***A:*** *Change in pronotum length as the insect grows through the instars. Each instar is about 25% larger than the previous one. Note that the rate of increase diminishes as the insect becomes an adult (at the 10th or 11th instar). Data has been spread slightly (jittered) along x-axis for clarity.* ***B:*** *Change in ovipositor length and tusk length in relation to pronotum length. Note that the tusks first appear in older juveniles and enlarge much faster than ovipositors*

developed. If we found one had grown by about twice this, then we had missed a moult and went back to examine our eating records (Chapter 15) to find when and how we made the mistake. We eventually proved that both male and female tusked wētā went through either nine or ten moults and became adults at either the 10th or 11th instar.[106] What we didn't expect was that wētā that matured at the 11th instar grew faster than those that matured at the 10th instar, so they all had similar lifespans (on average, about two years after hatching).

Most structures increased by about 25% except for the ovipositors of females and tusks of males. Both appeared after the insects had already grown somewhat, but once they appeared, they enlarged at a much faster rate than the rest of the body.

106 Mary McIntyre first reported that there are two or three distinct sizes of adult male tusked wētā (McIntyre 2001). We found that both males and females can mature at the 10th or 11th instar (Stringer *et al.* 2006), and I have since seen one very small adult male on Double Island, which suggests some may mature at the 9th instar in the wild.

HOW ABOUT SOME THEORY?

In 1896 and 1890, respectively, W. Brooks and H. Dyar independently discovered that the hardened cuticular structures – entomologists refer to these as sclerites* – of most juvenile arthropods increase by a constant proportional amount each time they moult. This is known as the Brooks-Dyar rule. Dyar explained it as follows: when moulting, each hypodermal cell (the single layer of cells that secrete the cuticle – Greek: hypo, under; dermis, skin) divides once and then the two daughter cells grow to occupy the same area as the parent cell. So, after a moult, a sclerite will occupy twice the area it did before the moult. It follows that the linear dimension of such a hard plate should be related to the square root of this new area. After all, if we take a square of cuticle then the length of one side multiplied by the length of an adjacent side equals the area. So, if our original square of sclerite has an area of 1 unit, then it would increase to an area of 2 units (twice as many cells) after moulting. Now $\sqrt{2}$ = 1.4142..., so the length of each side of our square should increase by about 40% after each moult, and the sclerite should also increase by a factor of about 1.4. This is a much greater proportional increase than we observed in tusked wētā, but some insects do grow at this rate. We are saved by H. Przibram and F. Megušar, who in 1912 theorised that each hypodermal cell divides at moulting and then each grows to the same volume as its parent cell. So, the linear dimensions of the new cell should now be related to the cubic root of 2, and $\sqrt[3]{2}$ = 1.2599.... a 26% increase, about the same as in tusked wētā. Phew!

It so happens that many insects do increase in size between 25% and 40% at each moult. There are, however, many insects with hypodermal cells that do not divide at each moult. These are the insects with a pupal stage in their life cycle, such as beetles, flies, bees and wasps, and butterflies and moths. Their hypodermal cells simply grow larger at each moult, so they retain the same number of hypodermal cells as they grow, and yet many still increase in size between 25% and 40% when they moult. Again, there are exceptions because some grow even larger at each moult and so have fewer moults (some beetle larvae, for example, moult as few as three times before they moult into pupae).

Those insects that retain the same number of hypodermal cells when they moult into a pupa or chrysalis have a second set of hypodermal cells that take over at the pupal moult and divide rapidly to form the pupa and then the adult. The original juvenile hypodermal cells break down to provide a nutrient soup that nourishes these new cells. Just thought I would warn you that everything is not always that simple.

Ovipositors first appeared in the second instar as four tiny projections[107] and subsequently increased in length by about 60% at each moult. In other words, they became on average 1.61 times longer at each moult, whereas tusks first became noticeable as slight bulges on the front surfaces of the mandibles at the seventh instar and then grew on average 3.5 times larger at each moult, so they increased in length very quickly after first appearing.

So why do ovipositors and tusks grow faster than the rest of the wētā? Tusks interfere with digging because adult males, in captivity, only make shallow scrapes and wild ones either rest under leaf litter or logs, or occupy cavities made by females (Chapters 23, 26 and 28). The larger the tusks are, the more they interfere with digging, so tusks are suppressed until the last few instars, and then develop very rapidly. Last instar juveniles successfully dig chambers, whereas adults do not. Ovipositors, by contrast, don't stop females from digging, but they compel them to excavate larger cavities to accommodate their ovipositors. This conveniently creates sufficient space for other tusked wētā – particularly adult males – to join them. I often found multiple adults sharing a cavity in the wild: pairs of males, pairs of females, two females and a male, and two males with a female. But I am getting ahead of myself here because this is more relevant to Part 4.

The stadia or lengths of time between moults also increased as our tusked wētā grew, but these measurements were approximate because we seldom knew exactly when the insects moulted. We did unintentionally open chambers on two occasions when wētā were in the process of moulting. This allowed us to report that when they moult, the old cuticle splits down the centre of the back of their thorax and the insect wriggles out.[108] This is what happens in most other orthopterans.[109] However, we found that tusked wētā moult while lying on their side or in the normal upright position, whereas many insects hang upside down so that gravity helps them pull out from their old cuticle. The new cuticle of both wētā we saw moulting had quite a pinkish blush, but we don't know how long it took for the insects to complete moulting because we quickly photographed them and covered them up again. We

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107 These develop in the embryo as limb buds on the eighth and ninth abdominal segments. They are slight bulges in first instars and are only recognizable as small projections on the seventh and eighth abdominal segments in second instars. The cerci similarly develop from embryonic limb buds on the tenth segment. Embryonic limb buds also appear on all the other abdominal segments but are resorbed before the insect hatches.

108 We never attempted to observe the whole process of moulting (termed eclosion by entomologists: Latin ex, out; claudere, to hatch) so we do not know how long it takes.

109 Orthoptera (Greek: orthos, straight – pertaining to the wing veins; pterygon, wing) is an insect order (a level in the classification scheme) that includes wētā, grasshoppers, crickets, katydids, and their kin.

THE TRACHEAL SYSTEM

Tracheae are branching and anastomosing (joining up) tubes through which insects respire. They open to the air through spiracles located along the side of the body between the thoracic and abdominal segments, and then branch repeatedly inside the insect's body, getting narrower each time until they are smaller than many cells. They supply oxygen directly to the cells and remove some carbon dioxide. Carbon dioxide, in contrast, can pass through tissue more readily than oxygen so some simply diffuses out through the body and outer cuticle of its own accord.

were concerned that interrupting the process for too long could cause the moults to fail, and the insects were then likely to die.

Tusked wētā eat most or all of their cast-off cuticle before they emerge from their cavities again. Most insects with chewing mouthparts do this to recycle the protein, which would otherwise be lost. The cast-off cuticle is called an exuviae, derived from Latin, meaning something stripped off. An exuviae (correct spelling for both singular and plural), when intact, contains every detailed feature of the insect (just like the cast skin of a snake or lizard) and also includes the (cuticular) linings of the fore- and hindguts, and the tracheal system: in other words, all cuticle secreted by hypodermal cells wherever they are.

Recognising when a tusked wētā is an adult

So far, I've glossed over the problem of how to recognise an adult tusked wētā. Most adult insects have wings, but adult tusked wētā do not and look just like large juveniles, so how did we know when they were adults? We confirmed this by observing if they showed reproductive behaviour. We paired males with females (which we thought might be adults) together in a large arena and filmed them at night using a time-lapse video recorder and infrared light. Most insects, including wētā, cannot see red light, so infrared light is completely undetectable.[110] If a male

110 Light is detected in an eye when it bleaches the pigment rhodopsin. This causes a depolarisation of the retinal cell membrane which is then transmitted as a nerve impulse to the brain. In humans (and other mammals) the bleached rhodopsin is regenerated metabolically – so if you look at a spot of bright light and then look away you see an afterimage patch (usually for a few moments) until the rhodopsin is regenerated and normal vision returns. Insects use the energy in red light to regenerate rhodopsin so they presumably don't see such afterimages. But this comes at a cost – they cannot see red. From our point of view, though, it means that you can use red light to watch insects at night without disturbing them.

mated, then it was an adult, but if a female mated, we kept it isolated afterwards to check if it laid eggs, just to be certain it was an adult. We wanted to be certain that it was not a large juvenile that had been – how can I put this – molested by the male.

Observing mating behaviour was time-consuming because it involved setting up each pairing and watching the video afterwards. But we had a problem: the wētā were becoming adults just when Liz, Hamish and I were at our busiest with teaching obligations. Mark Frazer, a student, rescued us by taking over this part of the investigation. Mark had previously helped as a volunteer on one of the field trips to Red Mercury Island (Chapter 21) and was already familiar with handling the insects. He worked in a small portable building that happened to be in the car park next to the building at Massey University, where we reared the insects. The outside door opened into a small room with windows, which Mark used as an office for viewing the videotapes, and he used the adjacent insulated windowless room equipped with air-conditioning as his laboratory.

Mark positioned the infrared time-lapse camera above a large arena of deep, moist Vermiculite™ enclosed by high Perspex walls. Whenever he tested a pair of wētā, he first corralled them in separate, smaller areas with food and water and left them overnight so the females could excavate new underground chambers. Males were provided with their usual upturned two-litre ice cream containers to hide in. The next day, he removed the barriers so the wētā could emerge in their own good time and started video recording when the lights automatically turned off. This happened at the same time as the lights turned off where the wētā were reared.

The next day, he viewed the video and left the wētā together for another night if he had not seen them mating (sometimes the male entered the female's chamber, so what happened there was anyone's guess). If mating was recorded, he returned them to their original separate containers in the rearing room.

Pairing large wētā together when we didn't know if they were large juveniles or adults caused us some anxiety because adult males often kill females when confined together.[111] We provided excess food and water and hoped for the best. As it turned out, though, no wētā died.

Mark's investigations allowed us to recognise that adult males had slight circumferential swellings or ridges along their tusks. Juvenile males have smooth tusks, and adult females can be recognised by how far the darkening (sclerotization) extends along their ovipositors: an adult ovipositor is darkened for more than half its length, whereas in juveniles it is darkened for less than half.

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111 Winks, Fowler and Ramsay (1998).

Back to the problem of distinguishing tusked wētā from ground wētā

When we started rearing tusked wētā, we quickly discovered that hatchlings lack tympanal organs – the major feature that differentiates them from ground wētā – as well as some of the spines on their middle legs, including the very spines that distinguish tusked wētā from ground wētā.

I've already explained how these changes affected how we differentiated between the two species and how we overcame them in Chapter 11. Here, I'll look at how these structures develop.

The inner and outer tympanic scars first appear during different moults in different individuals, although both are always present in fourth instars. Inner tympanal scars are present in some second instars and absent in others, but they are present in all third instars. In contrast, the outer tympanal scars first appear in some third instars and are present in all fourth instars. So, both tympana are present in all fourth instars.

The number of outer rear-facing spines on the middle leg that differentiate tusked wētā from ground wētā also varies between moults. In this case, all third instar tusked wētā possess both spines, whereas some second instars have either one or both.

An adult male tusked wētā with pieces of Vermiculite™ (from the rearing container) adhering to its body and middle leg. Photo: Kahori Nakagawa

PART 4
TRIALS AND TRIBULATIONS
The experimental releases

The releases onto Double Island and Red Mercury Island were experiments to find if simply liberating the insects in holes was successful. We also wanted to follow their progress after release by intensive monitoring, so we provided them with retreats in the hope they might return to them each time after foraging. We also tried monitoring them by searching at night and searching for their underground chambers during the daytime. All three methods worked to some extent, but all had shortcoming.

The first release on Double Island. Rob Chappell has just liberated a tusked wētā under a release-saucer and is tying flagging tape to a peg to make it easier to find again. The rock helps prevent dislodgement by seabirds and Vermiculite™ (from the container the insect was transported in) is scattered around the saucer. Photo: Ian Stringer

CHAPTER 17
DECISIONS

I began working with tusked wētā in August 1998 by attending an "Islands Seminar" organised by the Department of Conservation. The purpose was to develop conservation strategies for Cuvier Island and the Mercury Islands, except for Great Mercury Island, which is privately owned. I was there to find out what they wanted me to do with tusked wētā. It seemed simple enough when I applied for the contract – establish the insects on at least one additional Mercury Island – but it turned out to be more complicated.

I knew almost nothing about the Mercury Islands, so I asked lots of questions. Green Island (4 ha) and Middle Island (13 ha), I was told, have always been mammal-free, while kiore (Pacific rats) were exterminated from the other islands between 1987 and 1995. Rabbits (released as food for castaways) died out on Korapuki (18 ha) and Stanley (100 ha) Islands, once the ground cover grew too tall after the rats had gone. Cats (taken to Cuvier Island (194 ha) by the lighthouse keepers) were eradicated in 1964. So, all the islands had been mammal-free for three to 11 years before the Islands Seminar.

My mission, I was told, was to establish tusked wētā on Double Island first and then, if this was successful, to release them on other islands.

"Why Double Island?" I asked.

"Well," someone said, *"We're reserving Double Island for insects and other invertebrates, so we're not going to release any birds or reptiles there."*

Murmurings seemed to indicate previous agreement. Double Island, it turned out, was the smallest island that had once had rats, and they wanted tusked wētā released there because the habitat was similar to Middle Island.

Someone later mentioned that Red Mercury Island is the only island with running fresh water. The largest of its three streams (Te Roroi Stream) is also permanent and supports tuna (eels) and banded kokopu (an endemic galaxiid fish). Stanley Island has a temporary pond that usually contains water[112] whereas the other islands are either completely dry or have small fetid seepages near their shorelines. Mary McIntyre

112 Located at the base a rock structure called the Amphitheatre

(who did the first field research on tusked wētā) said she found most tusked wētā in an area of less than 0.2 ha where the soil was dampest, so I suggested releasing some on Red Mercury Island as well. The wētā could then choose the soil moisture level – from wet near the stream to dry up hill – that suited them.

"No, Ian," came an emphatic chorus, *"You can't release them there. You'll just be feeding the little spotted kiwis."*[113]

I explained that tusked wētā would once have coexisted with kiwi because the Mercury Islands were part of the mainland during the last ice age (they became islands about 6,500 years ago as ice from the last glaciation melted and caused the sea level to rise).

This convinced no one. Then I had the brainwave of using takahē as an example to try to persuade them. A few of these birds were discovered in the Murchison Mountains 50 years after they were deemed extinct. The habitat was suboptimal, but they survived because introduced mammalian predators, such as stoats, were relatively scarce. The birds, however, thrived when translocated into suitable predator-free habitats at lower elevations. My point was that tusked wētā were probably in a similar situation.

But the mood of the meeting was firmly fixed on releasing tusked wētā only on Double Island. They argued that these insects had survived on Middle Island, so it was safest to release them into a similar habitat. Their reasoning was understandable when dealing with critically endangered fauna, so I suggested we try alternatives if sufficient insects were reared in captivity. After all, if we didn't experiment, we were unlikely to find a better way to increase a species' recovery. I left after suggesting that we fence off a small area of moist ground on Red Mercury Island to exclude kiwi and release a few tusked wētā in it to see if they thrived.

Approval to release tusked wētā on Red Mercury Island

I was unaware that Rob Chappell had quietly agreed with me. So, I was surprised when he rang a few days later and told me 'they' had confirmed I could release a maximum of 50 tusked wētā on Double Island and release any additional ones on Red Mercury Island. He also thought it wise to release some into an exclosure[114] just in case kiwi ate all the unprotected ones.

113 Translocated to Red Mercury Island in 1983.
114 I use the term exclosure here (instead of enclosure) because it was to keep little spotted kiwi out.

I enthusiastically suggested constructing a long, narrow fenced exclosure extending from a dry ridge down to Te Roroi Stream. This would allow the insects to find their preferred moisture level, and we would know where to release them in future. Rob pointed out – taking great care to be polite – how impractical this was. Firstly, it would be much too expensive. Secondly, seabirds land by simply falling through the canopy and would become trapped in an exclosure because they cannot take off from flat ground – they need cliff tops or sloping tree trunks. I already knew this from visits to other islands, so why didn't I think of it? How embarrassing! My answer was to stretch netting over the top and fasten it around the trunks of trees growing within the exclosure. Rob pointed out that it would be almost impossible to find a suitably long area devoid of seabird burrows. He persuaded me that a smaller square exclosure would be better.

Rob and I went on to develop most of the procedures used during the entire project. I usually rang him to instigate these discussions with something I had just thought of. There would be a pause … Rob would either explain (politely) why it was impractical or mention some aspect I had not thought of. Some of my suggestions were laughable, but Rob was unfailingly courteous (there was not so much as the hint of a smile in his voice). I would then suggest a modification or an alternative. Again, the pause … and Rob would either explain what was still wrong or suggest a modification and we would make further changes. This often involved several telephone calls while we mulled things over. Eventually, Rob would say… again after the dreaded pause … *"Yes, I think that might work"* (and it usually did). We then presented the idea at the next Mercury Islands Tusked Weta Recovery Group for scrutiny and official approval.

The first Mercury Islands Tusked Weta Recovery Group meeting

The Department of Conservation, very wisely, did not give us free rein to do whatever we wanted with the Mercury Islands tusked wētā, given that it was Critically Endangered. So, the Mercury Islands Tusked Wētā Recovery Group was created (it soon became known as the MITW Recovery Group) to oversee us and give official approval to our intended actions. The recovery group also helped develop our strategies and provided constructive discussion. It comprised Department of Conservation staff including Rob Chappell, appropriate external experts, and me.

The inaugural meeting was held in July 1999, eight months after Rob had introduced me to Middle Island in September 1998 and after I had already had field trips there in November 1998, April 1999, and June 1999.

First on the agenda was deciding how big tusked wētā should be when we released them. Each insect was reared individually, so we wanted to do this when they were as young as possible to reduce the cost and time of captive-rearing them. They also had to be large enough to be ignored by many of the small predators they could encounter. The best size, we agreed, was half-grown – about 2 cm long. These should be safe from most invertebrate predators such as ground beetles (Family Carabidae) and ground-active spiders, but they would still be eaten by moreporks and reptiles. Fortunately, these large predators were relatively scarce on Double Island and Red Mercury Island, so they were unlikely to kill many wētā. [115]

Next, we decided to release 50 wētā on Red Mercury Island and liberate the others on Double Island, reversing what I had originally been told to do. This seemed sensible because we would lose fewer wētā if, as some people thought, kiwi did eat all the unprotected ones on Red Mercury Island.

Chris Winks, who was captive rearing the tusked wētā, then told us he had 418 eggs and was likely to raise about 300 juveniles. Rearing them all individually would be a huge effort, so we spread the work between three sites. This also reduced the risk of losing all of them if they were in one place and contracted some unknown disease or were accidentally killed, for example, by overheating if the air conditioning failed. As a result, I got 21 of the hatchlings, and Liz Grant and Hamish Mack helped me document their growth (described above in Part 3: Captive-rearing); Paul Barrett of Auckland Zoological Gardens received 60, which were eventually released on Double Island and Red Mercury Island; and Chris single-handedly reared all the others.

Incredibly, very few wētā died in captivity – a tribute to Chris's rearing method. Only one of mine died soon after we got it, and none of Paul's died. Chris intended to keep some wētā for further captive-rearing, but most were eventually released, as agreed, when they were about half-grown.

Chris's announcement that so many tusked wētā could be ready to translocate early the following year alarmed me: I had never visited Double Island or Red Mercury Island, so I had no idea where the best places were for letting them go. I also had to choose a site for the exclosure on Red Mercury Island and get it built. I needed Rob's help.

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115 At the time, tuatara occurred on Red Mercury Island, the large Duvaucel's gecko occurred on Double Island and there were smaller geckos and skinks on both islands. All were rarely encountered. Moreporks were also present on both islands, but these owls were widely dispersed.

Rob had an all-embracing knowledge of the Mercury Islands administered by the Department of Conservation, and he immediately said he knew of several suitable locations. I desperately wanted to see them as soon as possible, and I got there unexpectedly two months later, well before I could organise a visit specifically for this. It happened while I was waiting for the sea to calm down sufficiently to land on Middle Island at the start of the fifth field trip.

The fifth visit to Middle Island

Lisa Sinclair, Carl McGuinness (both entomologists in the Department of Conservation) and I arrived in Coromandel on Monday, 6th September 1999, to begin the fifth field trip to Middle Island, but rough seas prevented us from getting onto the island for four days. Early each morning, we rang Russell Clague of Matarangi Charters, who was to transport us, only to hear that a big north-easterly swell would be funnelling into the Landing Bay. On Wednesday, a two-metre south-easterly swell also developed so our chances of landing seemed even slimmer. Russell cancelled the trip on Thursday as well but Rob decided to see if we could land on Double Island and Red Mercury Island so he could show us his suggested release sites. He explained it was likely we could find places in the lee of these islands where we could get ashore safely.

We hurriedly packed everything into barrels just in case we could get ashore on Middle Island as well. There was too much gear for Rob to take together with the three of us, so Carl volunteered to stay in Coromandel and drive everything over to Russell's boat at the Whangapoua wharf if we found Middle Island was accessible.

Rob, Lisa, and I left Whitianga in the *Kuaka* just after midday and soon realised it was far too dangerous to land on either Middle Island or Double Island. However, we got ashore easily at Roly Poly Bay, on the lee coast of Red Mercury Island. Rob immediately led us over to Lunch Bay and showed us his suggested site for the exclosure. It was a large, clear area within continuous forest, surrounding a central tree. The ground sloped gently towards the Te Roroi Stream and nearby debris indicated it was just above the highest flood level. The adjacent hillside also looked suitable for liberating tusked wētā because the undergrowth was sparse enough to see them at night using spotlights. The location was also conveniently close to a small hut and associated campsite. Everything looked perfect to Lisa and me.

The waves had diminished considerably when we left Red Mercury Island, so we went to Middle Island and saw that we could now get ashore safely at the Landing

Bay. However, there was now insufficient time for Russell to bring Carl and the gear over and for us to get everything around the rocks and up to the hut before nightfall, so we decided to delay until the next day.

Friday dawned clear with a brisk, cool southerly, and Russell got us to the Landing Bay at 9:15 am. The tide was fully in, so we were spared from clambering over slippery rocks, but the waves were still quite big and we had to time our arrivals to avoid the largest of them.

That night, we did a single search from 8:40 pm to 11:15 pm and then went to bed. The temperature had dropped to just above 10°C, so I thought it unlikely that tusked wētā would be active. We had seen no ground wētā and very few other invertebrates except for 196 *Mimopeus* beetles (black darkling beetles) out grazing a thin layer of moss or lichen on tree trunks. We were also tired after getting up early each day and packing up, ready to leave by 6 am in case Russell could take us to the island.

The next day, Carl painted the roof and outside walls of the hut with wood preservative using an aluminium ladder we had brought with us. This ladder was *the* most annoyingly difficult thing we ever carried around the rocks. Lisa and I, meanwhile, checked the oviposition trays for eggs and the concrete tiles for tusked wētā, but found no eggs or wētā.

As we were returning to the hut, we found an emaciated tuatara on the Central Plateau near the western track. It took a few slow steps away before collapsing on the ground. It was covered in soil, so we supposed it had been trapped in a bird burrow for a long time after the roof had caved in. The tuatara was still in the same place, with its eyes closed, when we searched that night, but woke up when we shone torches at it and very slowly walked a few metres away.

Russell warned us on Saturday night that the wind was forecast to increase to 40 knots and turn northeast by Monday and if we stayed, he probably wouldn't be able to get us off the island for some days. We agreed to leave the following morning: we didn't want to risk being marooned when we were due back at work the following week.

This was the shortest of all my field trips, and the five-day delay before we got to Middle Island was the longest I experienced. All three of us were disappointed that we didn't find tusked wētā. We only saw three ground wētā and few other insects, except for 410 *Mimopeus* on tree trunks. But Lisa and Carl were consoled somewhat by having seen from 11 to 14 tuatara during each search, and two of the large Duvaucel's geckos. This was the first time they had seen these reptiles in the wild. It might surprise you that few Department of Conservation staff have seen these reptiles in the wild because most don't have the opportunity to visit offshore island sanctuaries.

PITFALL TRAPPING

We used pitfall traps during this fifth field trip to see if we could trap tusked wētā attracted to food. Previously (Chapter 6), we put different foods onto ceramic squares protected by metal mesh cages (to stop tuatara and large lizards from eating everything) and checked them whenever we walked past at night. We never saw any tusked wētā near them, but they could have come and gone during the long periods between our visits, hence the use of pitfall traps which would catch any attracted to food.

The Recovery Group restricted us to three pitfall traps, which we set on the Northern Plateau on Saturday and Sunday nights. Each trap was a 2-litre paint tin set into the ground with the openings at soil level. A heavy sheet of galvanised iron perched 3–4 cm on three or four rocks above each trap, kept the rain out.

We baited the traps when we started searching each night and checked them each time we went past, but no tusked wētā were caught. It was important to check them whenever we passed by so we could remove any predators, such as lizards or giant centipedes that might also be trapped, but none were. We closed the traps by replacing the lids the last time we passed them each night.

One trap was baited with peanut butter, one with tinned cat food ('Chef Jellymeat'), and one with tinned pears, but all we caught on Saturday night was one spider and lots of sand hoppers (Amphipoda) and slaters (Isopoda). On Sunday night, we "caught" a diving petrel that had squeezed under the galvanised sheet of the trap baited with Jellymeat (which it ignored) and was perched over the opening. This was at the end of the night, so we lifted the bird off gently and put it down close by. We were leaving the island the next day, so we removed the baits, pressed the lids firmly back onto the tins, and upended the tins in the holes to ensure nothing could get trapped and die in them.

We opened the pitfall traps again during the next (sixth) field trip on the nights of the 5th and 6th of October. This time, we baited them with peanut butter, Jellymeat, and honey but we only caught one spider, a sand hopper, and a single slater. I decided to stop using pitfall traps from then on because we were often absent for an hour or more between checks, and I worried that a tusked wētā could easily be killed while we were absent if a predator became trapped with it. So, at the end of the last night, we removed the tins, their lids, and the galvanised sheets and refilled the holes with soil.

WHY WATER VAPOUR PRESSURE DEFICIT IS IMPORTANT

As animals get smaller, their surface area becomes larger relative to their volume. Compare, for example, the surface areas and volumes of cubes with sides of 1 metre, 1 centimetre and 1 millimetre, as shown in the following table.

Side length (cm)	Volume (cm^3)	Surface area (cm^2)	Area/Volume ratio
100	1,000,000	60,000	0.06
1	1	6	6
0.1	0.001	0.06	60

And, of course, the body shape, legs, antennae and spines etc., all add extra surface area. So, water loss through the body surface is much more of a problem for insects than it is for us and even less so for elephants.

Insects secrete a thin layer of wax onto the outside of their cuticle to slow down water loss. This waterproofing is not perfect, so insects do lose some water through their surface cuticle. However, they cannot afford to lose much because their body volume is relatively small, so they minimise this loss by being active when the air is less drying. They also minimise water loss associated with excretion and respiration.

Insects excrete nitrogenous waste (produced during protein katabolism) as uric acid. Uric acid is almost insoluble, so it can be excreted as a white paste or as a dry powder whereas urea (which mammals excrete) is soluble and has to be flushed out in water. Insects lose most water during respiration, but they cannot reduce this loss much because oxygen and carbon dioxide gases have to be exchanged. Their only option is to modify their respiratory system to lessen the loss. The details are intriguing and complicated, but (fortunately, I am sure you agree) it would take too long to go into the details here.

The paucity of wildlife was probably due to the cool nights (10.3°C–14.1°C) rather than the dry conditions because the water vapour pressure deficit (a measure of how drying the air is as explained in Chapter 6) varied from 2.84 mb to 4.15 mb and this was within the range when tusked wētā had been found previously (0.5–4.8 mb).[116]

Russell was due at 9 am, so we got up early, packed up, and carried everything to the Landing Bay. A stiff north-to-north easterly wind was blowing towards us, and we watched with consternation as the waves got bigger. Heavy seas slowed Russell down, so he arrived 15 minutes late. By then the waves had become too big to back the dinghy in stern first without being swamped. This was the same situation we had experienced when we left the island at the end of the second field trip (Chapter 8), so we used the same method to get back and forth from the shore.

Russell didn't have a deckhand, so I swam out to get the dinghy.[117] I then waited for a lull just behind where the waves were breaking and then frantically rowed straight in. Carl, waiting chest deep in the sea, caught the bow, spun the dinghy around, and held the bow into the waves. When Lisa and I had loaded it, Carl moved to the stern, I jumped in and readied the oars, and we waited for a lull. Carl and Lisa then gave a mighty shove, and I rowed quickly out to safety.

Surprisingly, I didn't get capsized during the three trips it took to get everything out to Russell's boat. This was most likely to happen when I was coming into shore and especially when surfing down waves about to break. It happens when the bow (where the hull forms a deep V) digs in while the flatter hull behind tends to swing around quickly, bringing the dinghy sideways onto the wave which then flips it over. I also got everything safely transferred to Russell, even though the two boats moved about erratically in different directions. The aluminium ladder, of course, caused the most concern because it was unwieldy and we would lose it if the dinghy capsized or if it were pulled from our grasp during the transfer.

Lisa perched on barrels in the stern during the last trip, and Carl pushed us off during a lull. He then held onto the transom, so we pulled him along, trailing behind. When all was aboard, Russell took us to a sheltered bay on Great Mercury Island where we changed into dry clothes and ended the trip with hot coffee and muffins, freshly baked by his wife.

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116 The relative humidity at night varied from 71% to 80% which was not unusually low compared with other trips (it had been lower than this for two thirds of the time previously). Insects, however, usually respond to water vapour pressure deficit (WVPD) rather than relative humidity as explained in Chapter 6. Mary McIntyre (1991) reported that 70% of adults were found at a WVPD of less than 3.3 mb and all were found when the WVPD was less than 4.4 mb.

117 All three of us had brought short-leg surfing wetsuits and used these in lieu of life jackets.

Leigh Marshall and Ian Stringer scrape searching a plot on Red Mercury Island. Photo: Matthew Low.

CHAPTER 18

PROTECTION FROM KIWI

Four months after Rob Chappell showed Lisa Sinclair and me a suitable site for an exclosure on Red Mercury Island, I was back on the Island to build one. The exclosure was designed to exclude kiwi so we could confirm if tusked wētā can survive at the location if the worst happened and little spotted kiwi ate all the insects we released outside the exclosure.

Jens Jorgenson and Maree Hunt accompanied me: Jens (pronounced 'Yens'), an engineer, worked in a workshop at Massey University and was there to build the exclosure. Maree was an experienced field worker who had previously helped me on other research field trips.

Jens relished a challenge and wholeheartedly agreed to help as soon as I asked him. We met a few weeks before the trip and designed the exclosure. It was to be a 5 m x 5 m cage with sides of fine nylon windbreak netting and a tent-shaped roof of chicken wire to prevent seabirds from falling in. We added a continuous wide band of aluminium flashing along the top of the sides to stop (we hoped) lizards and predatory insects from climbing in, and an overhanging aluminium ledge on the inside to keep tusked wētā in. We drew up a plan and submitted it to Rob Chappell, who added flaps to the bottom of the windbreak to discourage anything from burrowing under the sides. These were to extend 20 cm inside and outside the exclosure and be buried.[118]

118 The only predator we found in the exclosure, while it was in use, was a small skink (*Oligosoma moco*) which we evicted in September 2001 because it could have eaten small juvenile wētā. Perhaps we missed it when we did exhaustive check for predators immediately after completing the exclosure. We must also have failed to catch it when we set a pitfall trap in the enclosure the night before we released tusked wētā (Chapter 19). We don't know how it got into the exclosure but it couldn't have hatched from an egg buried in the ground because this species gives birth to live young as do most New Zealand skinks.

Building the enclosure

Russell's boat resembled what you might imagine a floating builder's truck might look like when we left Whangapoua wharf on the morning of Sunday, February 6, 2000. The deck was stacked with a jumble of lengths of wood, bundles of waratahs and windbreak, rolls of chicken netting, and hoops of wire, together with our usual collection of barrels and chilly bins. Two foam mattresses, destined for the hut, and an upturned dinghy were perched precariously on top and secured with rope stretched back and forth like a cat's cradle. Fortunately, the sea was calm and there were almost no waves at Lunch Bay when we arrived three-quarters of an hour later.

We took great care to avoid scratching or damaging Russell's dinghy or boat while we unloaded. Everything was safely ashore at 11:30, and Russell provided us with hot drinks before he departed. Back on shore, we ate sandwiches we had purchased in Whitianga and then pitched our tents: no one wanted to sleep in the hut, even though there were new mattresses for the bunk, because the hut was just too small, dark, and dank – Maree declared it 'manky', which seemed apt.

As soon as our camp was set up, Jens changed into a black bush shirt, shorts, and working boots and started on the exclosure. First, we dragged his two heavy barrels of tools to the exclosure site and made sure there were no bird burrows where the cage was to be built by jumping up and down over the area. Maree and I then scuttled back and forth to the coast some 100 metres away, bringing whatever Jens wanted as he needed it. Occasionally, Jens got one of us to hold something firm while he sawed or cut it.

Sounds of hammering, sawing, and the thumps of digging through roots soon replaced the peacefulness of the bush, which had been dozing under the hot afternoon sun. The building noises were occasionally punctuated with loud explosions of incomprehensible guttural Danish delivered with passion and vehemence. Maree and I looked forward to these outbursts because they transcended any cursing we had ever heard.

Jens stopped work at 5:45 pm, and we all went for a swim to wash ourselves. The tide was low and a wide stretch of boulders covered with slippery seaweed was exposed, so we realised how fortunate we were to have arrived at high tide. We dried off under the afternoon sun and then Jens and I continued working on the exclosure until 8 pm while Maree cooked a delicious casserole of chicken, apricots, and sour cream.

After dinner, we waited until it was dark and then spent an hour and a half searching the Roly Poly Bay track for wētā but were unsuccessful. I wanted to ensure that none had survived on the island by some remote chance. Numerous people, including entomologists, had camped on the island after the rats were exterminated in 1992, but no one had reported seeing tusked wētā. Even so, it was still possible that they could have seen juveniles or adult females and had not recognised what they were because they lacked tusks. This, after all, is what I imagined happened on Middle Island before Tony Whitaker found the first adult male in 1970.

The next day, I was woken up before dawn by the **kak-kak-kak-kak-kak** calls of grey-faced petrels circling above the island before flying off to sea. Their calls became less and less frequent as it got lighter until they eventually stopped. This was followed by 20 minutes or so of quiet, followed by a dawn chorus of melodious bellbird song. I stayed in my sleeping bag, warm, comfortable, and relaxed until I heard Jens get up around 7 am. This was my cue to reluctantly emerge and prepare coffee and cook breakfast on the gas stove while clanging and clattering pots and pans loudly to annoy Maree out of her tent.

The exclosure on Red Mercury Island. Ian Stringer is releasing tusked wētā in the cage. The stile is hidden behind the exclosure, and the two containers in the foreground were used to transport the insects. Note the aluminium flashing designed to exclude reptiles and flightless invertebrate predators. Photo: Rob Chappell

After breakfast on Monday and Tuesday, Maree and I worked relentlessly as unskilled labourers for Jens and supplied him with hot drinks or food on request. We stopped work at 6:30 pm and relaxed with wine, cheese, and nibbles on the seashore until it was dark, and then we searched the entire Roly Poly Bay track again with spotlights but saw very few insects and no ground wētā. We finished with a late dinner and retired to bed at about 10 pm.

On Tuesday, Jens worked until he had completed the exclosure at 7:30 pm. He then got us to bury the skirts of windbreak netting that were attached along the sides of the exclosure. We couldn't dig them in because the ground was covered with a meshwork of interlocking tree roots so we covered them with mud that we carried up from the creek, and sand and gravel from the shore – small quantities were present at the Te Roroi Stream outlet – plus any bits of soil we managed to scrape up from here and there. It took us until almost dark to complete this.

While we were so occupied, Jens built a stile to provide access into the exclosure. It consisted of one set of steps inside the exclosure and the other outside. Both were separated from the exclosure by gaps that we could easily step over, but – we hoped – lizards or insects could not. Access to the exclosure was gained by unclipping the wire netting (that kept seabirds out) next to the stile and folding it back.

We had expected Jens to take seven days to build the exclosure and, as he completed it in three, I decided to spend the last two nights searching for tusked wētā on Middle Island. This seemed the most useful thing to do with the extra time. Jens and Maree were also very keen to visit the island, so it served as a reward for their hard work.

Our last night on Red Mercury Island was spent carefully inspecting the ground in the exclosure for any lizards that might have been trapped inside while it was being constructed, but we found none. Then we did a last search along the track beside the Te Roroi Stream but again saw no tusked wētā. All the night searches had been disappointing because we only saw at most one or two ground wētā and one or two ground beetles. Few other insects were out except for small groups of bristle-tails grazing on some of the moss-covered rocks.[119]

119 Bristle-tails are small primitive wingless insects (see text box 'An abundance' in Chapter 12).

A brief visit to Middle Island

The next morning, we packed what we needed for Middle Island into barrels and marked them, then put everything else in unmarked barrels to leave with Russell after he had transferred us. We also wanted a small amount of unused building material and off-cuts, and one mouldy mattress from the hut taken back to Whitianga.

Russell arrived at 3:30 pm, and we had difficulty loading the boat because the tide was partway out and we had to take extra care negotiating the slippery boulders. Once aboard, Russell produced coffee and the traditional muffins and took us for a tour around Red Mercury Island before heading to Middle Island.

We landed opposite the hut in a flat calm but had difficulty rowing in because strong gusts came around the northern edge of the island and kept pushing the dinghy sideways. We eventually got everything up to the hut and our tents pitched by 7 pm, so we migrated to The Razorback with wine and cheese. It wasn't pleasant being buffeted by the northwester though, so we didn't stay long.

That night, the three of us did a single search from 10:50 pm to 1:30 am. A good number of invertebrates were out, but we only found three ground wētā, which we took back to the hut and kept them until we measured them the next day. I was pleased that Rob had replaced the climbing ropes along The Razorback and The Cliff with sturdy chains. These provided more security and, we felt, would give us more confidence when these paths were slippery with rain.

On Thursday night (after another wine and cheese on The Razorback), all three of us did two full searches starting at 21:50 and finishing at 2:25 am. We released the three ground wētā collected the previous night and found a further 20, five of which we caught and brought back to the hut. This time, Maree and I measured them later that night and released them where we found them. We finished at 4 am and only got three hours of sleep before Jens woke us up again to begin packing up to leave.

Junk

The exclosure was still intact when I visited Red Mercury for the last time, 18 years later in October 2018 – a real testament to Jen's workmanship. The only deterioration was a steel waratah at the corner closest to the sea that had completely rusted away, so the wooden post to which it had originally been fastened now supported the corner. Jens had driven a waratah into the ground at each corner for extra security because the meshwork of tree roots prevented him from digging the posts in as deeply as he would have preferred. Birds and invertebrates can now move in and out of the exclosure because a seabird finally dug a burrow under the exclosure in March 2003, and the roof of the burrow subsequently caved in. This coincided with our decision to stop using the exclosure – we knew by then that tusked wētā and kiwi coexisted, so we were saved the trouble of opening the exclosure. Rob and I used to remind each other periodically that we really should remove the exclosure, but ... well ....

Five of the Mercury Islands. From left: Green Island, Middle Island, unnamed rocks, Korapuki Island, Stanley Island, part of Red Mercury Island. Double Island is hidden behind Stanley Island, and Great Mercury Island is out of view to the left. Photo: Ian Stringer

CHAPTER 19

WAY TO GO

"How do you want to release the wētā, Ian? Tipping them out onto the ground at night seems a bit risky."

"Well, Rob, I suppose the easiest way would be to make holes in the ground with a stick and let them go in those. We could do that during the daytime, too."

"Better make the holes deeper than a little spot's beak, then."[120]

"I've also been wondering if it's worth letting them go in some sort of artificial refuge in case we can monitor them afterwards. But they need to return to their refuges for this to work."

"Yeah, I was wondering about that too, but do you think they might return or just walk away?"

"I'm not sure. The ones in our lab certainly reuse the same chambers again and again, but they are confined in small containers. Mary told me she thought some had homed, but she also said that all those she attached transmitters to dug new chambers each night."[121]

"Well, I reckon it's worth giving it a go."

We eventually settled on using round plastic plant-pot saucers, 27 cm in diameter[122] and referred to them as release-saucers. We released each wētā by first digging a bowl-shaped depression in the ground large enough to accommodate the insect. We also added an exit trench that extended past the rim of the saucer so the wētā was not trapped. The wētā was then released in the depression and immediately covered with the plant-pot saucer, which was pegged into the ground through holes near the saucer's rim. The pegs were lengths of number 8 galvanised fencing wire with hoops at the top, and the holes also served to drain rainwater. Lastly, rocks were piled onto the saucer to make doubly sure kiwi couldn't kick the saucer off.

120 Little spotted kiwi beaks are less than 8.5 cm long.
121 Mary McIntyre did the first research with tusked wētā on Middle Island.
122 The central part was beyond the reach of little spotted kiwi beaks.

ESTABLISHING TREE WĒTĀ ON KORAPUKI ISLAND

Ours were not the first translocations of wētā in the Mercury Islands. Chris Green[1] translocated tree wētā to Korapuki Island in 1997, well before I began working with tusked wētā. He attached 100 "wooden boxes" to tree trunks on East Double Island[2] and then, when tree wētā occupied 39 of them, he moved the boxes (together with 52 wētā within them) to Korapuki Island and attached them to trees. Chris subsequently used the same boxes to monitor how the tree wētā survived and multiplied and was quickly able to confirm that the translocation was successful.

1 Chris Green was a member of the Mercury Islands Tusked Weta Recovery Group. The translocation is described in Green (2005).

2 Tree wētā only occurred on East Double Island and Great Mercury Island in the Mercury Islands Group.

Rob then came up with the brilliant idea of inserting transparent discs of Perspex beneath the saucers. These would let us watch the wētā as we covered them and ensure we didn't squash any. They were precious insects[123] because of the time involved in rearing them individually. Rob also thought the discs would enable us to check the wētā later without disturbing them. All we had to do was lift the saucers off and look through the Perspex. This, however, didn't work – fine water droplets always condensed on the underside of the Perspex and obscured our view, so we had to lift both the saucers and the discs and then wipe the condensation off before replacing them. The transparent discs were, nevertheless, worthwhile because we never injured any wētā when we released them.

Freedom!

Just over two and a half months after Jens built the exclosure, Maree Hunt and I were back on Red Mercury Island preparing release saucers for liberating the first captive-reared wētā reared by Chris Winks and Paul Barrett (who worked at Auckland Zoological Gardens).[124] The insects were around half-grown, the ideal size for liberating them (Chapter 17).

The sea was flat calm when we arrived at Lunch Bay, but the tide was out, so we had to get everything ashore over the wide expanse of slippery boulders. This

123 The cost of rearing the 334 wētā release in 2007–2008 was about $41.92 per wētā.

124 Chapter 4 and Winks (2002).

time, in addition to barrels and chilly bins containing our usual camping gear, we had bundles of plant-pot saucers and Perspex discs, two infrared video cameras and a time-lapse video recorder packed inside strong waterproof cases, and a fully charged car battery to provide power. The battery proved the most difficult thing to get ashore because it was heavy and awkward to carry, and it would discharge if it got wet with seawater. I ended up wading between the boulders with it while Maree went ahead searching for a suitable passage.

It took four hours to unload the boat, set up camp, and pitch our tents. We then had a late lunch and began work in the exclosure. First, we dug in a pitfall trap and baited it with a concoction of honey, peanut butter, and raw chicken meat – all food that lizards love. This was to make doubly sure no skinks or geckos had been accidentally trapped inside while the exclosure was being built. Next, we installed six release-saucers and two oviposition trays and made two deep holes for releasing wētā by pushing a sharpened stick into the ground. Lastly, we hung one infrared video camera above two release-saucers and the other above a third release-saucer and an adjacent hole. We planned to film the areas at night to see when the wētā emerged and – most importantly – if they returned to the saucers and holes.

After a coffee break, we began installing release-saucers on the hillside above the exclosure but had had enough after setting up three of them. It was 5 pm, so we collected the wine and some nibbles and retired to Lunch Bay and relaxed.

As dusk came, petrels started appearing – mostly flying close to the surface – far out to sea. It looked like there were dozens of them. They gradually came closer as it got darker until we could see there were only 20 or so. Once they reached the island. they soared above us in wide circles, making their kak-kak-kak calls. It looked so chaotic that we thought some must surely collide, but they never did. We eventually returned to camp when it became too dark to see much and cooked dinner.

Later that night, we searched the Roly Poly Bay track using spotlights. A few grey-faced petrels fell through the canopy around us, but the highlight was coming across a little spotted kiwi. It was a couple of metres off the track, but it ignored us and our lights, so we watched it for quite some time as it snuffled and probed about with its bill. Other than that, there were disappointingly few insects and only a single small wētā, which we took back to camp and identified as a ground wētā.

The next morning – inexplicably – our gas stove didn't work. So much for bacon and eggs! I rang Rob, who was due to arrive later that morning with three pairs of tusked wētā destined for the exclosure, and asked him to please bring us a replacement.

"No", I assured him, *"we still have lots of gas – it's definitely the stove that's not working."*

So, we ate cornflakes for breakfast and brewed coffee on a small tramping stove we had brought with us as a backup. Then it was back to the hillside to prepare as many release-saucers as we could before Rob arrived. He was bringing the first tusked wētā to be released in what we hoped would be a successful series of translocations onto rat-free islands, so the occasion was to be marked with a small ceremony.

Rob arrived soon after we had set up the sixth release-saucer, and we helped him unload two plastic bins, each with three tusked wētā in individual transfer containers.[125] Just as we got them onto the beach, the Mercury Safari boat arrived with Te Iwi Nichols (representing the local Ngāti Tamaterā iwi), Victoria (a reporter from the Hauraki Chronicle), and Des Williams (public relations officer from the Hamilton office of the Department of Conservation). As soon as they were ashore, we picked up the plastic bins and led them to the exclosure. Rob and I then explained how we were going to release the wētā and why we were putting all three pairs in the exclosure instead of letting them go on the hillside. Te Iwi then welcomed the wētā back to the island with a pōwhiri, followed by a karakia and a waiata,[126] and we began the release, thereby returning the species to the island.

Antennae immediately appeared, followed by scrabbling front legs as soon as Rob carefully lifted the edge of the first container. The wētā within was frantic to get out, and we realised the other five would react the same way. After all, they had been jiggled and bumped about for hours during the journey. We certainly didn't want them springing out of their containers and jumping unpredictably here and there while people leaped about trying to avoid them. Our carefully planned release didn't include having them disappear unceremoniously into the undergrowth or, even worse, being stood on.

What to do? The plastic bins were not deep enough because these insects are champion jumpers. I eventually remembered the two new mattresses we had brought for the hut on the last trip. Fortunately, they were still in their clear plastic protective bags, so we acquired one and Rob tipped the contents of each container into it, one at a time as needed, then captured each wētā in a clear plastic vial, and passed it to me inside the exclosure. I let four go under release-saucers and one in each hole.

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125 These were 700 ml round plastic food containers – the sort you get take away soup in – with small holes drilled through their lids for ventilation. Each was partly filled with damp Vermiculite™, which is light and doesn't damage wētā if the container gets accidentally tumbled about.

126 The Mercury Islands are within the Ngāti Hei rohe (Ngāti Hei, The Wharekaho Settlement trust, The Crown; 2017).

Releasing wētā into holes was straightforward: they just walked towards the dark entrance when I held the vial at an angle near it. Releasing them under release-saucers, however, was fraught with difficulty: The wētā had to be tipped out by upending the vials, but the insect's reaction was to climb upwards, so I had to dislodge them by tapping the vial. The result was that as soon as they landed in the depressions (where they were to be covered with release-saucers), they immediately began jumping. It took some persuasion and a lot of patience, but I eventually got them all installed without squashing any, thanks to Rob's transparent Perspex discs. This, of course, became a spectator sport for the five people leaning on the exclosure peering in. Lots of warnings and encouragements were shouted with occasional advice that usually began with, *"Why don't you ...?"* I ignored it all. I was fully occupied.

A half-grown tusked wētā in the plastic food container used to transport it. The container is partly filled with damp Vermiculite™, which is lightweight and does not injure the insect. Photo: Ian Stringer

All six wētā were safely released by 2 pm, and Te Iwi, Victoria, and Des departed for Whitianga and a late lunch. We helped Rob unload another fully charged car battery (to provide more power for the infrared video equipment), 20 litres of fresh water, and a replacement gas stove, before he also returned to Whitianga with the malfunctioning stove.

Maree and I set up a further 12 release-saucers on the hillside before we retired to Lunch Bay with wine and cheese to watch the spectacle of petrels coming in to land. Then, just as it was getting dark in the bush, we returned to the exclosure and turned on the cameras and infrared video recorder. Dinner was next, followed by a retreat into our tents.

I got up at dawn the next morning and turned off the video recorder to save power. Then, after breakfast, we installed the last six release-saucers and numbered them all consecutively from 1 to 24. We finished by pushing a tall yellow fibreglass pole into the ground next to each saucer and tied pink flagging tape to the top of each pole so we could find them again if they became obscured by undergrowth.

Rob arrived at 11 am with 36 tusked wētā (in individual transport containers) and Barry Brickell, a well-known ceramic artist from Coromandel, who had volunteered to help. The waves had increased overnight, so they landed where it was calmest at the western end of Lunch Bay. This meant we had to carry everything over the boulders to the eastern end of the beach where the campsite was. I followed Barry as we rock-hopped back to get a second load and watched as he frantically wind-milled his arms and fell over in a tangle of thin arms and legs. He got up uninjured only to fall over again a short distance later. This happened a few more times. He must have been hurt by the falls – it was excruciating to watch – but it didn't seem to curb his enthusiasm to continue helping. Rob had also noticed and solved the problem by persuading him to lug things up the track to the campsite while we brought everything over the boulders to him.

We liberated 24 wētā under release-saucers and let the others go in prepared holes. This took until lunchtime, and then Rob and Barry returned to Whitianga. Maree and I remained on the island for a further three days to run the IR video (the batteries lasted for three nights) and record the numbers of wētā under the release-saucers on the hill each day.

I had brought a powerful infrared light, a night scope, and a hand-held infrared video camera with me on this trip to see if we could monitor tusked wētā by simply scanning a large area from a suitable vantage point. So, after dinner, we settled on a large flat rock overlooking the release-saucers on the hillside and took turns swapping between the night scope and the infrared video camera. All we saw was a pair of flesh-footed shearwaters squabbling. We eventually concluded that a night scope or an infrared video camera was not suitable for monitoring wētā: everything was in monochrome, so it looked very much as if wētā, at a distance, would blend in with the soil and leaf litter. Nearby vegetation was distracting too because it showed up brightly. We tried turning off the infrared light and using the night scope by itself, but that proved unsuitable because insufficient starlight filtered through the trees – all we saw were dancing pixels. We did, however, decide that the infrared video camera was suitable for observing individual tusked wētā on open ground within a few metres of us, and it would be useful for checking the exclosure at night without disturbing the wētā.[127] This all reminded me how much I envy people who work with scorpions because scorpions glow white at night when illuminated by ultraviolet light, whereas wētā do not!

127 Insects cannot see red or infrared light but can see into the near ultraviolet.

INTRIGUING BEHAVIOUR

When I examined the infrared time-lapse video recordings we took in the exclosure I got information about the behaviour of two wētā that emerged. One that was released in the hole emerged during the first night and walked downwind and out of the field of view and returned upwind to its hole 240 minutes later, following a slightly different path from its outward journey. The next night, it left and returned to its hole eight times for between 48 seconds and 28 minutes, and each time it went downwind and returned upwind following slightly different routes. So, it didn't appear to follow a scent trail (as ants do), but it could have homed in on an odour from its cavity (there would have been a slight breeze in the exclosure, surrounded as it was with windbreak netting) or possibly by using dim visual cues illuminated by what starlight filtered through the trees.

The second wētā emerged from its release saucer the first night after the other had returned to its hole. It went downwind (north) out of the field of view, then reappeared 45 minutes later from the south and went straight back to its saucer and disappeared under it. It could not have used an odour from its underground chamber because it went downwind, but it could have used visual cues.

Tusked wētā are nocturnal, so they might see well enough on dark moonless nights to use visual cues as honeybees and some predatory spider wasps do during the day. What intrigued me, though, was the possibility that tusked wētā might have the ability to navigate using path integration. Here, the insect 'knows' where it is relative to a starting point by compensating for the distance it moves and the angles it turns through.

You are probably thinking 'How ridiculous; surely insects cannot do that." Don't scoff – many insects do have this facility including honeybees and even the humble German cockroach.[1] What made me think of path integration was a report that an Australian raspy cricket (Family Gryllacrididae which is related to the Anostostomatidae, the Family which includes tusked wētā) can remember how far it has gone to a food source and the direction it has to turn to get back to its nest. It can even distinguish its nest from nests made by others of the same species.[2]

Path integration in insects appears to provide an approximate direction and distance for returning home: it's not precise, so other cues become important for locating the exact position of the refuge when the insect gets close. Think what a great opportunity for experimental research this would be – finding out what mechanisms tusked wētā use to home. And wouldn't it be just so pleasing to a researcher if they found they do use path integration? I would have jumped at the opportunity if I were still at Massey University.

1 Rivauly & Durier (2004). .

2 Hale & Bailey (2004).

A TRULY MAGNANIMOUS GIFT

Ahuahu or Great Mercury Island was purchased by the Crown between 1858 and 1861 and is now in private ownership. This is a short history of the ownership of the other islands in the Mercury Group – Red Mercury Island (Whakau), Kawhitu or Stanley Island, Double Island (Moturehu), Korapuki Island, Atiu or Middle Island, and Green Island, together with what the Secretary for Internal Affairs described in 1913 as "associated stacks".

Records of government purchases were destroyed in a disastrous fire in 1872, leaving no direct evidence of possible Crown ownership. Then, near the start of the 20th century, the government began taking an interest in the Mercury Islands when the traditional Māori owners sought title through the Native Land Court. The Chief Surveyor considered it doubtful if these islands could be considered 'customary' land in 1912 because they were not occupied or cultivated when the Treaty of Waitangi was signed. Another opinion held that small islands which were not occupied by Māori passed together with the sale of the mainland, whether specifically mentioned in the deed or not. L.D. Steedman, who investigated the situation, wrote that old residents told him that only Māori had occupied the islands, and that the last inhabitant was an old woman, Catherine, who had lived on Red Mercury Island in the 1850s. He added that the Māori claimants "informed me they did not intend to reside or cultivate the island [Red Mercury] but intended to sell to the highest bidder" and that there was "no animal life ... but numerous Paroquets and a few Australian Quail." Another suggestion in March 1913 was that these islands should be treated as wasteland – no rates or taxes had been recently paid – and they should be vested with the Crown. A proclamation to this effect was prepared (April 1913) but not signed, so no action was taken, and the islands were eventually awarded to the Māori claimants as customary land.

Stanley Island and Double Island were purchased by the Crown in 1858 (Gazette 1862, page 13/14: Stanley was misnamed and misspelt as Aitu). In June 1963, the Secretary for Internal Affairs (F.L. Newcombe) considered that these two islands should be given some form of reservation. Meanwhile, the Royal Forest and Bird Protection

Society and at least one other person (Mr Dragovich) investigated purchasing Red Mercury Island, but it was not sold.

The Royal Forest and Bird Protection Society was concerned for the safety of the forest and bird life on the Mercury Islands because it had become easier for the public to access them, so they urged the Crown to purchase them. The government was "well-received" when it approached some of the Māori owners in May 1967 to explore purchasing the islands in order to make them a reserve. But what was a fair price? A geological survey in March 1968 concluded they were of negligible economic value, and the government eventually settled on unimproved values of ₤200 for Red Mercury, ₤20 for Korapuki Island, ₤20 for Middle Island, and ₤10 for Green Island.

The owners within the Ngāti Tamaterā tribe and their representatives met in October 1968 but considered these prices to be "inadequate". They then unanimously offered them as a gift to the Crown with the condition that they were protected and used for conservation purposes. The application for this gift was "dispatched" in December 1968. The islands became Crown land in March 1970 with the conditions that they are maintained as scenic reserves and wildlife sanctuaries and that, should they be considered for any inconsistent purpose, then they are to be vested in the owners or their descendants (Māori Purposes Act 1969, Part II, Section 14).

This was a truly magnanimous gesture by the owners, especially after being offered a derisory price for them! The ₤20 offered for Middle Island in 1968 (decimal currency was adopted in July 1967) would have the equivalent purchasing value today of about $490.

Imagine if you owned a small island – especially Middle Island with its unique faunal assemblage – and the government offered you a contemptibly low price for it, would you then donate it to the people of New Zealand?

NOTE: The Mercury Islands are within the Ngāti Hei rohe (territory) but are not owned by Ngāti Hei. (Deed of Settlement of Historic Claims; Ngāti Hei and Wharekaho Settlement Trust and The Crown, 17 August 2017).

A Middle Island ground wētā (body length about 1.7 mm).
Photo: Rob Chappell

CHAPTER 20

AN ISLAND TO EXPLORE

Map of the tracks on Red Mercury Island showing the release sites and campsite. Fifty tusked wētā were released at Site 1 during 2000 (Chapters 19 and 20), and 15 tusked wētā (that hatched late) were released at Site 2 in September 2001 (Chapter 22)

Maree Hunt and I stayed another three days on Red Mercury Island after we helped Rob Chappell release 36 tusked wētā on the hill above the exclosure (Chapter 19). We wanted to find out how long the wētā occupied the release-saucers after we let them go. We planned to leave those on the hillside undisturbed until Thursday, two days after the translocation, but we were going to check those in the exclosure each day.

Into the unknown

Wednesday dawned warm and sunny, and the island invited exploration. All we had to do workwise was check the exclosure, which we opted to do after lunch. Both of us had been to Roly Poly Bay, so we decided to investigate von Luckner's Cove.

A rough map of the island was pinned inside the hut, showing it was criss-crossed with tracks. The island was surrounded by high cliffs except at three places. Lunch Bay, where we were, and Roly Poly Bay are boulder beaches backed by flat land and low hills, whereas a third boulder beach at von Luckner's Cove is backed by high cliffs.

The von Luckner's Cove track began conveniently by the campsite, and we soon entered open pōhutukawa forest with well-spaced seabird burrows dotted about. The track crossed a narrow pool of the Te Riu-O-Whakau Stream, which we jumped across, then turned left – roughly eastward – parallel to the stream and beneath tall kanuka scrub, perhaps three to four metres high, interspersed with some broad-leafed trees. This led into a dense thicket through which we zig-zagged until we emerged into a wide valley. Here, the track merged with the stream, which was dry except for a few small pools, and we walked along what was essentially a narrow, shallow ditch that snaked through an extensive carpet of dense low ferns. Strategically placed orange triangular markers on tree trunks confirmed that the stream bed was indeed the track.

We continued to a junction where a track branched off to the north. Large signs, nailed to nearby trees, indicated the way back to Lunch Bay, the way onward to von Luckner's Cove, and named the branch track as the Te Huhu Track. We were unlikely to get lost. Further on, more signs identified the Te Awa Track branching off to the north. From then on, the von Luckner track became increasingly overgrown until it became obliterated, and we had to push our way through undergrowth from track marker to track marker.

Our route steepened at the head of the valley and ended abruptly on a narrow ribbon of low vegetation running along the brim of a high cliff. Below, von Luckner's Cove shimmered with heat reflected off the cliffs we were standing on. Then, to our surprise, we saw the track markers continued straight down through Pōhutukawa trees clinging to the steep cliff face. Numerous stout roots had been exposed by weathering, and these together with branches provided a jungle gym of firm foot- and handholds.

Hmm. It was a long way down.[128] Did we really want to go? We scrutinised what we could glimpse of the beach below but couldn't see anything worthy of closer examination. The day had also warmed up, and we realised it would be unpleasantly hot climbing back up. We retreated into the bush and turned north along the Te Awa Track. The Cove could be left for a cooler day.

128 The topographical map indicates the cliff here is about 20 m high. Further north these cliffs are up to 120 m or so high.

The Te Awa track sidles around through open forest near the northeastern cliffs, and we continued along it until we came to a branch signposted as "The Stairway to Heaven." This we had to explore. It took us through relatively uniformly open bush – we could see perhaps 15 to 20 metres between slender tree trunks – with knee-high undergrowth. It ended at two ledges that formed two huge steps down to the junction with the Trig Track running alongside the Te Roroi Stream. It was now almost midday, so we turned left and followed it back to camp.

First, we checked the exclosure and found the four wētā under their release-saucers, but only one of the two holes was still occupied. We decided not to search for the missing wētā because this would damage much of the habitat: we had already flattened some of the vegetation while checking the release-saucers – it was unavoidable.

After lunch, we swam and then walked the full length of the Trig Track, but there was no sign of a trig at the end. Next, we explored the Shag Bay and 309 Tracks and then started back to camp via the Link Track. This follows the northern cliff tops, which are fringed with Pōhutukawa trees that shade low, sparse undergrowth, so walking was easy. We eventually came to a junction with Lucy's Track, which forms a shortcut to the Trig Track, so we turned down it. This was a mistake because it was completely overgrown and looked like it had not been used for a long time. We struggled through dense waist-high grasses, rushes, and sedges that were so thick in places it was easiest to fall forward onto them and then crawl over what we had flattened. It was a great relief when we burst onto the Trig Track and followed it back to camp.

First thing on Thursday morning, we checked the release-saucers on the hillside (15 of the 24 were still occupied) and the exclosure (four wētā still occupied the release-saucers and one hole was still occupied). We now had the rest of the day free and, as Rob had asked us to collect lots of pōhutukawa seed for Project Crimson[129], we retraced our way along the Link Track, gathering seed as we went. This track ends on a hilltop in an open area of rock and clay with – much to our surprise – a small elongated shallow pond of water. The clearing was fringed with dense native vegetation and several bushes of hakea, each up to two metres high. How did this spiny Australian weed get there, we wondered? The seeds are winged (although the

129 The Project Crimson Trust is a charity formed in 1990 to help save pōhutukawa after a survey showed more than 90% of coastal pōhutukawa trees had been eliminated (largely from defoliation by introduced brushtail possums). It later expanded to include other threatened trees such as northern and southern rātā (also browsed by brushtail possums).

seed capsule is heavy, hard, and woody), so they are dispersed by wind, but surely we were too far away for them to have been blown here. We decided they were probably introduced long ago when the island was mostly covered with pasture.

There were no signs to indicate the connecting tracks here, and the entrances were obscured with vegetation, so we had to search for the openings. We eventually found the start of a track but couldn't recognise if it was where we had emerged from the Shag Bay Track earlier. We hoped it was the start of Faulkert's Folly Track and followed it until we came to a junction with the Te Awa and 309 tracks. Signposts here confirmed that we had been along Faulkert's Folly track. We continued up the Te Awa Track to The Stairway to Heaven and returned down it and back to camp.

Each night, we spent between 1.5 to 2.5 hours searching for wētā along the tracks leading from camp. There were very few insects, and we only found one more ground wētā to add to the one we found during the first night (Sunday night). I got the impression that there were few nocturnal insects on Red Mercury Island despite the island having been rat-free for eight years. The nights had been cool, though (12.4°C to 16.8°C), which could have suppressed their activity.[130]

Our stay on Red Mercury Island ended on Friday after Maree and I had spent six days on the island. Rob arrived with eight tusked wētā, which we let go under vacant release-saucers on the slope above the enclosure, bringing the number released on the island to 50 insects, the maximum allowed. We were pleased to find that 13 wētā were still under release-saucers on the hill and that the five wētā in the exclosure were still where they were the day before.

After we packed up camp and got everything aboard the *Kuaka*, Rob took us over to West Double Island, where we liberated 28 tusked wētā on a wide terrace about halfway up the island. This was the first release on Double Island and the first time I had been ashore there. Rob had chosen the site because of its deep friable soil and because it was moister than the surrounding slopes. I thought it was perfect.

We then worked furiously for an hour and three-quarters, setting up 22 release-saucers and releasing wētā under them before Rob called a halt: he had to be back in Coromandel later that afternoon, and Maree and I also wanted to begin our long

130 We never saw many insects during night searches on any of the subsequent field trips to Red Mercury Island. Others have also commented on this, so it seems that invertebrates were indeed relatively scarce there.

journey home as soon as possible. We quickly let the last six wētā go in holes we made with a sharpened stick and left the island.

Rob returned to Double Island two weeks later (May 18, 2000) with Paul Barrett (from Auckland Zoological Gardens) and Chris Winks and released a further 16 half-grown tusked wētā. These insects had been captive-reared by Chris and Paul, and both wanted to see the insects' new home.

Four more releases were made on Double Island as tusked wētā became available: Rob, Suzanne Bassett, and Paul Barrett (both Massey University) released 17 on September 25, 2000; Rob released eight on April 22, 2001; two males were added on January 24, 2001, after we removed them from the exclosure on Red Mercury Island (Chapter 21); and eight adults were released by Rob and me on September 22, 2001. This brought the final number of tusked wētā released on Double Island to 84.[131]

Typical pōhutukawa forest habitat on Double Island with patches of relatively dense ground cover (mostly small kawakawa bushes). Photo: Ian Stringer

131 Table 1 in Chapter 21 gives a summary of the numbers released.

TRACK NAMES ON RED MERCURY ISLAND

The Te Awa track was already present when kiwi were released in 1984. It runs along part of the Te Awa-A-Ngauru stream, which drains the northwest area of the island, and hence the track takes its abbreviated name. The Te Awa track runs eastward out of the valley, skirts the north-eastern cliffs, and joins the von Luckner track, which runs from von Luckner's Cove to Lunch Bay.

The track was named after Count Felix von Luckner, who was the colourful commander of a German raider, the SMS Seeadler (Sea Wolf). This was a three-mast auxiliary sailing ship that was active during the First World War and was eventually wrecked on a coral reef in the Society Islands. Von Luckner, with five of his crew, sailed to Fiji in one of the ship's boats, hoping to capture a larger vessel and return for the rest of the crew. But he and his crew were captured and transported to Motuihe Island in the Hauraki Gulf, where they were imprisoned. However, von Luckner and some of the other German prisoners escaped in the Commandant's launch on December 13, 1917, and sheltered briefly in the cove on Red Mercury Island, which now bears his name. The next day, they captured a sea-going scow and sailed for the Kermadec Islands, where they were recaptured 18 days later.

Some of the other tracks were named by Hugh Robertson and Rogan Colbourne when they monitored little spotted kiwi after the release in 1983. Others were named by people checking if the aerial poisoning in 1992 had eradicated the kiore (Pacific rats).

Lucy's track was named after one of Rogan Colbourn's dogs that led him to where kiwi were hiding. Faulkert's Folly was named after Faulkert Newland, a vet who accompanied Rogan and Hugh Robertson to Red Mercury after Brodifacoum poison was applied to kill the rats in 1992. He was there to provide the antidote (vitamin K) to any kiwi that became ill (only one dead saddleback was found (Towns & Broome 2003)). As far as I am aware, he did nothing silly, so perhaps folly was added because it sounded good.

The Shag Bay and Trig tracks lead to the named places, and the Link track provides access between other tracks on the north and west of the island. The 309 track is named after the 309 road, which winds across the Coromandel Peninsula, and the Southern Motorway track was named after that motorway. I have no idea why the Te Huhu track got its name.

Lastly, the Stairway to Heaven track, with the two giant steps at its lower end, was named after the song *Stairway to Heaven* by Led Zeppelin, which was popular at the time.

CHAPTER 21
KEEPING TABS ON WĒTĀ

We planned to monitor tusked wētā until they had time to produce second-generation island-bred insects. If they did, then they were likely to become established on the islands, and we would consider the translocations a success.

A brief visit to the exclosure in January 2001

The exclosure was next searched almost nine months after the wētā were released. This was done by Rob Chappell, Grant Blackwell, Phillip Eades, and me by making a day excursion during the 10th field trip to Middle Island.[132]

Rob and I came up with the idea that scraping off the topmost few millimetres of soil could be an alternative way to find tusked wētā by exposing them in their shallow underground chambers. We called this scrape-searching, and we tried it out by searching the entire 23 m^2 of ground in the exclosure. We hoped to find all six tusked wētā we had released in it.

First, we checked under everything on the surface – six release saucers, four oviposition trays, and two rocks – and found four wētā in separate chambers. Then we scrape-searched the entire area and found a fifth wētā in a chamber under open ground. We thought scrape-searching was wonderful.

Our tools were flat plastic smoothing tools that plasterers use, and we created mounds of soil and leaf litter, which we carefully spread back after we finished. Even so, it looked as if pigs had rooted through the exclosure when we left it.

All five wētā were large juveniles that could become adults at the next moult. We assumed that the missing wētā, a female, had died because we were sure we would have found it by scrape-searching. It had most likely been cannibalised because we didn't find any remnants, such as the tough head capsule and jaws, which would be left behind if it had died of other causes.

We gathered around the exclosure, leaning on the walls, looking in – like farmers around pens at a stock sale – and discussed the situation. The longer we thought

132 This was the field trip where Grant found the last tusked wētā ever seen or detected on Middle Island as recounted in Chapter 14.

about it, the more the exclosure seemed too small to support five big juveniles, let alone larger adults. What to do? The solution, we decided, was to reduce the number of wētā by removing two males and hope that the remaining male and at least one of the females were fertile.[133]

Rob had to be back in Whitianga by mid-afternoon, so, as time was limited, we removed two males from the exclosure, rushed them across to Double Island, and released them under release-saucers. We also quickly checked the other release-saucers and found five tusked wētā under them.

So, how good were release-saucers for monitoring?

The release-saucers provided less information than we had hoped because the number of wētā occupying them quickly diminished after the releases and subsequently remained low for some months until the insects disappeared. Red Mercury showed this best because there was essentially a single release of 44 insects on May 2 and 5, 2000. Thirteen (28.3%) were under the release-saucers two days later (Chapter 19), four (8.7%) occupied them on May 24, and on August 16, and the last two (4.3%) were found on November 14, 2000, 203 days after being released.

The occupancy pattern on Double Island was confounded by additional releases, although there was still a marked reduction soon after the first release. This was followed by low but fluctuating numbers as more wētā were added until the last two, an adult male and adult female, were found in December 2001 (Table 1).

Most of the wētā that occupied release saucers on both islands excavated new chambers near the edges of the saucers. Some of these chambers were occupied consecutively; some were vacated and reoccupied later, and some were never reoccupied after the original occupant left. We, of course, didn't know if a chamber was occupied sequentially by the same wētā because it's not possible to permanently mark juveniles: everything on the cuticle is lost when the insect moults (see text box 'Moulting' in Chapter 15).

It seemed most likely that the insects had dispersed and dug new chambers elsewhere, and we thought it unlikely that those on Red Mercury Island had been eaten by little spotted kiwi as some people had predicted (Chapter 17). The wētā could, of course, have died from unknown causes.

133 It seems likely from captive-rearing that infertility was common

We knew nothing about the wētā after the last ones were found under the release saucers on Red Mercury Island until two adult females were found while searching at night, five months later. It was even longer – 14.5 months – before the next wētā was seen on Double Island during a night search.[134]

Table 1. Numbers of tusked wētā found under release-saucers on Double Island and the percentage found in relation to the accumulated numbers released.

Date	No. wētā released	Accumulate No. wētā released	No. wētā found under release-saucers	% wētā found
5 May 2000	28	28	-	-
18 May 2000	16	44	5	17.9
24 May 2000	0	44	3	6.8
25 Sept. 2000	17	61	1	2.27
24 Jan 2001	2	63	5	8.2
22 April 2001	8	71	4	6.3
11 May 2001	0	71	1	1.4
22 Sept 2001	13	84	3	4.2
14 Oct 2001	0	84	2	2.4
14 Dec 2001	0	84	2	2.4

The insects clearly grew larger as Rob continued to check the release saucers, and the last four he found in October and December 2000 on Double Island were adults. He could have followed their development in more detail by measuring them, but we had agreed to disturb them as little as possible.

The verdict

The release-saucers were useful in confirming that at least some tusked wētā survived for some months after being released. This was in contrast with most other insect translocations, where nothing is known about initial survival, and several years can pass before the insects are found again. If the insects are not found again, and insect translocations often fail, then it is difficult to decide when a translocation has failed.

There are, as always, rare exceptions where success is known much sooner. An

134 Trip 24 (Appendix 1); March 5, 2003. This was the first time Double Island was searched at night.

Cathy Lake using an harmonic radar unit. The hand unit is powered by a battery in the backpack. Different-sized antennae are for transmitting and receiving. (This photograph was taken at Te Paki Farm Park while searching for snails tagged with harmonic radar transponders). Photo: Ian Stringer

example is the translocation of tree wētā to Korapuki Island as described in the text box 'Establishing tree wētā on Korapuki Island' in Chapter 19. In this case, the insects were monitored immediately after translocation by checking the 'weta boxes' they inhabited. Another example is a translocation of an endangered field cricket in Germany, where the crickets were heard chirping the following year.[135]

Two other ways of monitoring adults

Once we knew that adults were present, we made a concerted effort to find as many as we could to try to get a minimum survival rate to maturity. We searched for them at night, and I also tried attaching harmonic radar tags[136] and, in some cases, micro-transmitters to them, so we could find them again. I hoped the insects we tagged would lead us to untagged ones they paired with so we could then attach harmonic radar transponders to them, and these in turn would lead us to more adults. This method, of course, could only work with adults because, as you know, juveniles would shed the transponders when they moult.

So, how does harmonic radar work? A hand-held radar unit produces high-frequency radar that is absorbed by the transponders and re-emitted at double the frequency. The hand-held unit can also detect the emitted radar and its direction, so you can home in on the transponders. The transponders we used were small and lightweight and would work for many years (until they corroded and broke up) because the hand-held unit provides all the energy, whereas batteries would go flat. Harmonic radar is therefore ideal for finding things when there are long intervals between searches.

There are, however, two downsides. The transponders I used had to be small

135 Hochkirch *et al.* (2007).

136 Gábor Lövei (AgResearch) introduced me to Harmonic radar. He developed it for tracking large ground beetles (Carabidae) in the Manawatu district (Lovei *et al.* 1997). We quickly realised it was ideal for following the movements of large land snails because it enabled us to find them when we monitored them at yearly intervals (e.g. Stringer *et al.* 2002).

enough to fit onto wētā, and this reduced their detection range to about 10 metres when the soil is dry and about two metres when the soil is wet. The other hitch was that our radar unit needed recharging after about an hour, and I didn't have sufficient solar panels to do this in the field, so we had to make our searches as fast and efficient as possible.

The opportunity to test harmonic radar came in April 2001 when Matthew Wong and Mark Fraser (both research students at Massey University) and I visited Red Mercury Island. We brought 12 adult tusked wētā to assess the effectiveness of harmonic radar: two pairs were from Massey University (Chapters 15 and 16), and eight were provided by Chris Winks. I had attached transponders to the ones from Massey University before we left, and I attached them to Chris's insects immediately after he gave them to us.

Rob took us to Red Mercury Island in the *Kuaka* first, and we unloaded our gear with difficulty at Lunch Bay because the waves were almost too large to get ashore safely. We then spent the rest of the morning checking the 22 release-saucers on Double Island, installing another 28 saucers, and releasing eight captive-reared wētā that Chris Winks had given us.

We found four adult female tusked wētā under the saucers (Table 1), and Rob and I attached transponders to them while Matthew and Mark worked furiously installing 28 new release-saucers. When we opened the travel containers to let Chris's wētā go, we found to our dismay that transponders had fallen off six of them. We couldn't glue them back on because the superglue had dried in lumps, and the transponders would no longer fit snugly enough to bond securely. There was nothing for it but to let them go with the two tagged ones.

Adult female tusked wētā with an harmonic radar attached to its pronotum. Note the diode projecting backwards from the thin copper shield. The aerial attached to the diode is folded down out of sight. Photo: Ian Stringer

I was responsible for this fiasco: I had attached the transponders when Chris gave me the insects at

HARMONIC RADAR

Harmonic radar was developed for locating skiers buried in avalanches (where there is no liquid water), and most skiing apparel sold overseas contained them. The transponders are located using a hand-held device that emits high-frequency radar. The transponders capture the radar and transmit it back at double the frequency. Directional aerials on the hand-held unit then allow searchers to home in on the signals from the transponders. The advantage of using this system is that the hand-held device supplies all the energy, so the transponder does not require a battery (which would eventually go flat), and they can be made very lightweight (mine added about 0.3 g when glued to an adult wētā and increased the insect's weight by 1.4% to 2.7%). However, mine could only be detected if they were within about two to 10 metres away (depending on how wet the environment was), so we searched by systematically walking along parallel lines about 5 m apart.

I developed the transponders we used by trial and error because I know nothing about radio or radar. Each was a thin sheet of copper, which I cut to the shape of the pronotum, the shield-shaped region immediately behind the head of a wētā. I then heated the copper close to melting and dropped it into cold water to anneal it. This softened the copper and made it easier to mould into the shape of a pronotum. Next, I soldered on a small diode with a fine stainless-steel aerial that would project a bit past the rear end of the wētā. The transponders were glued onto wētā permanently using superglue gel. They worked, much to my surprise!

Thames, and we must have driven off before the superglue had set properly. I was so annoyed with myself: I should have attached them while we were staying at Rob's home overnight, when there was plenty of time for the glue to set.

The waves had become much larger when we finished on Double Island, and we got thoroughly wet when we left. It was now too dangerous to get ashore at Lunch Bay, so Rob put us ashore at Roly Poly Bay, where it was calm. We were so thankful for his foresight in unloading our gear at Lunch Bay before we went to Double Island because we would otherwise have had to carry it all over the hill to the campsite.

Using micro-transmitters

A micro-transmitter being glued to an harmonic radar transponder on an adult male tusked wētā. The aerial has broken off the diode (the broken end is visible just by my thumb), but the transponder could still be detected. Gloves ensured the insect remained docile. Photo: Danny Thornburrow

As soon as we had set up camp at Lunch Bay, we checked the release-saucers on the hillside above the exclosure, but there were no wētā under them. Next, we attached micro-transmitters [137] to the transponders on the two pairs of adult wētā from Massey University. These transmitters could be detected up to a kilometre away and would allow us to find wētā that wandered out of the area we searched with harmonic radar.

137 Each transmitter and its battery were sealed in epoxy resin. The battery lasted 10 to 12 days and the transmitter was turned on by removing a magnet taped to the outside (it opened a tiny magnetic switch in the transmitter).

We glued the micro-transmitters onto the transponders using a rubbery, neutral-curing Silastic glue that would allow us to cut the transmitters off the transponders when we left the island. The males were to be returned to Massey University, and the females were to be released on Red Mercury Island. We removed the transmitters from the females so we didn't lose them: the batteries only lasted for a fortnight and would have gone flat long before we returned.

We kept the wētā overnight (to ensure the transmitters were properly attached), then let them go under release-saucers. Both females remained under their saucers until we caught them again three days later, removed their transmitters, and let them go under their saucers.

The males, however, vacated their saucers during the first night. One was located the following day, four metres from its release-saucer, resting alongside a fallen branch under deep leaf-litter. It had moved 10 m away the following day and was deep within a bird burrow, where it remained until we caught it at the end of the trip and took it off the island.

The other male had moved nine metres uphill the day after it was released and was sharing a chamber with an adult female and another adult male. We glued transponders onto both untagged wētā and returned all three to the chamber. Finding two males sharing a chamber with a female was unexpected because males are known to fight using their tusks when above ground.[138]

The tagged male from Massey University subsequently remained in the chamber with the female until we took it off the island, but both the transponder and transmitter had fallen off in the chamber. The newly tagged male left the chamber, and we couldn't find it again the next day, so we assumed it had moved outside the area we searched with harmonic radar.

Searching with spotlights at night

During the first two nights, we also systematically searched the area above the exclosure where the release saucers were but didn't see any tusked wētā. On the third night, we searched the entire Roly Poly Bay track and, again, saw no wētā. Tusked wētā were, however, completely forgotten for a while when we saw a little spotted kiwi near the start of the Roly Poly Bay track. This was the first time Mark and Matthew had seen kiwi in the wild and, as they put it, they were 'rapt.'

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138 I have never seen male tusked wētā fight except in a film taken by Rod Morris for the TV series *Wild South*.

The kiwi snuffled and probed about with its beak and took no notice of us, sometimes approaching right up to our feet. We watched it alternately with an infrared video camera (which I now took on every field trip) or by illuminating it with a spotlight (which it also seemed to ignore). I even tried videotaping it, but the intervening undergrowth showed up brightly and distracted from the bird. After 15 minutes, it jumped the stream and wandered off into dense undergrowth.

We continued towards the Roly Poly Track junction and caught up to a little penguin waddling along the track in front of us. It took fright and ran ahead and fell into a deep pool where the Roly Poly Track crosses the Te Roroi Stream. It swam about seemingly confident of its safety, and, as we watched, an eel slowly emerging from below apparently bit the penguin because it shot out of the water amid a flurry of splashing, landed on the far bank, and disappeared rapidly into the undergrowth.

Finally, on our last night, Matt saw an adult male tusked wētā while we were searching amongst the release-saucers, but it jumped away and we couldn't find it even though the three of us searched extensively for it. Then, as we were returning to camp, we startled an adult female, which jumped repeatedly away until it landed in the stream. It swam vigorously across to the other side, where we caught it, glued a transponder on, and let it go again.

This was the first time I had seen Mercury Islands tusked wētā in water, and I was surprised that it floated: I expected it to behave like its close relative, the Raukumara tusked wētā, which sinks when it jumps into a stream. This wētā then walks along the bottom and hides under cover for up to half an hour before emerging back onto dry land. It seems like an effective escape response against rats to me and probably explains why these wētā survive on the mainland.

Checking the exclosure

We scraped-searched the exclosure the first day we were on the island and found two adult females and the adult male, which was sharing a chamber with one of the females. We caught all three, attached transponders, and returned them to their chambers.

We concluded during the previous trip that the third female must have died, so I was completely surprised when we shone our lights into the exclosure during our first night on the island and saw four wētā – two females and a male each with transponders and one untagged female. This was both good and bad: good that all three females had survived, and bad in that scrape-searching was not as effective as I had thought.

This untagged female proved elusive to find. We searched the exclosure with harmonic radar the next day and removed the three tagged insects as we found them. These had to be taken about 10 m away from the exclosure because transponders interfered with each other, making them difficult to locate. Both tagged females were in their respective chambers, but the male had changed chambers and was now cohabiting with the other female. We then scrape-searched the exclosure again but couldn't find the missing wētā.

We tried again on the third day and caught the two tagged females using harmonic radar, but this time the male eluded us. We assumed it was in a chamber near the edge of the enclosure because the walls interfered with the radar.[139] However, three days before we left, we finally located it with the untagged female in a chamber hidden under a large overhanging tree root. From then on, we assiduously scraped under the edges of exposed roots and rocks.

Oviposition

One of the tagged females was probing its ovipositor about in one of the oviposition trays when we shone our spotlights into the exclosure during our first night. I immediately rushed back to camp to get the infrared video camera, but the insect had finished when I returned. Soon after, another female began preparing to lay eggs, and I was able to film the entire thing. She began by repeatedly pushing leaf litter away from its body, using its legs sequentially until it had cleared a small area. It then raised and hunched its body so its ovipositor was directed vertically downward and thrust it into the soil. It prodded about with its ovipositor for a few minutes, then withdrew it and walked off.

The highlight of the trip, though, was finding two tusked wētā eggs in one of the oviposition trays in the exclosure. Matthew and Matt had gone off to explore von Luckner's Cove after we had searched the exclosure during the second morning, and I had stayed behind to write up the trip diary and search the oviposition trays. Soon after starting the second tray, I unearthed the eggs and immediately reburied them. I was hugely pleased: this was confirmation that at least one female was laying eggs, so we might not have messed up by removing the two males in January 2001 (we still did not know if the eggs were fertile, though). The last thing I did was dig up the area where we had seen the wētā probing, but I couldn't find any eggs.

139 The interference was probably caused by reflection from pieces of twisted wire used to fasten the windbreak netting to wire stretched between the corners of the exclosure.

An exhausting departure from Red Mercury Island

Just before we left the island, we removed two females from the exclosure (leaving one female and the male behind) and liberated them under saucers on the hillside. This was to reduce the number of eggs laid in the exclosure and lessen the potential for overcrowding the juveniles.[140]

Everything was packed and on the boulder beach by 10:15 am, but we could see that the waves were too big to use a dinghy safely, so I decided to pull our barrels and other water-tight containers out to the boat using a long rope. Swimming out through breaking waves was easy enough, but getting back ashore as they crashed onto boulders was a bit tricky, although we had had a lot of experience doing this while swimming each day.

Rod Ray arrived a quarter of an hour later, and I swam out with the end of the rope and explained my plan. Rod, however, was having none of it, and I couldn't persuade him to change his mind. Instead, he offered to go around to Roly Poly Bay and see if we could leave from there. I explained that it would take us a few hours to get everything over the hill, but he was willing to wait.

While he was away, we discussed whether we should leave the island or stay and wait for calmer weather, but we all had reasons for returning to Palmerston North and unanimously agreed to leave. Rod soon returned with the news that it was much calmer around the headland, and it would be easy to get off there, so we began the daunting task of carrying everything up and over the Roly Poly Bay track.

We followed the well-tried routine of carrying one or two pieces at a time and leaving them beside the track as soon as we began to tire. We then walked back to get something else, recovering as we went. Mark volunteered to take the rear to ensure nothing was left behind, while Matthew, who was strong and fit (he worked as a bouncer at a pub on Friday and Saturday nights), and I concentrated on taking the heaviest things first, so Mark was not left with them as would otherwise surely happen.

It took us three and a half hours to get everything to Roly Poly Bay and another hour to get it all safely aboard. We were exhausted.

140 The pair of adults left in the exclosure would probably have died by the time the eggs hatched.

What we achieved

Our main objective was to find if any of the tusked wētā we released outside the exclosure had survived and matured into adults, and we confirmed that at least four had. We were disappointed that the four wētā tagged with harmonic radar transponders and micro-transmitters had only led to the capture of two untagged adults. However, we left five adults with transponders on the island, which we hoped might lead us to more untagged adults when we returned.

Adult male tusked wētā with micro-transmitter. The harmonic radar transponder is visible beneath the transmitter with the diode projecting back on the right. The transponder aerial is the fine wire from the diode that is bent to the left and passes under both the transmitter aerial and the left femur. Photo: Danny Thornburrow

CHAPTER 22

TWO SURPRISES

The first surprise happened during my thirteenth field trip to Middle Island. Daryl Gwynne, a Professor in the Biology Department at the University of Toronto, and Kahori Nakagawa, who worked at Cape Sanctuary in Hawke's Bay, were searching for tusked wētā on Middle Island with me when Rob arrived unexpectedly and took us over to Double Island and Red Mercury Island to check the release-saucers and the exclosure.

A newly hatched juvenile tusked wētā in its chamber. This was the first evidence that tusked wētā had successfully reproduced in the exclosure on Red Mercury Island. Photo: Kahori Nakagawa, April 17, 2002

No wētā were under the release-saucers on the hillside, but we discovered an adult female and a small juvenile under release-saucers in the exclosure. I was elated because I never expected to find small juveniles. The insect was in an ovoid chamber just under the surface of the soil, so it was undoubtedly a tusked wētā (ground wētā make vertical J-shaped burrows).[141] It was so tiny that I suspected it had recently hatched, but I couldn't know for sure until I measured it. We usually did this under a microscope, but we could also get its measurements by photographing it alongside a scale. In our haste to leave Middle Island, however, I had left my micrometre callipers and camera behind, so Kahori (who always had her camera) came to the rescue and photographed it alongside a ballpoint pen. This allowed me to confirm it was a newly hatched juvenile when I got back to the lab (with the same pen).

We abandoned our planned scrape-search of the exclosure to avoid crushing small juveniles and removed the adult female, so it couldn't eat any hatchlings. This adult was liberated under a release-saucer on the hillside.

141 Juvenile ground wētā of this size also stay in the adult female's burrow until they have moulted several times.

Overall, we were pleased with this short visit to Red Mercury Island. The small juvenile showed that tusked wētā can potentially reproduce successfully on Red Mercury Island, and finding a live adult female showed that some adults can live for up to a year.[142] I had warned Kahori and Daryl that we might not see any tusked wētā on Middle Island – and we didn't – so they were pleased to have seen the adult female in the exclosure.

Rob took us to Double Island next, but no wētā were under the release saucers. We finally got back to Middle Island at about 5 pm and relaxed with gin and tonics at the hut before going to bed at 6:30 pm. Kahori and I got up at 9 pm and searched until 11:35 pm, then we woke Daryl and had dinner. Daryl and I did a second search from 2 am to 4:26 am while Kahori got some sleep.

Gourmet meals

This thirteenth field trip was also memorable for two gourmet meals. Darryl cooked the first one, a delicious Mexican meal, two nights before we went to Double Island and Red Mercury Island, and Kahori, not to be outdone, cooked a Thai meal the next day. Her meal was, as anticipated, also delicious. Then they pressed me to choose which was best while extolling the virtues of their meals. I diplomatically awarded a tie.

These two meals were as close to fine dining as I ever had while camping, and they, of course, completely outclassed my paltry efforts. What impressed me most was that they prepared their meals from individual ingredients (they had asked me to purchase these before the trip), whereas I always used preprepared packaged ones, the sort that you add meat and one or two other ingredients.

The most notable thing I saw on Middle Island during that field trip was a tuatara eating a giant centipede. Bites from these centipedes are excruciatingly painful to humans, and these large centipedes routinely kill and eat skinks and geckos, so I thought tuatara would avoid them. I was wrong. We missed the initial capture but watched (while Kahori took photographs) as the tuatara periodically gulped and swallowed the centipede so it disappeared slowly, bit by bit. The centipede fought back in vain by alternately trying to pull free or bending around and repeatedly sinking its poison fangs into the tuatara. But the tuatara remained nonplussed and only swiped at the centipede when it was being bitten near an eye. It took ages – at least 20 minutes or so – for the centipede to be completely swallowed, and then

142 Mary McIntyre found adult tusked wētā from March to November on Middle Island (McIntyre 1998). They live for an average of 9–10 months in captivity (Stringer *et al.* 2006, Winks and Ramsay 1998).

the tuatara remained standing where it was, frozen like a statue. I expected that the tuatara would die, so I checked the next morning, but it was still standing in the same place until I approached too closely, and then it scuttled off energetically.

Another surprise

I was completely astonished when Chris Winks announced that 17 eggs had hatched a year after the first ones. This meant he would be providing a second batch of half-grown juveniles for release in late 2001.

Tuatara eating giant centipedes.
Photos: upper by Ian Stringer, lower by Kahori Nakagawa

The Recovery Group decided these juveniles were to be released on Red Mercury Island because there were probably too few to become established on one of the other Mercury Islands. This meant that Rob and I had to decide where to release them. If we liberated them at Lunch Bay, where the first ones were released in 2000, then we would probably have to wait an extra year before we could be sure that the first generation of island-bred wētā had reproduced successfully.[143] This was an important milestone because Chris reported that first-generation captive-reared tusked wētā were incapable of producing offspring (Chapter 4). We didn't want this delay, so we looked for a different release site.

We chose a damp area about 500 metres from Lunch Bay alongside the von Luckner Track and liberated six male and nine female half-grown juveniles under release-saucers there in September 2001.[144] This was the furthest suitable location from Lunch Bay we could find, so we hoped it was sufficiently far for the two groups of wētā to remain separated for some years.

Consequences

So, when could we know if our translocations were successful? Ideally, this is when they survive long-term on the islands and become established. So, the more generations they pass through, the more likely this will happen. This would require increasingly longer times, so we had to be pragmatic. We reasoned that tusked wētā were likely to become established if they produced second-generation insects, and we based the time this would take on the generation time – the time to complete an entire life cycle.

We originally believed tusked wētā have a three-year life cycle (from Mary McIntyre's first research on Middle Island and Chris Winks' early captive-rearing results[145]) but the late-hatching insects showed it was a three-to-four-year life cycle. In addition, the insects can develop into adults at widely differing rates, and we found later (Chapter 28) that some adult females can live for at least a year in the wild, so they could potentially lay eggs over two years. As it happened, we found tusked wētā of all ages at Lunch Bay in 2005, so it had only taken four years for the generations to merge there. However, we only found three large juveniles and one adult on Double Island in 2005, which only informed us that they had successfully reproduced there.

143 We were unlikely to find small juveniles, so if we made a second release then large juveniles could be either second-released insects or first island-born insects.

144 Chris kept a male and female to try breeding from them.

145 Data from Winks & Ramsay (1998) indicates that the theoretical duration of the lifecycle in captivity, from egg hatch to adult death, varies from a minimum of 1.9 years to a maximum of 3.3 years, Mary McIntyre's results indicate a similar life span on Middle Island (McIntyre 1998).

DIAPAUSE: AN ESCAPE IN TIME

Diapause is a state of arrested development that occurs even when conditions are suitable for continued growth. It is quite different from quiescence where the insect responds directly to an adverse environmental condition by simply slowing down (for example, during cold weather) and returning to normal activity when conditions become favourable again.

Most insects do not undergo diapause, but in those that do, it occurs once in their life and at a characteristic stage for the species. So, depending on the species, it can occur in the egg, the larva, the pupa, or the adult. Adult diapause differs in that it is often a reproductive one where the insect is active but does not reproduce.

The factors that influence diapause also differ between species and are very diverse so what follows is a very simplified account. Diapause can be initiated by many external factors (depending on the species) such as day length (an excellent predictor for future conditions) or food quality. These can differ from the environmental conditions the insect avoids while in diapause. The trigger to enter diapause may also be initiated a long time before the onset of diapause so the trigger can be very difficult to identify. Metabolic processes, of course, continue during diapause but often at a vastly reduced rate: in other words, the insect is still alive. In addition, diapause also undergoes development which eventually causes it to cease (or become broken) and normal quiescence and growth then commence.

Diapause stops insects from emerging at the wrong time and allows them to avoid unsuitable conditions. Take for example an insect that eats the leaves of a deciduous tree. If it were simply quiescent then it would die if it became active during warm spells in winter because there are no leaves to eat. Diapause prevents this. Such insects often require exposure to low temperatures for a certain length of time before diapause is broken.

Most native trees in New Zealand are evergreen (there are only eleven native deciduous tree species) so insects can potentially feed on their leaves throughout winter and so most insects in New Zealand are quiescent during cold periods. Our climate is also temperate and this also contributes to diapause being uncommon.

Diapause, then, is an escape in time that synchronises the insect’s life history with the seasons or with favourable conditions.

We had to wait seven years before we could know that any small juveniles we found were at least second-generation insects and eight years before any large juveniles and adults were at least second-generation insects.

Diapause

Let's take a brief look at delayed hatching in insect eggs. If you are not game to continue, then skip to 'The need to know.'

Chris's result indicated that late-hatching eggs became dormant for a period, but we do not know which of the two sorts of dormancy – quiescence or diapause – they underwent. Quiescent insects slow down when they are cold and continue their normal life again when conditions become favourable. Diapausing insects, in contrast, remain dormant for extended periods – usually until the next growing season – and even during temporary periods when conditions are favourable. For example, diapause is common in insects that survive freezing winters because it prevents them from emerging during an unseasonal warm period (such as an 'Indian summer') and dying because there is no food. Many other insects use diapause to survive unfavourable conditions.

Chris kept his eggs at similar temperatures to those on Middle Island (but about 1.5°C higher during winter), so they experienced comparable seasonal variations. So, it's possible that some of the eggs laid late in the year developed very slowly during the following year and hatched the next year, but I think it's also possible that they could have entered diapause. We would only know for certain, though, if someone investigates this by keeping the eggs for different lengths of time at different temperatures.

The need to know

This chapter shows why conservation managers need to understand the basic biology of the species they are protecting. In our case, knowing the life cycle of tusked wētā enabled us to interpret results from post-release surveys and draw conclusions as to whether the initial steps in the recovery programme were successful and whether tusked wētā were likely to survive long-term where they were released.

CHAPTER 23
WHEN THINGS GO WRONG

Searching for tusked wētā at night wasn't a particularly satisfactory way to monitor tusked wētā, whereas scrape-searching worked reasonably well when we tried it in the exclosure (Chapters 21 and 22). Scrape-searching has advantages in that it can be done during the day and it provides a measure of the number of wētā within a given area – the absolute density of wētā. But scrape-searching is time-consuming, and we wanted to find out if it was practical to use over large areas. I decided to test this on Double Island in March 2003 with help from Corinne Watts and Katie Cartner, both from Landcare Research. The following is taken from my field diary the day after we arrived at Rob Chappell's home in Coromandel.

Diary: March – April 2003

Thursday 27 March

Rang Leigh Marshall on Stanley Island, who, with Kerry Nielsen (both Department of Conservation), was monitoring translocated Whittaker's skinks. Leigh said it was too rough to land on Stanley Island, and landing on Double Island looked marginal. Russell Clague (Matarangi Charters) also advised against trying. Decided to try again on Friday. Kerry needed to return to the mainland as soon as practicable, so was disappointed.

Friday 28 March

Leigh rang at 6:55 am and said it was too hard to make the call for landing on Double Island. Rang Russell at 7 am, and he also advised further delay. Rob was willing to try to get Leigh and Kerry off Stanley Island about 4 pm but cancelled when he learned the wind was blowing 44 knots. Back at the DOC (Department of Conservation) office in Coromandel, we glued harmonic radar transponders to two adult male tusked wētā supplied by Chris Winks using Selleys KwikTite Power Gel® superglue. These wētā were the last of 17 that hatched a year after the first hatching. The intention was to release them on Double Island and see where they went. Cooked dinner in Coromandel for five people with some of the field trip food.

Saturday 29 March

Leigh rang at 6:50 am and said that Double Island was now accessible. Departed Whitianga at 9:30 am. Collected Leigh and Kerry from Stanley Island (this required three trips with the inflatable dinghy). We unloaded our gear onto Double Island using a long rope to pull the inflatable dinghy back and forth between the boat and the rocks. Leigh came ashore to help. After disembarking, we returned to the boat for coffee and fresh muffins supplied by Russell's wife. Leigh delayed jumping from the rocks into the dinghy a fraction too long and swam to the boat. About midday, Corinne Watts, Katie Cartner, and I returned to Double Island and hauled everything up to the campsite, sweating profusely in the warm, humid bush. Our campsite was a level area surrounded by a few huge house-sized boulders to the east of the release site. We cleared a path from the seashore up to the campsite, avoiding the release site. Rang the DOC Kaueranga Valley Office to arrange a daily safety schedule.

Set up camp by 4:30 pm and began gluing micro-transmitters onto the harmonic radar transponders we had attached to the two male tusked wētā we had brought with us using 'Selleys roof and gutter sealant'.[146] At sunset, we slid back down to the rocks for some wine and cheese, then climbed back up at dusk to make dinner.

Started visual searching at the release area at 8:07 pm, walking slowly three abreast and about three metres apart. Bioluminescent fungi were scattered everywhere amongst the leaf litter – the densest display I have ever seen and mesmerising. Corinne caught a juvenile male tusked wētā at 9:45. Part of its gut was ruptured through the side of its abdomen between the 2nd and 3rd segments. We measured and released it. She found it close to the path up from the shore, so one of us had unwittingly crushed it as we were hauling up our gear. It may even have been damaged while it was in its underground chamber because the soil there was soft and deep.

We immediately stopped searching because we didn't want to damage another tusked wētā, and it was hard to see where to place our feet safely in areas of dense ferns and kawakawa plants. Deep leaf litter (in which the insects could hide), with numerous fallen branches, added to the difficulty. We then released the two wētā equipped with transmitters in a clear area near the centre of the release site at 9:50 pm and went to bed. (We released them after searching, so we didn't inadvertently step on them.)

146 We used this sealant because it is easily cut with a knife when removing the micro-transmitters. Super glue fixed the harmonic radar transponders permanently onto wētā.

A small juvenile tuatara. We only saw three during the day on Middle Island. Such juveniles are day-active after hatching and become progressively nocturnal after a few months. (Cree (2014, page 277)). The orange-red spots are ectoparasitic red chigger mites. Photo: Ian Stringer

Sunday 30 March

Found the injured wētā again. It had died close to where we left it last night. Preserved it in vinegar because we had no 70% alcohol. Next, we located the two tagged wētā using a hand-held receiver and Yagi aerial. Both had excavated shallow depressions under small branches covered with dead leaves. Next, we marked out a long, narrow area (2.5 m wide by 18 m long) that ran uphill through the release site and systematically scrape-searched it. Found two juvenile tusked wētā in underground chambers within the first two metres. One was under a stout root in the middle of our access track to the campsite. Measured both, returned them to their chambers and covered the openings with sticks and leaves. Continued searching. Found three empty chambers, then extended the search area by 5 m uphill and downhill, and found two additional empty chambers. The entire scrape-search of 29.4 m^2 had taken three of us just over an hour and a half, so we concluded that scrape-searching is too time-consuming for surveying large areas.

We then modified the track to bypass the two occupied chambers and checked 22 release saucers (all we could find), but there were no wētā under them. Made an accurate survey of the release area, including the area we had scrape-searched, the locations where we had released the two wētā equipped with transmitters and where we had found them again, and the positions of the 22 release saucers.

View up the track towards the Saddle on Middle Island, taken from above the upper campsite. Photo: Ian Stringer

Made the daily safety call to the Kaueranga Office, then had another wine and cheese on the rocks at sunset.

Carefully visually searched from 8:45 to 9:45 pm, this time limiting ourselves to open areas. We progressed slowly by clearing the leaf litter away before taking each step. Saw no tusked wētā. We periodically used the harmonic radar to check where the two wētā with transmitters were so that we didn't stand on them. Neither wētā left their shallow depressions. The only insects we saw were large numbers of slaters on tree trunks, some weevils about 6–8 mm long, some tiny cockroaches, and a few small cave wētā.

Monday 31 March

Got up at 6:30 am and decided to move to Middle Island if possible because it was too difficult to search effectively at night on Double Island. We could see the backs of waves breaking on Landing Bay from where we were, but we couldn't tell how large they were, so we couldn't decide if it was safe to land. Rang Rob at 7 am. He decided to try transferring us and estimated arriving around 9:30 am. We recaptured the two wētā and cut the micro-transmitters off (leaving the harmonic radar transponders still attached) and put them into their transfer boxes. Packed up camp, putting what we needed for Middle Island into seven barrels marked with brown adhesive parcel tape to distinguish them from the other barrels (containing everything we didn't need) we were to leave with Rob. Then pulled everything down the steep slope to the shore.

The upper rocks were damp and very slippery, which slowed us considerably, but we managed to get everything to the water's edge just as Rob arrived ashore in the dinghy. Rob took one load out to the boat and returned with his friend Kay, who jumped ashore to help us load. When everything was aboard, we motored over to Red Mercury Island, landed at Lunch Bay at 11 am, and released the two male wētā with harmonic radar transponders at the second release site in von Luckner's Valley. Meanwhile, Rob checked some additional mouse baits he had previously placed around Lunch Bay.

When we left the island, the waves were small enough for us to re-embark directly from the western rock platform at Lunch Bay. Rob nosed the bow up against the vertical rock face, and we stepped aboard, leaving behind clouds of ephydrid kelp flies. When we arrived at Middle Island, we couldn't tell how big the waves were at the Landing Bay. All we could see were the backs of breaking waves, but we eventually decided to try to get ashore through them.

Rob and Corinne went with the first load and landed safely, although the inflatable dinghy got swamped. The tide was out, and it was difficult to tip the inflatable up to drain it on the partly submerged slippery boulders. Rob eventually made it safely back through the surf and took Katie ashore with the next load. When they reached the surf zone, I watched the stern lifting up just as a wave was breaking, then the dinghy suddenly turned sideways and disappeared in front of the wave. All I saw was an arm flailing and an oar flung skywards, then two heads supported by orange lifejackets surrounded by bobbing barrels appeared on the back of the wave as it passed on.

A thoroughly drenched Rob eventually returned and drew alongside with a cheery *"That was fun!"* He explained that a rollock had popped out of its holder, so he couldn't control the inflatable as it accelerated down the steepening wave face, and it swung sideways and overturned. *"Your turn,"* he said, passing me a dripping wet lifejacket. I had taken the precaution of changing into swimming togs, but we got ashore with hardly a splash.

As usual, we decided to leave as much gear as possible at the Landing Bay and only took two loads containing the minimum we needed to the hut. We rang the Kaueranga Office and told them we had transferred to Middle Island, then pitched our tents and tied the tarpaulins over the deck by the hut. Everything was set up by 2:45 pm, so we had lunch and then raked the paths clear of leaves between 3 and 4:15 pm. Corinne returned to the Landing Bay for her bathing suit and a few other essentials that we had forgotten, but she couldn't find the barrel of scientific gear. How could we have left it aboard Rob's boat by mistake? Unbelievable! It had the "Cat-eye" lights and batteries we used for searching, the Petzel lights we used for backup, and the spare batteries. Fortunately, there was one Cat-eye light and a charged battery in the hut, and a spare set of callipers for measuring wētā. Two of us also had Petzel lights for use around camp, so we decided to make do with these until our batteries ran flat. We hoped they would last for two nights.

Had a swim to wash, then the customary wine and cheese on The Razorback as the sun set over the Coromandel Ranges. When it was dark, we started cooking dinner and discovered that the gas stove didn't work, but the gas light did. We managed to cook on a tiny spare "Gaz" camp stove I kept in the hut for such an emergency.

We began searching the Northern Plateau first at 8:45 pm. I led with a Petzel, followed by Corinne with the Cat-eye, and Katie trailing with another Petzel. Corinne said her Cat-eye spotlight was hot, but I dismissed this: they always got hot. Her light then started to flicker erratically as we went along the eastern track on the Central Plateau, and Corrine said her light was getting too hot to hold. This time I checked and found it was so hot and the wire lead burnt my fingers. Suddenly, Katie, from behind, shouted, *"Smoke's coming out of your daypack!"* Corinne immediately put her camera down and flung off her pack.

I quickly opened it to disconnect the lead-acid battery inside. The pack was filled with dense, pungent smoke through which I could see the wires glowing bright red. Luckily, nothing had caught fire, so I quickly tipped everything out onto the bare path (thankful we had raked it clear) and disconnected the battery. The plastic insulation around the wires had melted where it was partly covered by Corinne's polar fleece, and the fleece had melted and fused in places. Numerous holes of varying sizes were scattered over much of the rest. The nylon zip on the day pack had melted where the lead emerged, and deep channels were melted into the plastic battery case where the cable had been wrapped around (we did this to prevent the leads from being pulled off the terminals).

What had happened? The plug from the lead to the Cat-eye had shorted out, and the discharging battery had melted everything. Once the battery and what remained of the cable had cooled down, we left them on the path and continued searching with our Petzel lights. We finished at 11:30 and collected the damaged gear as we returned to the hut.[147]

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147 I later reimbursed Corinne for a new polar fleece.

Tuesday 1 April

I decided to leave the island because our Petzel lights alone were not adequate for searching effectively, so I rang Russell at 8 am and arranged a pickup at 1 pm. Corinne and Katie wanted to stay another night and thought I was trying to play an April Fool's joke on them, but I convinced them that we would be wasting our time because the Petzel lights were only bright enough to search a few metres effectively. Also, we only had a few spare batteries, so we would be limited to a few hours searching. I didn't relish trying to get back to the hut in the pitch black if our lights went out.

The next day, we packed up and hauled everything around to the Landing Bay. Russell and his son had arrived early and were waiting for us. The waves were much smaller than when we arrived, and we only got an occasional splash going back and forth to the boat. Once aboard, we rummaged in our barrels for dry clothes and discovered that we did have the barrel with the Cat Eye lights and scientific equipment after all. Clothes had been packed on top, so Corinne thought it was one of our barrels of personal gear. We reluctantly returned to Whitianga because I didn't have enough funds to pay Russell for another trip if we stayed on the island for another two nights.

We arrived in Whitianga at 2:30, rang Kaueranga Valley to advise we had left the island, had coffee at Café Nina, then drove to Coromandel and stayed the night with Rob Chappell. We cooked some of the remaining food for dinner. Rob suggested going back to Middle Island to do a final search on Wednesday night (returning the same night), and we agreed to this.

Wednesday 2 April

We unpacked all the barrels and cleaned the gear we had borrowed from the DOC Field Centre. Corinne, meanwhile, became concerned that she had an awful lot of work to do, so Katie and she left for Hamilton about midday. Rob was away checking the Alderman Islands for rats with Fin Buchanan and his rodent detector dog, so I sorted out the equipment for the coming night and stowed it in a barrel, made sandwiches for our dinner on Middle Island, and drove to Whitianga to meet up with him at 5 pm.

We arrived at the hut on Middle Island about 6 pm and ate our sandwiches while waiting for it to get dark. Started searching at 20:50. I led, checking the path and a metre or so on either side while Rob did the wider search behind. My Cat-eye battery started to fade about half an hour into the search, so Rob continued searching by himself and finished a complete circuit at 22:40. In the meantime, I returned to the Landing Bay for spare batteries for my Petzel light. We met again at the hut and started a second search at 23:04. This time, I went first, doing a wide search using Rob's Cat-eye light while Rob followed using his Petzel to search the first few metres on either side of the path. Finished at 2:10 am but saw no tusked wētā. We did, however, follow the usual procedure of recording every animal we saw. Returned to the dinghy at 2:40, arrived at Whitianga about 3:30 am, and got back to Coromandel at 4:20.

Thursday 3 April

Got up at 10:30 am, had an early lunch, and unpacked and cleaned the gear from the previous night. Rob and I then planned what to do next with the tusked wētā work. I left for home at 12:30 and stopped by the DOC Area Office at Thames to tell John Gaukroger, the manager there, what we had done, but he was out. Stayed overnight at a friend's home in Rotorua because I was too tired to drive back to Palmerston North.

Serendipity

We ended the field trip convinced that scrape-searching was impracticable for monitoring large areas. This was disappointing because our only other monitoring method requires spending many hours searching with spotlights at night. We would also be constrained by having to do it on moonless, warm, humid nights when it is possible to get ashore on the islands. Searching at night was our only viable option to detect the first island-born tusked wētā when they appeared. We were keen to detect them as soon as possible to get early confirmation that our translocations had succeeded and so were reconciled to the many hours of work this would entail.

Corinne eventually rescued us by devising a reliable method of detecting tusked wētā that was faster, easier, and more convenient to use than searching at night. She did this in time to confirm that the second generation of island-bred insects had reproduced. But I am getting ahead of myself again because that's a story for Chapter 27.

CHAPTER 24
SUCCESS

A first generation of island-bred wētā

We waited until March 2003 before searching for first-generation island-bred tusked wētā on Double Island and Red Mercury Island. By then, the insects we released should have died, and only their progeny should be present.

Leigh Marshall[148] from the Department of Conservation, and Matthew Low, a student at Massey University, helped this time. We combined our trip with one led by Graeme Taylor to share transportation costs. Graeme, Leigh Hull, and Clare Miller were going to collect Pycroft's petrel chicks on Red Mercury Island and release them in artificial burrows on Cuvier Island. The chicks would then be hand-fed until they fledged. This is the standard method for translocating petrels because the birds return after two to three years to nest on the island where they fledged.[149]

We planned to spend five days on Middle Island searching for tusked wētā and four on Red Mercury Island trying to find the first island-bred tusked wētā. I also hoped to get onto Double Island one night to search there. But we were delayed for four days by a storm, so I cancelled Middle Island and we went directly to Red Mercury Island with Graeme's party.

The sea was too rough to get ashore safely at Lunch Bay, but we managed to land with difficulty at Roly Poly Bay and camped there to avoid carrying everything over to Lunch Bay. Leigh, Matt, and I began work as soon as we pitched our tents, while Graeme's group kindly set up camp.

Our destination was the second release site in von Luckner's Valley. The usually dry stream bed that served as the track was now flowing water, which we waded up rather than struggle through the saturated bush alongside. We were rewarded by finding an adult female tusked wētā and two large juveniles under the release-saucers there. The adult must have been one of the insects we released in 2001, but the juveniles could only have hatched on the island and so were first-generation island-bred insects. I was well pleased.

148 Leigh had just taken over as convener of the MITW Recovery Group.
149 This behaviour is termed natal philopatry.

The campsite at Roly Poly Bay, Red Mercury Island. Photo: Leigh Marshall

We got back to camp about 8 pm to a dinner of perfectly cooked fresh kahawai that Graeme had caught trolling on the trip over. We carried our food and wine down to the boulder beach even though it was overcast and quite windy. It began drizzling soon after we finished eating, so we retreated under a large tarpaulin stretched between stout tree trunks.

The drizzle turned to steady rain when Leigh, Matt and I started for the release site at Lunch Bay that night, but stopped as we arrived, although the trees continued dripping. We did three careful searches with spotlights in line abreast where the release-saucers were (we covered about 900 m^2) and caught one tusked wētā. This was a half-grown juvenile, so it had hatched on the island.

We checked the exclosure next and saw a large juvenile tusked wētā that froze when illuminated. We left it alone because we intended to scrape-search the exclosure the next day and would measure it then. A search of the von Luckner site was next, so we waded up to and searched it thoroughly, but only found two small ground wētā.

It was drizzling when we got up around 9:30 am the next day, and the six of us huddled under the tarpaulin, eating breakfast and making sandwiches for lunch. We delayed about an hour before starting, hoping for a fine spell, but the rain had set in, so we put on our parkas and walked over to the exclosure. The normally dry gully down the Roly Poly Track to Lunch Bay was now an energetic stream which we had to jump over several times following the track as it wound back and forth across it.

We scrape-searched the exclosure, taking extra care in case small juvenile tusked wētā were present, but there was no trace of them. We found five large juveniles, though – two males and three females – in separate underground chambers. These were first-generation island-bred insects. We did wonder, though, if other juveniles had hatched and been cannibalised.

Lastly, we checked the release-saucers on the hillside above the exclosure, but no tusked wētā were under them. We finished mid-afternoon, ate our sandwiches, and returned to camp, where we relaxed until late afternoon, when we began cooking dinner for everyone.

The rain finally stopped when the meal was ready, so we carried it down to the boulder beach to escape dripping from trees at the campsite. Later that night, we went back to Lunch Bay and searched approximately three hectares centred on the release area and caught five tusked wētā. Their measurements indicated they were all new captures and not the three we had caught previously. It seemed there was a good population of first-generation wētā at Lunch Bay.

On the third day, we set off for Lunch Bay just before 11 am to scrape-search part of the release area. First, we marked out a plot six metres wide that ran up through the middle of the release-saucers for 8.7 m and uncovered one adult tusked wētā near the top. Then we marked out an irregularly shaped plot north of the first one and found one more wētā. Lastly, after lunch, we took about 20 minutes to search – without success – a small plot (2 m x 8 m) uphill (west) from the first plot. Overall, it took us an hour and forty minutes to scrape-search a total of 86 m^2, so each person searched about 17 m^2 per hour. This surprised me because this equates to a plot of 4.1 m x 4.1 m, and I had thought a person could easily search much more than that in an hour.

We finished about 4 pm and discovered, as we approached camp, that a wide, shallow sheet of water now occupied the upper part of the broad, flat valley we were camped in, and the front edge of the water was slowly creeping inexorably towards our tents. The water behind was flowing faster but was soaking into the soil. We had camped in a very wide, shallow waterway.

It wasn't long before the water was a few metres from Matt's tent, so we quickly helped him dismantle it and transfer to higher ground. Each of us then did the same with our tents.

We had now accomplished what we had planned for Red Mercury Island: we had confirmed that tusked wētā had reproduced successfully and produced a first generation of island-bred insects. All that we had to do now was to get onto Double Island during one night to find if tusked wētā had survived and reproduced there, but we had to wait for Jim Hope, who had transported us to Red Mercury Island. He was due to return the next day.

With nothing else to do, we went with Graeme's team that night and watched them catch a chick and then helped them catch more. But we were tired after working late the previous nights, so we left them after an hour and went to bed.

HOW USEFUL IS SCRAPE-SEARCHING?

Scrape-searching during this March 2003 field trip showed that it could be used to confirm if tusked wētā were present, but it was unsuitable for searching large areas because of the time it would take: the three of us took 100 minutes to search 86 m^2, so we each searched 17.2 m^2 per hour. If we wanted to estimate the density of tusked wētā in a larger area, then we would have to search close to 32 randomly located plots of equal size – 32 is the ideal number for this type of sampling. Fewer plots would result in a less accurate estimate (the predicted range within which the true density lies would be wider). For example, if we chose plots of 49 m^2 (7 m x 7 m), then it would take six people close to two 8-hour days to scrape-search 32 of them. If we reduced the plots to 25 m^2 (5 m x 5 m) – which reduces the chances of finding tusked wētā in each plot – then it would take three people one day to scrape-search 32 plots.

So, scrape-searching could potentially be used for estimating the number of tusked wētā in an area, but we couldn't justify the time to do this when all we needed was to confirm that the insects were present. The great advantage compared with searching at night is that scrape-searching can be done during the day.

Fine weather greeted us when we woke on the fourth day. The sea was moderately rough, and an underlying two-metre south-easterly swell was refracting around the southern headland of Roly Poly Bay, so waves ran along the boulder beach and broke at an angle to it. Graeme's team had caught about 30 Pycroft's petrel chicks, and Jim arrived late morning to take them to their new home on Cuvier Island. He also had four people with him who were going to join a gang of chick-feeders already on the island. I had never been to Cuvier Island, so I went along after helping load the birds. Leigh and Matt, meanwhile, stayed on Red Mercury Island to help catch the next batch of chicks.

The chick-feeders were clustered on top of a huge, tall, concrete Landing Block, eagerly awaiting the extra helpers and more supplies when we arrived at Cuvier Island. Behind them, a decrepit tramline ran steeply up to a path that sidled around to a group of houses and sheds where the lighthouse keepers lived before the light was automated. A winch (long gone) at the top of the tramline had once hauled up gear in a wheeled buggy from the landing block where a crane (also long gone) had once unloaded boats moored directly below. Everything now had to be carried up narrow concrete steps running diagonally up the seaward face of the concrete block, then hauled up the remains of the tramline and carried to the houses where the chick-feeders were living.

The Landing Block is situated in a wide south-west facing bay, bounded to the north by the headland where the lighthouse is. Here we were protected so well from the northerly swell that Jim lay his boat alongside the steps. Two chick-minders fended it off and held it in position while the other two and I formed a chain-gang up the steps and passed up the birds in their transfer boxes and barrels of supplies. This went quickly and smoothly until the last large barrel, which was far too heavy to pass from hand to hand. We only managed to heave it up one step at a time with one person pulling – the steps were too narrow and eroded for two people to work side by side – while I pushed from below. Its weight and suspicious clinking within indicated there were bottles inside, and I realised why the chick-minders might have been so eager for our arrival – they were to be well rewarded for their work. And fair enough, too, but why not wine casks or beer cans? Rob had emphatically told me that I was never to take glass containers (which can shatter) onto such islands.

As soon as everything was up on the block, Jim called me back to the boat so he could return to pick up Leigh and Matt and transfer us to Double Island in daylight. So much for exploring Cuvier Island.

I decided to cut the trip short after we finished with Double Island because we would then have all the information I wanted. So, I arranged to stay on Jim's boat overnight and return to the mainland with him the next day. Meanwhile, Leigh and Matt decided to stay on to help Graeme catch more chicks, so I got them to add a

Landing Block Bay, Cuvier Island. The landing Block and the tramline down to it, and some of the lighthouse keepers' buildings are visible. A Second World War radar station is hidden beneath the aerials on top of the island. Photo: Rob Chappell change of dry clothes to the barrel containing our spotlights while I packed up my gear, ready to leave.

As evening approached, we launched the dinghy and loaded it with our barrels. Then, just after Leigh and Matt climbed aboard, we were capsized by a large wave. We also had another unexpected swim as we were landing on Double Island.

Once ashore on Double Island, we dragged the dinghy well up onto the rocks, changed into dry clothes, climbed up to the release area and waited until it was dark enough in the bush – about 9:30 pm – to start searching. The groundcover had flourished since we liberated the wētā in 2000, and there were now far fewer clear areas where we could search effectively. Most of our time was spent parting vegetation before taking each step to ensure we did not stand on a wētā.

Just before we had to stop searching – Jim was due to pick us up at 10:30 pm – we found a large juvenile wētā. This could only be a first-generation island-bred insect, so we had confirmation that the insects had successfully reproduced at least once. We hurriedly measured it and slid back down to the shore, changed into our wet clothing, and waited for Jim. This time, we got off Double Island without capsizing, and I also landed Leigh and Matt back onto Red Mercury Island without incident.

Back on the boat, I changed back into dry clothes while Jim motored first to the western end of Double Island, searching for calm water and then to the west of Stanley Island, where he anchored for the night. The next morning, he decided to stay at sea (and fish) until he was due to take the final batch of chicks to Cuvier Island, so it looked unlikely that I would get home early. But, quite fortuitously, Rob Chappell arrived with Fin Buchanan and his predator-detecting dog to check some of the islands, including Red Mercury Island, for rodent incursions, and I was able to cadge a lift back to Whitianga with them.

More success: A second generation of island-bred wētā

I next visited Double Island and Red Mercury Island in early April 2005, when all the first-generation insects should have died, and any we found would be second-generation insects.

This was a four-day field trip with Rob, his daughter Esta and Greg Sherley, who was my manager at the Department of Conservation. We chose Lunch Bay on Red Mercury Island as our campsite because Rob had recently built a large shelter next to the old hut. It was an open-sided carport with transparent plastic roofing, which Rob had furnished with crude bench seats and a rustic table made from boards washed ashore on the boulder beach. It was perfect for cooking and sheltering from the rain. The hut, which had been pronounced 'manky' five years earlier during my seventh field trip, was now only fit for storage, so we pitched our tents near the sea on an area clear of vegetation.

As soon as we had carried everything up to the shelter, Esta, Rob, and I quickly pitched our tents and unpacked the food and cooking gear onto the table. Where was Greg? We realised he was still trying to pitch his tent, so we crept up and sat quietly nearby to watch. He had the base pegged out and was walking around and around it, trying to work out which fibreglass rod went into which sleeve. After a few minutes, he realised our chattering had stopped and looked around and saw his grinning audience. We razzed him and scoffed at his explanation of what bamboozled him: he had borrowed the tent, which was one of those complicated ones with poles of different lengths, and was unfamiliar with it. We continued to watch and provide gratuitous advice until he finally managed to get it pitched.

Our first task was to carefully scrape-search the exclosure. There, we found one live adult female tusked wētā, another adult female that had recently died and a partly decomposed adult male. Greg wanted to photograph the live insect, so we caught it in a large plastic food container and took it back to the campsite. When he was ready with his camera, I tipped the insect onto the table, and it immediately raised the front of its body, lifted its front legs off the table, spread them apart, and opened its jaws wide: this is the threat posture. It was ready to bite. But it was in the wrong place for Greg to photograph it, so he picked it up even though I warned him to wait until it had calmed down. The inevitable happened: he got bitten where the skin is stretched between thumb and forefinger on his right hand. He swore and promptly dropped the insect, fortunately without flicking it off (it might have been damaged if he had flung it onto something solid). Rob and I eventually caught it again after an energetic chase amongst our haphazardly stacked groceries. Greg, meanwhile, ignored the turmoil around him and cleaned his bloody hand with disinfectant and applied a sticking plaster.

Tusked wētā (a large juvenile female) in the defensive stance with forelegs raised and jaws open. Photo: Ian Stringer

I took the opportunity to razz him again (he would certainly have razzed me in such a situation) by reminding him that these insects include decaying animals in their diet and are even partial to a snack of bird poo – and they don't clean their teeth with toothpaste! Greg proudly showed us the bite each subsequent morning with a "Look! No sign of infection. See, it's healing."

We then put on surgical gloves, which we should have done in the first place, and Greg photographed it without further incident. Wild wētā, when handled, usually bite humans, but are docile if you wear surgical gloves, whereas captive-reared wētā can be held with bare hands without being bitten[150]. We measured the wētā when Greg had finished, then dabbed a tiny spot of white Twink® behind the head so we could recognise it if we saw it again and let it go under a release-saucer on the hillside above the exclosure.

That afternoon, we checked the other release-saucers on the hillside (there were no wētā under them) and systematically scrape-searched a 10 m x 10 m area in the centre of the release area, where we unearthed two medium-sized juvenile tusked wētā. These were just what we hoped for – they could only be second-generation island-bred insects.

We celebrated with a swim and snorkelled out over the boulder-strewn seabed, admiring the usual variety of invertebrates, including starfish, small paua, and kina (sea urchins). Small fish were abundant – mostly pākirikiri (spotties), some red moki and juvenile snapper, and several blue maomao. We also saw two black angel fish and a few demoiselles, which I had only seen in deeper water when scuba diving around offshore islands. We enjoyed this so much that we chose to swim each afternoon instead of using our solar showers to wash with warm stream water.

After dinner, we searched along the Te Roroi Stream track with spotlights and found two live tusked wētā – an adult male and adult female – and an adult female that had recently died. On our way back to camp, we found the adult female we had marked and released. It had crossed the stream and was 13.8 metres from the release-saucer we had left it under.

We finished the night by walking up to the von Luckner release site (the stream was dry) and carefully searched it but saw no wētā there. We were, however, restricted to the immediate area around the release-saucers because the surrounding area was densely carpeted with low ferns.

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150 We discovered this by accident when we used surgical gloves to protect our hands from the superglue we used to attach harmonic radar transponders.

Early the next day, Rob took us to Double Island, where we scrape-searched a 16 m x 3.9 m plot running uphill through the centre of the release area. We uncovered two large juvenile females and an adult male, and Esta found a third large juvenile female just outside the plot. It was under a log she dislodged while reeling in one of the tape measures we used to mark the edges of the plot. These were the insects we had hoped to find: second-generation island-bred tusked wētā, and they confirmed that the translocation to Double Island had also been successful so far.

We had lunch when we returned to Red Mercury Island and then scrape-searched a second area of 30 m^2 (10 m x 3 m) alongside the Te Roroi Stream track. This was on the same side as the shelter and yielded three juvenile female tusked wētā and seven unoccupied chambers. Later that night, we saw two juvenile females, an adult female, and three juvenile males when we searched the Te Roroi Stream track. Most were within five or so metres of the stream, so it looked like all we had to do was search alongside the stream if we wanted to find tusked wētā in future.

Much of the third day was spent scrape-searching a 5 m x 4 m plot at the von Luckner release site and checking under the release-saucers there, but we didn't find any tusked wētā. This scrape-search was particularly difficult because the soil was dry and hard, and it was covered with a matrix of interlocking tree roots.

We had now accomplished everything we had planned to do on both Double Island and Red Mercury Island, so we took the rest of the afternoon off. Greg had brought a collapsible rod and headed off to the beach carrying his fishing tackle in a large white bucket he found in the hut. Esta, Rob, and I relaxed under the shelter, chatting until we got tired of swatting flies and went to see how Greg was getting on. He was on a ledge at the end of the western headland, silhouetted against the glittering sea with his rod bent into a C while he repeatedly leaned back, then bent forward slowly while furiously reeling in. This looked worth watching, so we boulder hopped closer to the base of the headland. The boulders there are large and pile steeply up from clear water three or so metres deep. Swishing back and forth over the seabed were the white bucket and various bits of fishing gear – a spare roll of line, an opened packet of bait and so on. Greg yelled when he noticed us, but it was lost in the noise of the waves breaking below us. He kept yelling until we realised it was something like, *"I need a hand. Come and help."*

The only ways to get to him were to swim or take a long detour over the top of the headland. The usual access was a narrow ledge now partially submerged by the rising tide, and 1.5 m high waves were running along the rock face, which would

A ROLE REVERSAL

Greg Sherley and I share a long history. I taught him during his second year at Massey University when I had just started as a lecturer. I must have been awfully bad, but even so, some years later, when he was the scientist responsible for endangered invertebrates in the Department of Conservation, he invited me to collaborate with his research on threatened *Placostylus* land snails, and we worked together on them until 1998. Greg also set up the tusked wētā project that year and got funding for it. He intended to do the research himself but was seconded to the South Pacific Regional Environment Programme based in Samoa. He converted the funding for both the *Placostylus* and tusked wētā projects into contracts so I could continue the research.

We resumed collaborating when Greg returned to the Department of Conservation in 2001. I left Massey University in 2002 and took up a scientist position in the Department of Conservation and we continued working together until Greg became a manager in 2004 and was my boss.

sweep us off. None of us relished the thought of walking back in sopping clothes if we swam out, and going over the headland would take quite some time. "No!" I yelled, but I was shouting into the wind. So, we all yelled "NO" together, but he kept beckoning us whenever he could spare an arm. He eventually realised we were not coming and we tried to shout why we weren't, but it was completely hopeless, so we sat down and watched.

He was having an exhilarating time playing something large and powerful. It was probably a stingray or a large eagle ray from the way it was circling and zig-zagging back and forth in front of him. I could well imagine the high-pitched thrumming his tightly stretched line must be making. The line eventually snapped, and Greg reeled in the slack and looked around for his fishing gear, which had vanished. So, he climbed up the steep, high rocky headland and disappeared into the forest.

I thought he would go over the headland, but he must have sidled around it because he emerged halfway up a high slip-face. We watched with trepidation as he slowly but safely negotiated this by holding on with one hand while grasping his rod in the other. He was angry when he got down onto the boulders. I had only seen him angry once before, when his top-of-the-range mountain bike was stolen in Samoa while I was visiting him: I feared for whoever was riding it if Greg ever saw them. He calmed down when we pointed out that the narrow access ledge had been cut off by the rising tide and showed him his fishing gear rolling about on the seabed in front of us.

As soon as we got back to camp, Greg grabbed a mask and snorkel and went back to retrieve what he could. He surprised us by returning with everything except the bait.

It seemed appropriate to celebrate finishing our work with a wine and cheese that evening. A strong wind was blowing into the beach, so we had it under the shelter after trying to block off some of the wind with driftwood, our barrels and two mouldy mattresses from the hut.

Our last day was spent exploring some of the tracks, then we had an early dinner, and Rob took us over to Middle Island. Once it was dark, we searched in pairs in opposite directions for almost three hours but saw no tusked wētā. We did find (and recorded) between us a total of 18 ground wētā, six cave wētā, 56 darkling beetles (*Mimopeus opaculus* and a species of *Chrysopeplus*), nine spiders, four ground beetles (carabids) and one large centipede.

We eventually got back to our tents on Red Mercury Island about 1 am. We returned to the mainland later that morning, very pleased that there were now second-generation island-bred tusked wētā on both Double Island and Red Mercury Island.

We were now so confident that our translocations had been successful that Rob and I published the results.[151]

An adult female tusked wētā (it was alive and – fortunately – docile) on a wine cask in the shelter at Lunch Bay. Photo: Ian Stringer

151 Stringer and Chappell (2008).

PART 5

ENSURING LONG-TERM SECURITY

Translocations to more islands

Our experimental translocations to Double Island and Red Mercury Islands seemed to have succeeded by 2005, and we were hopeful that the insects would establish long-term self-perpetuating populations on the islands. The Mercury Islands Tusked Wētā Recovery Group therefore decided to translocate tusked wētā to other islands nearby to increase the species' security. It made sense to do this while Chris Wink's captive rearing facility was still operational, rather than starting from scratch later, so the requisite funding was obtained, and the additional translocations are described in Part 5 below.

The northern landing beach on Korapuki Island. The view is to the northeast with part of Green Island and a small unnamed islet in the distance. Photo: Ian Stringer

CHAPTER 25

A NEW FIELD BASE

Korapuki Island

I first stayed overnight on Korapuki Island in October 2001 when Richard Parrish (Department of Conservation) and I were on our way to Middle Island. We shared a charter boat with David Towns and Chris Green (both Department of Conservation) to reduce costs, and as Katrina Hansen (Department of Conservation), my other volunteer, had been delayed for two days, we took the opportunity to take a short stay on Korapuki Island. Rob Chappell was taking her to Middle Island when she arrived in Whitianga and offered to pick us up from Korapuki Island when he did this.

David and Chris were using Korapuki Island as a case study for restoration.[152] They had translocated several skink species and Auckland tree wētā (see text box 'Korapuki Island: a restoration case study') onto the island, and Richard, who was interested in reptiles, and I wanted to see how these species were faring. Richard also wanted to sample the micro-snails (one of his many specialities).

We were completely taken with Korapuki Island. The hut was luxurious compared with the one on Middle Island, and we were not plagued by flies as we were on Red Mercury and Middle Islands. There were relatively few seabird burrows, so we could walk wherever we wanted, provided we avoided stepping near their entrances. Bird burrows were also well spaced apart on Red Mercury, but getting ashore there or departing could be difficult or dangerous, whereas Korapuki Island is more accessible. Most landings are made on a small stretch of sand at the eastern end of a north-facing gravel beach. Great Mercury Island and the other Mercury Islands provide some shelter from the north and east, while a low reef and the mainland, further away, provide protection from the west. Two small boulder beaches on the south side of Korapuki Island often suffice when it is too rough to land on the north-facing beach.

A picturesque lagoon adjoins the eastern end of the south-eastern beach. It is mostly encircled by high cliffs except where a narrow stretch of boulders cuts it off from the sea. Access is through a cave at the base of a towering precipitous pinnacle. The lagoon looks safe for getting ashore in calm weather, but Chris was emphatic that we should never do this.

152 Towns (2023).

The lagoon on the south side of Korapuki Island with a surge coming through the cave. The end of the eastern boulder beach is on the right. Photo: Lesley McKay

"Why ever not?" I asked. *"Surely we could drag the dinghy high up on the rocks where it would be perfectly safe."*

"No! You must NEVER do that!"

Chris explained that when they did this once a strong southerly developed while they were on the island. Huge, steep waves were coming through the cave when they wanted to depart. The height and steepness were created by the cave's funnel-shaped seaward entrance and the shelving seafloor. Some waves almost reached the cave roof.

They were in a tricky situation because they used an outboard motor with their dinghy and were reluctant to leave the adjacent beach in case the surf crashed their boat on the boulders and wrecked the motor. The dinghy and motor couldn't be hauled up the cliff and across the island, and they couldn't leave the dinghy for Rob to collect later because they needed it to ferry everything to a charter boat anchored off the calm northern beach, patiently waiting to return them to the mainland. Their only option was to take the dinghy out through the cave. So, Chris jumped aboard, started the outboard motor, and waited idling in the lagoon until David, stationed on the boulders looking out to sea, yelled when there was a lull. Off Chris went at full throttle only to find the waves in the tunnel were still terrifyingly steep and high. They never left the dinghy in the lagoon again.

When we later based ourselves on Korapuki Island, we, of course, rowed our dinghy around to the cave on a calm day and entered the lagoon (I never used an outboard motor because most of my landings were on rocks or boulder beaches).

There was almost no swell out at sea, but waves still materialised in the mouth of the cave and got bigger as they entered. We experienced a giddying sensation of going up and down about a metre or so quite abruptly, intensified by the cave walls. It was fun, but we could appreciate how helpless and terrified Chris must have felt when the waves were huge.

On later trips, as you might imagine, we often swam in the lagoon on warm days. All we had to do was climb down a steep rocky ridge and jump in. The vegetation alongside this ridge was always severely damaged by salt spray – almost blackened – up to the cliff top because it was opposite the cave entrance, so the wind must blast through the cave during southerly storms.

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But I have digressed, so back to the October 2001 field trip.

We got everything ashore easily on the northern beach and started carrying things up to the hut. This was securely locked, and the windows and skylight were covered with heavy, thick plywood covers fastened with bolts that passed right through the framing of the hut. David unlocked the door, and then Chris and he transformed into a mostly silent, efficient, and wonderfully coordinated team. Gone were the good humour and lively banter that otherwise constantly surrounded them. They shooed us out of the way.

They uncovered the windows first. David, outside, held a bolt head while Chris, inside, undid the nut with a large adjustable spanner. Communication was reduced to brief shouts: David would yell *"top left"* and push down on the bolt head to stop it rotating. A muffled shout of "done" eventually came from inside, and David pulled the bolt out; then David yelled *"top right"* and so on until the plywood cover was lowered to the ground.

Immediately, the first cover came off, a gecko scurried off erratically across the wall, and a few others (it was hard to count them in the confusion) fell to the ground and zig-zagged frantically away under the hut or into the undergrowth. This was entertaining, so we followed David to the next window and watched the geckos scatter when that cover was removed.

Richard and I then watched, fascinated, as David and Chris continued to get the hut ready. What could we do to help? Nothing apparently – except bring more gear up from the beach, starting with the chilly-bins (and "please put them under the veranda out of the sun"). They later told us it was faster to do everything themselves than to explain what was needed. Everything in the hut also had its place, and I suspect they were concerned we would put things away in the wrong places and they would waste time searching when they were packing up to leave. I think their concern was justified.

Richard and I carried the chilly bins up and then stood outside the veranda watching quietly, awestruck, and deeply impressed. Mattresses (stored on their side to prevent mould) were pulled onto the bunks, a solar panel and a long cable appeared and were connected up to a large battery (YES! this hut had electric lighting!), a tall antenna was erected and connected to a two-way radio, a flexible gas hose was poked through a hole in the wall and the stove inside was linked to the gas bottle outside (which we had carried up). There was much more, but what topped everything off for me was watching them pour water into shallow pans in an old-fashioned meat safe (a shaded external cupboard with fine mesh walls) and setting the cut stalk ends of broccoli, cabbage, and lettuce in the water to keep them fresh for longer. This hut was certainly a step up from the one on Middle Island, so I kept Korapuki Island in mind as the ideal base for future field trips when we began spending more time on the other islands.

You might wonder why we didn't release tusked wētā on Korapuki Island in the first place. Department of Conservation staff decided to translocate them onto Double Island during my first meeting at the Kauaeranga Visitor Centre in 1998, and Red Mercury Island was added soon afterwards (Chapter 17). I only realised how unsuitable Korapuki Island was for releasing the first precious captive-reared tusked wētā during this October 2001 trip: geckos, including the large Duvaucel's gecko, and skinks are just too abundant. Double and Red Mercury Islands were more suitable because they had fewer of these predators.

When I think back to my visits to Korapuki Island, what impressed me most was how abundant skinks and geckos were on the gravel beach at night. We usually saw several every metre or so, mostly along the wrack of seaweed and other flotsam at the high-tide mark, where they foraged for sandhoppers and other invertebrates. This showed me how much rodents depress lizard numbers because I cannot recall ever seeing geckos or skinks on mainland beaches at night.

Once David and Chris had finished organising the hut, we carried the rest of the gear up, had lunch and followed David over to one of the south-facing boulder beaches where he checked it was suitable for releasing the 83 juvenile Suter's skinks (*Oligosoma suteri*) he had brought. The skinks had been reared at Victoria University of Wellington from a few individuals David had captured on Green Island some years previously. These skinks are sometimes called egg-laying skinks because they are the only native skink or gecko to do this: all the others give birth to live juveniles.

David pronounced the beach a suitable habitat, and we returned to the hut, where he measured 12 of the skinks. We then trooped back down to the beach, carrying them in their travel containers, and let them go. The release, though, was disappointing in that the skinks quickly vanished between the boulders without so much as a backward glance.

We spent the rest of the day dodging rain showers while we collected bags of well-rotted leaf litter for Richard. He was looking forward to the lengthy process of extracting the micro-snails by hand back in Whangārei.

The second day dawned fine and cloudy with a strong south-westerly, so David gave us a guided tour of the eastern end of the island. He led us up a ridge to the highest point then down a barely discernible track on a steep bush-covered slope. We emerged onto a wide rock ledge perched a few metres above the high-tide mark at the eastern tip of the island. Richard happily collected a few tiny black *Potamopyrgus* snails from a thick mat of bright green algae that fringed a large stagnant pool of brackish water. David pointed out a narrow fissure in the high vertical rock face bounding the southern end of the ledge. We took turns peering through to view a semicircle of high reddish cliffs with a fringe of jumbled rocks at their base bordering the sea.

We had now seen all the points of interest and decided to return to the hut. But we couldn't find where we had emerged onto the rock ledge, so we pushed our way into the bush and cast around for a while but still couldn't find the track. Our only option was to struggle straight uphill through the thick vegetation to the top of the hill. However, our way was barred by a cliff partway up that angled upwards to our right, so we followed this and eventually reached the hilltop. From there, it was simply a matter of retracing our steps down the ridge back to the hut.

Another insect translocation

Rob Chappell arrived with Katrina on the third day, and we transferred to Middle Island, leaving Korapuki Island to David and Chris. We were overjoyed to find we could land directly below the hut and were saved the effort of carrying everything around from the Landing Bay. But this field trip, like most of the others to Middle Island, was unsuccessful even though we spent many hours searching during the three nights we were there. We did, however, initiate the first stage of a translocation of large *Mimopeus* beetles to Korapuki Island for Chris Green.

He provided us with 50 small artificial roosts, which he hoped the beetles would take refuge in during the day. The roosts were small, elongated wooden boxes with an open end. We nailed these with the open end facing downward to the trunks of

A large Mimopeus *darkling beetle (*Mimopeus opaculus*: Tenebrionidae) (16 mm long). Photo: Rob Chappell*

milk trees on the Central Plateau. If the beetles used them, then Chris intended to take the roosts, together with the beetles inside, over to Korapuki Island and attach them to tree trunks there.

Large *Mimopeus* beetles are stout black insects about 1.5 cm long. They were the most abundant insect we saw at night on Middle Island – on average 26 per search and up to 102 on 'good nights'. Almost all were grazing on a thin layer of green moss or lichen that grows on the trunks of milk trees. Another species of *Mimopeus* also lives on Middle Island, which we called small *Mimopeus* beetles because they are about half the size of the large ones. We only ever saw them on the trunks or branches of fallen trees or the trunks of living pōhutukawa trees, so the two species never seemed to mix.

We checked Chris's artificial roosts during the next field trip to Middle Island in December 2001. Twenty were crammed with large *Mimopeus* and others had cave wētā, slaters, spiders, and a gecko. Only two were empty. The roosts were similarly occupied when we checked them in April 2002. Chris then transferred 50 beetles to Korapuki Island in late 2002. This matched the 50 he had previously translocated there in 2000. The translocations were successful but it was several years before the beetles were seen again.

We continued to use the hut on Middle Island when we searched for tusked wētā, but Korapuki Island became our field base from 1999 to 2012 when we worked on the other Mercury Islands. These visits to Korapuki Island were made once a year to monitor tusked wētā after translocating them to all the large Mercury Islands, except Great Mercury Island, which was privately owned. The visits were in late summer when the weather was usually settled, and we, of course, also chose this time of year because it was pleasantly warm and perfect for swimming and sunbathing.

But I've got ahead of myself, so I'll return to the tusked wētā story in the following chapter.

CHAPTER 26
SECURITY IN NUMBERS

An unexpected problem

Planning for the second series of translocations to additional islands near Middle Island, Double Island, and Red Mercury Island began in 2006. The intention was to captive-breed sufficient wētā to release 60 on Stanley Island in 2007. Any additional ones were to be released on Korapuki Island, preferably in groups of 50. Ngati Hei, the Māori owners of nearby Ohinau Island, had asked Rob Chappell if tusked wētā could be introduced there, and the Recovery Group agreed to do this in 2008 if enough insects were available (rats and rabbits were exterminated on Ohinau Island in 2005).

Captive-breeding, in the meantime, had not gone well: each generation of captive-bred wētā had become increasingly infertile, and by 2006 Chris Winks only had three females. The solution, Chris hoped, was to capture some from Double Island or Red Mercury Island and captive-breed from them. These, of course, were descendants of the wētā we had released there between 2000 and 2002.

Smoke!

Rob Chappell, Chris Winks, Melissa Thompson, and I went to collect the tusked wētā Chris needed during a day trip in early May 2006. We headed into large choppy waves on our way to the Mercury Islands, so we all held onto the quarterdeck of the *Kuaka* to steady ourselves. Rob, Melissa, and I sheltered behind the windscreen while Chris perched nonchalantly on the port gunwale beside me. As we neared the islands, Melissa, straightening her arms to stretch them, looked down and shouted, "Smoke!" Rob instantly cut the power, and the boat stopped dead in the water. We were all flung forward: Chris and I managed to brace ourselves, but Melissa, who was looking down, was caught by surprise and smashed into the quarterdeck. Her life jacket cushioned her body against the edge, but her forehead got gashed by the top of the windscreen.

First things first: where was the smoke coming from? It turned out to be road dust flung into the air as the boat pounded into the waves. It must have been trailered over a dusty gravel road recently. Next: the first aid box. We got Melissa to hold gauze over the cut and apply light pressure until the bleeding stopped. Then we put a large sticking plaster over it and fussed about cleaning lots of blood from her forehead and face. Rob wanted to take her back to Whitianga, but no, she had not come from Palmerston North to spend the day waiting to see a doctor and return home without seeing a tusked wētā. She insisted she was perfectly OK. We carried on.

Large waves prevented us from landing at either Lunch Bay or Roly Poly Bay on Red Mercury Island, but we were surprised to get ashore on Double Island. We climbed up to the ledge where the insects had been released and marked out a 10 m x 10 m area to scrape-search. The intention was to restrict ourselves to this area to ensure that we didn't harm the population by removing too many wētā.[153] Melissa, Rob, and I then systematically scrape-searched it, working side by side, going uphill while Chris hovered about and caught the tusked wētā as we exposed them. We stopped when Chris had his two pairs of adults – we had searched 77 m^2 and uncovered five adults and two juveniles in individual chambers, plus one adult male that was hiding within the leaf litter. We also found three empty chambers.

Rob and I were pleased because it indicated a thriving population on Double Island. Chris was pleased to have two pairs of tusked wētā for captive-rearing. Melissa was pleased we had continued after the accident and was delighted to have found two tusked wētā.

Releases on additional islands

Chris, as if by magic, produced 334 juveniles from these adults in early 2007. He reared each insect in individual containers by himself, a hugely impressive effort. The Recovery Group allotted 100 wētā to each of Korapuki, Stanley, and Ohinau Islands and the remaining 34 to Cuvier Island (195 ha), 15 km north of the Mercury Islands.

By June 2007, the first lot of these insects was half-grown and ready to translocate. We started the releases on Korapuki Island by letting them go in holes we made with sharpened sticks on the flat area south of the hut. This was done in two batches, a few days apart, because we thought it would take too long to release all 100 in one day, but each release took a little over an hour.

Stanley Island was next, but we had to wait until the next batch of 100 half-grown insects became available in mid-July. Rob had chosen two sites and warned that it would take a day to release the wētā at each site because of the time it takes to reach them. I looked forward to going with him because I had never been on the island.

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153 The rule of thumb is that a population is unlikely to be harmed by removing 10% of the animals. The area of 100 m^2 is far smaller than 10% of the area of the ledge so fewer than 10% of the tusked wētā would probably be within it.

The opportunity came on July 18, 2007. We landed on the western beach and spent some time tipping Vermiculite™ out of the containers the wētā were transported in to lighten the load. High cliffs completely backed the beach, and I couldn't see any way up them, but Rob, of course, knew the way. He led Oliver Overdyke (Department of Conservation), Leslie McKay (whom Rob later married), and me over a low spur covered with dense scrub and onto the northern beach. He then went directly to one of the pōhutukawa trees growing along the edge of the beach, scaled a low bank beneath it, and climbed rapidly up a very steep chute by holding onto tree roots and rocks on either side. There was nothing to hold onto in the centre, just smooth soil. We hurriedly followed before he disappeared altogether and emerged onto a poorly defined track that continued straight up. This, thankfully, was less steep than the chute, although we still grabbed flax and other vegetation to help haul ourselves up. I could imagine how tiring it would be if we camped on the island and had to carry everything up, including water and gas bottles.

Landing on Roly Poly Bay, Red Mercury Island. The floating rope was used to pull the inflatable back and forth to Bill Hope's boat. View to the west with Stanley Island to the left, Great Mercury Island to the right and Double Island above the cabin. Photo: Leigh Marshall

Rob waited for us at the top and then led us along a well-defined track to a large aviary about a third of the way along the island. This had been used to acclimatise birds to the island before releasing them (referred to as soft releases). We set about releasing 50 wētā nearby in holes we made after first scraping away deep leaf litter. This area became known as the Birdcage release site.

Two days later, Rob and I, together with two of Rob's friends, Dan Rapson and Kaye Robarts, returned with another 50 wētā. This time we went past the birdcage, following a well-marked route that sidled along the island through open forest. About a kilometre later, we emerged into a large area clear of vegetation or tree trunks but shaded by branches from surrounding trees. To our left, as we entered, was a pool backed by a long wall of black rock a few metres high. The rest of the area was a semi-circular depression that sloped gently towards the pool. This was the Amphitheatre site with the rock ridge as backdrop, the pool as the stage, and the semi-circular area as the spectator stands. All that was lacking were terraces for seating. The pool had no outlet and occasionally dried up, according to Rob, but the soil was always moist. It was ideal for tusked wētā.

The ground was covered with a thick layer of leaf litter, which we scraped away before making the release holes, just as we had done at the Birdcage site. It took us well over two hours to complete the release, then we sat for some time on some of the smooth moss-covered rocks around the periphery of the clearing, eating sandwiches and enjoying the tranquillity of the bush around us.

Other commitments prevented us from releasing tusked wētā on Ohinau Island until November 2007. Even then, there were only a few days when we were free from other work. We, of course, chose the day with the best forecast – fine in the morning with a calm sea but with a change to a strong westerly in the afternoon and increasingly rough sea. We thought we could get the release done in time to avoid the worst of the weather.

We left Whitianga at 9 am, with Joe Davis of Ngāti Hei and Leslie McKay. This time, we took all 100 wētā with us and removed the Vermiculite™ at the marina before loading the transfer containers into our backpacks.

Rob anchored the *Kuaka*, and we got ashore dry-shod on a boulder beach along the western side of a flat tongue of land that extends north. Joe welcomed the insects with a powhiri and blessed them with a karakia (prayer),[154] then Rob immediately set off while we scrambled along behind trying to keep up. Our immediate destination was a very steep hillside flanked by coastal cliffs. Rob pushed his way through vegetation near the base and onto a track that led diagonally up the hillside to the top of the island. The entrance to the track was well hidden, and we were thankful for Rob's local knowledge because the alternative was to climb through dense scrub.

The top was covered in bush but devoid of ground cover, so it was easy walking. Rob took us to a wide, shallow valley that drains to the east, and we set about letting the wētā go as soon as we reached it. The ground was covered with a dense mat of intermingled pōhutukawa tree roots, which slowed us considerably in our search for suitable places to make holes. We eventually completed the liberation by extending the release area a small way up the valley.

154 Ngāi Hei own Ohinau Island.

Large waves greeted us when we got back to the beach, but we got back aboard the *Kuaka* without mishap. We then headed back to Whitianga into steep, choppy waves. Sheets of spray burst from the bow each time we met a wave and were blown back into the boat. Lesley and Rob stood side by side behind the windscreen and tried to shelter as best they could by ducking down to avoid the bouts of spray, but they still got doused regularly with seawater driven, stingingly, straight into their faces. Some inevitably got forced in around the hoods of their parkas and trickled down, uncomfortably, through their clothing. Joe and I sat in the stern looking aft with our backs to the spray, having a shouted conversation over the noise from the outboard motor. Our parkas kept our bodies completely dry, but our boots filled with seawater and squelched when we got ashore. Even so, we reckoned we were better off than the two up front.

Packed and ready for a field trip (before the dinghy was lashed over the stern). The coiled yellow rope is used to pull the dinghy back and forth from boat to shore. Photo: Ian Stringer

The last 34 tusked wētā Chris reared were released on Cuvier Island in April 2008 by Rob and Wendy Davis (Department of Conservation), but that's a story for Chapter 29.

KORAPUKI ISLAND: A RESTORATION CASE STUDY

Dave Towns, Ian Atkinson and Charles Daugherty suggested in 1989 that the fauna and flora of Korapuki and Double Islands should be restored and that these islands should also be used as a nursery for rare or threatened species. Their plan was to translocate small numbers from Green Island or Middle Island to Korapuki Island and subsequently harvest them for translocation to Red Mercury and Stanley Islands after they were established. David, Ian, and Charles also suggested that Stanley and Red Mercury Islands should be managed to ensure the survival of species already there and that these islands could act as refuges for other endangered or vulnerable species. However, Green and Middle Islands, which have never had rodents, should be managed to "minimise both human interference and the influence of introduced plants and animals, which would be removed where feasible" (Towns *et al*. 1990). Double Island is now reserved for invertebrate restoration but only tusked wētā have been translocated there so far.

Korapuki Island was the first of the Mercury Islands to be completely cleared of mammals (introduced originally by humans) when kiore were eradicated in 1986. Kiore were also eradicated from Double Island later the same year. Exterminations of these rodents then followed on Stanley Island (1991), Red Mercury Island (1992) and Cuvier Island (1993). Cuvier Island also had goats, which were removed in 1961, livestock which left with the lighthouse keepers when they departed in 1982, and feral cats which were eradicated by 1994. Rabbits were originally present on Stanley Island but were exterminated in 1991 together with kiore during a combined eradication. So, by 1994 all the Mercury Islands were mammal-free except for Great Mercury Island which is privately owned. Rats and cats, however, have now been exterminated from Great Mercury Island as well (Chapter 30).

Restoration of Korapuki Island began with the translocation of Whitaker's skink (taken from Middle Island) in 1988. Since then, David has translocated robust skinks (*Oligosoma alani*), marbled skinks (*Oligosoma oliveri*) and Suter's skinks (*Oligosoma suteri*) onto the island (between November 1992 and March 1993). All were captured from Green Island. Robust and marbled skinks were released immediately but Suter's skinks were bred at Victoria University of Wellington and both the original individuals and their progeny were later released. Chris, not to be outdone, released Auckland tree wētā (*Hemideina thoracica* from East Double Island) in 1997 and darkling beetles (*Mimopeus opaculus* from Middle Island) in 2000 and 2002. Artificial roosts were used for transferring both species, and Chris successfully monitored the tree wētā using their roosts but the darkling beetles left their roosts and never returned.

CHAPTER 27

TRACKING WĒTĀ

A better monitoring method

"Why don't you try tracking tunnels to monitor tusked wētā, Ian?"

"I will. I planned to try them after we release tusked wētā on the other Mercury Islands next year, so I'll use them in early April 2008. I was also going to ask if you and Danny would like to be involved. How about it?"

"Of course we do. Let us know the dates as soon as you can, and we'll free up our time."

It was January 2006, and Corinne Watts, Danny Thornburrow (both Manaaki Whenua - Landcare Research Ltd.), and I were on Matiu/Somes Island in Wellington Harbour, using footprint tracking tunnels to document the slow spread of Cook Strait giant wētā over the island after they were released at the northern end.[155] Cook Strait giant wētā are active on the ground at night, so tracking tunnels should work with tusked wētā as well. As it turned out, they worked brilliantly.

A 'Black Trakka' tracking tunnel with a white tracking card partly inserted. The foliage is from a large-leaved milk tree (Streblis banksii). *Photo: Danny Thornburrow*

Unbeknownst to me, two weeks before our discussion, Pim de Monchy, who worked for the Department of Conservation in Whitianga, set tracking tunnels on Red Mercury Island to make sure rodents had not invaded. He reported that he had "... picked up big weta tracks in [one tracking tunnel]." Pim also reported seeing up to 12 tusked wētā each night between the "coast and the Rolly Polly/Trig junction ... The eastern limit may be about 100 m east ... [along] the track

155 Watts, Thornburrow, Stringer and Cave (2017).

to von Luckner's."[156] Pim knew tusked wētā had been released on the island and realised they were the only insects large enough to leave such big footprints. Pim filed his report, and it was forgotten until I found it two years later by pure chance.

The idea for using tracking tunnels for monitoring wētā originated from Corrine and John Innes[157] (Manaaki Whenua - Landcare Research Ltd.) while they were using them to check if rats were getting past the predator exclusion fence surrounding Sanctuary Mountain Maungatautari.[158] Corinne thought some of the footprints on the tracking cards might have been made by some of the Mahoenui giant wētā she had released there and asked me if I thought tracking tunnels might be suitable for detecting wētā. I confess that I was sceptical because insects certainly leave numerous small dots and scratches on tracking cards, but I thought their footprints wouldn't differ enough to distinguish species. Fortunately, as it turned out, I kept my doubts to myself and encouraged her to investigate further. She got wētā to walk through tracking tunnels in the laboratory and discovered that their footprints are quite different from those of most insects.

Corinne and Danny then ran a field trial to check if tracking tunnels could be used for detecting wētā. The 'Black Trakka" tunnels[159] they used were manufactured by Warren Agnew, so they invited him to collaborate because he was looking for additional uses for the tunnels. They did the trial on Little Barrier Island, where wētāpunga lived. These are the largest of the giant wētā, so their footprints are much larger – and therefore more easily identified – than those of any other insect on the island.

They set tunnels on both the ground and in trees and found wētāpunga footprints at both locations.[160] This surprised them because wētāpunga are arboreal, so they thought they would only go onto the ground occasionally (they knew that adult females do so to lay their eggs in soil). The tracking tunnels worked so well that Corinne, Danny, and I subsequently used them to monitor Cook Strait giant wētā on Matiu/Somes Island[161] and Warren was so pleased to find another use for his tunnels that he generously donated all the ones we used for our subsequent investigations.

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156 de Monchy (2006).

157 John Innes began using tracking tunnels to detect Ship rats for his MSc degree, and rats became one of his long-time research interests (e.g. Innes (2005), Innes, King, Fux & Kimberley (2001); Innes & Skipworth (1983)).

158 This is a predator-free area of 3400 ha surrounded by 47 km of pest-exclusion fence. (https://www.sanctuarymountain.co.nz)

159 Connovation Ltd.

160 The results are published in Watts, Thornburrow & Agnew (2008).

161 Watts, Stringer, Thornburrow & MacKenzie (2011).

Tracking tunnels and wētā footprints

Footprint tracking tunnels are used extensively in New Zealand for monitoring small mammals such as rodents, hedgehogs, and stoats. Their footprints are recorded on white removable cards after the animals walk over an area of thick, gooey ink in the centre of each card. An attractive bait (we used peanut butter for wētā) is usually placed on the ink, and everything that goes through the tunnel, including reptiles, insects, and even snails, leaves their footprints behind.

The feet (tarsi) of wētā have inflated pads (euplantae) that leave rows of three and sometimes four distinctive round blobs of ink on tracking cards. Most insects lack these inflated pads except for some of the other insects in the order Orthoptera (which includes wētā) – katydids and longhorn grasshoppers, for example, have them – but wētā, cave wētā[162] and a small Australian cricket[163] accidentally introduced to Middle Island are the only orthopterans that live on the Mercury Islands.

There are two drawbacks to using tracking tunnels for monitoring wētā. The footprints of different wētā species look the same, so if more than one species is present, then you can only identify the largest footprints as those of the largest species. Any smaller footprints could be those of other species or juveniles of the largest species. Fortunately for us, adults and large juvenile tusked wētā are much larger than other wētā on the Mercury Islands and the islands nearby. The other drawback is that tracking tunnels don't show how many different individual tusked wētā have walked through a tunnel (if there is more than one set of similarly sized footprints) because these could have been made by individuals going through several times. This didn't concern us because we only wanted to know when tusked wētā were present.

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162 The cave wētā (Family Rhaphidophoridae) that live on the Mercury Islands are smaller than half-grown tusked wētā (Family Anostostomatidae).

163 The Australian cricket *Ornebius aperta* (Orthoptera) was accidentally introduced onto Middle Island (see the text box 'Atiu or Middle Island' in the Introduction). It lives on shrubs towards the top of the steep slope above the hut where we never set tracking tunnels. I do not know what the footprints look like (probably two or three blobs because they have three tarsal segments unlike wētā which have four). The insect is less than 1 cm long so we would have ignored their footprints anyway.

So, are tracking tunnels effective for monitoring tusked wētā?

Fine weather and light seas were forecast for the first week in April 2008, and the new moon was on April 6, so the nights would be dark for our planned field trip. Our primary aim was to assess whether tracking tunnels were suitable for monitoring tusked wētā. Lunch Bay on Red Mercury Island was the obvious place to do this because Pim de Monchy had seen tusked wētā there in 2006. We were also going to bait the tunnels with peanut butter, as Pim had done and had found large wētā footprints in one tunnel. We intended to collect the cards a week later and leave the tunnels in place if they proved useful for further monitoring.

We also ran a trial to confirm that peanut butter attracted tusked wētā and another trial to see if canned fish (sardine-based cat food) or Marmite™ (a yeast extract) were better baits. Tusked wētā are primarily predators but will also scavenge, so we chose fish as a high-protein bait and Marmite™ as a low-protein, low-fat bait.[164] If either food attracted lots of wētā, we intended to run further trials to find which was best.

Lastly, we wanted to monitor the tusked wētā we had released onto Korapuki Island, Stanley Island, and Ohinau Island the previous year to find if any had survived. We planned to do this by scrape-searching rather than searching at night. We did not include Cuvier Island because Rob was due to go there later to maintain the lighthouse buildings (see Chapter 29) and would do the monitoring then.

WĒTĀ SPECIES ON THE MERCURY ISLANDS

Small ground wētā are present on all the Mercury Islands and Auckland tree wētā – a medium-sized species smaller than adult tusked wētā – are present on Great Mercury Island, Double Island and Korapuki Island. Those on Double Island occur only on the eastern islet (8 ha) and are absent on the western one (19 ha) where we released tusked wētā. East and West Double Island are connected by a narrow tombolo of boulders that is submerged at high tide and effectively isolates the two islets as far as wētā are concerned.

Tree wētā were not originally present on Korapuki Island but were translocated there from East Double Island in 1997 by Chris Green (Department of Conservation). The details are given in the text box "Establishing tree wētā on Korapuki Island" in Chapter 19.

164 Peanut butter: 26% protein, 48% fat, 11% carbohydrate, Marmite™: 18% protein, 1% fat, 17% carbohydrate.

Testing, testing, testing

Tuesday, April 1, 2008

Rob Chappell cut the outboard motor, and the *Kuaka* drifted over the calm, transparent sea until the hull gently scrunched into the beach on Korapuki Island. Corinne, Danny, Robbie Price (Manaaki Whenua - Landcare Research Ltd.), Rob, and I had arrived at our base for the field trip.

Rob handed us barrels of food and personal gear, a chilly bin of frozen food, a gas bottle, and bundles of folded tracking tunnels, and we waded it all ashore through ankle-deep water. Rob then took the *Kuaka* further out to anchor it and rowed back in an inflatable dinghy. We had to help him haul it up a steep bank of gravel at the back of the beach, so it was out of reach of the sea. The dinghy was light, but more people were needed because each time Rob stepped up the bank, the gravel shifted underfoot and he slid back down. The bank had not been there during my first visit to the island so it must have been created by a big storm.

We based ourselves on Korapuki Island primarily because it is the most accessible of the islands – landing on three of the others at low tide involves crossing boulders slippery with algae, while everything must be hauled up a high, steep slope on Stanley Island. The well-appointed hut on Korapuki Island also appealed, of course.

It took us an hour or so to open the hut and unpack everything. Corrine, Danny, and I pitched our tents on the extensive flat area by the hut and forwent sleeping on the comfortable mattresses inside the hut. We preferred falling asleep to the calls of seabirds circling overhead and awakening to the dawn chorus. I also remembered being kept awake all night by geckoes scrabbling over the corrugated iron roof during my first visit to the island.

Once we were settled in, we set up the two attractant trials on the flat area to the south and east of our tents. Both were grids of tracking tunnels spaced 10 m apart. One consisted of 20 tunnels arranged in five rows of four that were to be baited alternately with peanut butter or left without bait. The other trial used 10 tunnels arranged in two rows of five that were to be baited alternately with canned fish or Marmite™. The baiting was done at dusk because skinks would mess up the cards during the day.

It was only when I started recording the GPS coordinates of the tunnels and wrote the date down that I realised it was April Fool's Day, but it was well past the time for playing practical jokes. After we finished setting up the trials, I decided to explore the western end of the island, but I didn't get far before I came across a huge, intricate framework that someone had constructed at the southern end of the flat area, well beyond the tracking tunnels. The framework resembled a geodesic dome that had been stretched into a tunnel with open ends. It was made of thin, straight branches tied together in triangles rather than the hexagons of a geodesic dome and looked like it would support plastic sheets or tarpaulins: someone had camped illegally on our island. I returned to the hut and brought the others back to show them. They were incensed.

After lunch, Rob first dropped Corinne and Danny off on Double Island to scrape-search at the release area and took Robbie and me to Stanley Island to scrape-search there. We had arranged to collect Corinne and Danny four hours later, while there were still two hours of daylight.

Scrape-searching at the Birdcage site, to our surprise, was more difficult than anticipated. First, we had to sort through deep leaf litter in case tusked wētā were hiding amongst it, as they sometimes do. Then we removed numerous fallen branches and spent almost an hour carefully scraping an area of 20 m^2 without finding a trace of tusked wētā.

Deep leaf litter also covered the Amphitheatre site, and we found a single adult female amongst it. The three of us then spent an hour scrape-searching 61 m^2. of ground and found a single empty chamber. We then rushed back to the boat to collect Corinne and Danny, who were sitting on the rocks waiting for us.

We had expected Stanley Island to be much easier to search than it was and had planned to cover much larger areas – at least 100 m^2 at each site – but this was not to be. Corinne and Danny, meanwhile, scrape-searched 107 m^2 and uncovered four large juvenile tusked wētā and 18 empty chambers. We expected them to find some tusked wētā because we found four by scrape-searching on April 5, 2005, and nine were found on March 3, 2006, but it was still satisfying to confirm that the wētā were still present.

Back at the hut, Rob and Robbie cooked dinner while Danny and I helped Corinne bait the tunnels in the two attractant trials. Our meal was ready when we finished, and as it was still light, we went down to the beach to eat it. Small dark brown skinks that appeared black against the sunlit boulders sunbathed or darted about in short spurts around us, searching for insects. They ignored us for the most part but vanished between the boulders if anyone made a quick movement. We lingered on well into dusk, enjoying the late evening warmth and lulled by the sound of wavelets swishing quietly into the gravel in front of us. As it grew dark, we reluctantly gathered the cutlery and plates and returned to the hut. There was little for us to do other than read some old, tattered magazines someone had left behind – we certainly couldn't search for tusked wētā that night in case we disturbed the attractant trials – so we went to bed early.

Wednesday, April 2, 2008

Corinne collected the tracking cards immediately after breakfast. Numerous large footprints that we thought were made by tusked wētā were in four of the tunnels baited with peanut butter, whereas only one non-baited tunnel had a single set of large wētā footprints. Only one tunnel baited with Marmite™ was tracked in the 10-tunnel trial. We couldn't be certain that tusked wētā had made the footprints because tree wētā also live on the island, so Corinne measured them when she got back to the laboratory and confirmed that they were those of large juvenile tusked wētā and adults. We had hoped that more baited tunnels would be tracked and wondered if perhaps few of the tusked wētā we had released nine months earlier had survived when skinks and geckos were so abundant on Korapuki Island.

Rob and Robbie then organised everything we needed for installing the tracking tunnels on Red Mercury Island while Corinne, Danny, and I set up the attractant trials for the following night. When we had completed this, all five of us went to Lunch Bay on Red Mercury Island and installed 26 tracking tunnels baited with peanut butter.

Most of the tunnels were set about 50 m apart throughout the area where Pim had seen wētā, and others were set at 50 m intervals along the Te Roroi Track, the Roly Poly Bay Track, and von Luckner's Bay Track. We finished at midday, had lunch on Korapuki Island, and went to Ohinau Island to scrape-search at the release site. We expected this to be difficult and time-consuming because it had been hard to find sufficient patches of ground to make the holes when we released the insects, and so it proved.

Once the leaf litter was cleared away, it took several hours to find and search five areas ranging from 2 m^2 to 17 m^2. Then someone found a large, clear patch by some fax bushes, and we all pitched in and searched 50 m^2 there. We had had enough of scrape-searching when we finished that patch and returned to Korapuki Island: we had searched a total of 86 m^2 and found one large juvenile and one empty chamber.

The evening was perfect: it was warm, the sea was calm except for small ripples, and there was only the faintest breeze, so we ate dinner on the beach again. This time, we went to the middle of the beach and sat on large boulders at the edge of the vegetation. These soon became uncomfortable after a while, so we fossicked along the beach for boards and bits of plywood and made makeshift seats to recline on.

We lingered long after eating, enjoying the last of the setting sun. The undersides of a few small clouds in the west were beginning to turn red when Rob said, *"It's a perfect night for searching on Middle Island. It'll even be dark until the moon rises sometime after 1 am".*

There was a long pause. No one spoke. Then,

"It even looks calm enough to land below the campsite."

... there was a shorter pause ...

"Anyone feel like going for a search?'

We all did, but only three people were allowed on the island at a time, so we let Danny and Robbie go because Corinne and I had been there before. Rob then said,

"We better get a move on so we can get ashore while there's still some light."

We sprang into action, scooped up the cutlery and plates, and rushed back to the hut. Danny and Robbie frantically searched their barrels for head torches and for whatever else Rob yelled out they needed. This included a change of clothes in case they got wet getting ashore. Everything, including their boots (which had been scrupulously cleaned during the island biosecurity screening), was thrown into a couple of barrels, and they were off.

Corinne and I followed them down to the beach and watched until the *Kuaka* disappeared around the headland. We then wandered back and baited the tracking tunnels before washing the dishes. We didn't need to do this in the sea; we had a sink with running freshwater, although we had to boil the water first because bird and gecko droppings washed into the tank with rainwater from the roof, and geckoes occasionally got past the filter and drowned.

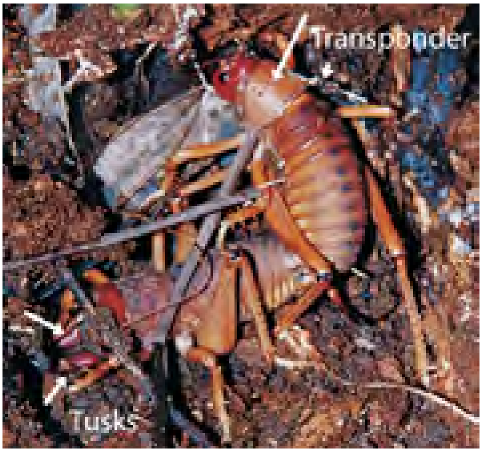
Thursday, April 3, 2008

"We didn't see any tusked wētā," Rob said as I entered the hut in search of a wakeup coffee.

"It wasn't a good night for searching after all because we only saw three ground wētā."

This, nevertheless, reinforced my growing suspicion that tusked wētā might have died out on Middle Island because I had searched for them unsuccessfully during 13 field trips after Grant Blackwell had found the last one in January 2001. Rob, however, still held out hope that they might survive in very low numbers or in areas we were forbidden to enter.

Danny and Robbie were full of their visit to Middle Island. Robbie was especially pleased to have seen tuatara in the wild for the first time. Both were impressed by the sizes of the five giant centipedes, one Duvaucel's gecko, and one robust skink they saw, and they marvelled at how much bigger these geckos and skinks were than those on the mainland. Rob mentioned he had seen a Whittaker's skink and a variety of insects, including 59 large *Mimopeus* beetles on the trunks of milk trees. I had to ask if there were many seabirds – it was the wrong time of year for nesting – but they couldn't remember seeing many at all – perhaps a few diving petrels and two flesh-footed shearwaters.



Tusked wētā copulating. These insects were located using harmonic radar and were found under a fallen branch amongst leaflitter. Photo: Ian stringer

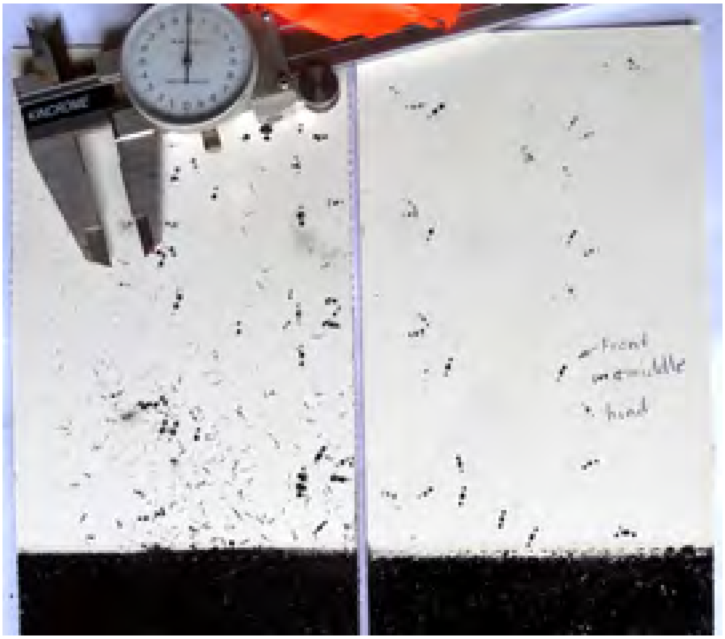
Later, after a leisurely breakfast, we collected the tracking cards from the two trials near the hut. No peanut butter was left in two tunnels with numerous large wētā footprints, and only one of the non-baited tunnels had a single set of similar footprints. It looked like peanut butter might attract tusked wētā, but the numbers were low, so we had to wait for a statistician to confirm this.

Two tunnels baited with cat food were tracked in the 10-tunnel trial, so it seemed that neither Marmite™ nor cat food was a better attractant than peanut butter, so we ended these trials.

When we finished, we scrape-searched 60 m² at the 20-tunnel trial site and 20 m² at the 10-tunnel trial site and removed the tunnels. We then collapsed and tied the tunnels into bundles and stashed them under the hut. There was no sign of wētā at the 20-tunnel site, but we found one adult and two empty chambers at the 10-tunnel site.

All that was left for us to do now was collect the tracking cards on Red Mercury Island in another five days. With time on our hands, we set up a similar trial on Korapuki Island to the one on Red Mercury Island and collected the cards the next day. This involved spending the rest of the morning setting up a grid of 26 tunnels, spaced at least 10 m apart, over the flat area by the hut and partway up the eastern hillside. This left us with four unused tunnels, which we took off the island at the end of the field trip.

All that was left to do was to bait the tunnels with peanut butter in the evening and collect the tracking cards the next morning. We had a long, leisurely lunch on the beach and then Rob and I led the others on a tour of the island, starting in the open forest on the western end. We visited the lagoon and then struggled through



The ends of two tracking tunnel cards (most of the central ink pad has been cut off) showing wētā footprints. **Left***: A mess of footprints made by wētā of different sizes. The largest are those of adult tusked wētā, while the smaller ones could be those of ground wētā or juvenile tusked wētā.* **Right***: Footprints of a single large juvenile tusked wētā. The calliper is set at 1 cm. Photo: Ian Stringer*

the bush at the eastern end of the island until we emerged onto the ledge above the sea. I had expected the large brackish water pool there to have dried up over summer, but it still had water in it, and the green algae and small black snails that I had seen there during my first visit were still present. This also surprised me because the water must have got quite hot in the sun. Dozens of the endemic New Zealand salt-pool mosquito (*Opifex fuscus*) were skating about on the surface, but they left us alone. Perhaps it was the wrong time of day for them to feed.

There was nothing to do once we got back but lounge on the beach, periodically squirming about to get more comfortable on our makeshift seating. We soon became bored. No one was willing to do more scrape-searching, so we agreed to cut the trip short after Rob assured us that he could collect the cards by himself. We still had to bait the tunnels we had set up near the hut, and we wanted to see if we could find some tusked wētā once it was dark (we didn't find any), so we stayed one more night.

Later that afternoon, I remembered the large framework, so we set to and dismantled it by breaking the branches into small, useless pieces. We dutifully bagged up all the bits of rope and string and took them off the island with our rubbish when we left. No one was ever going to use that framework again!

Pleasing results

Corinne gave the data from the attraction trials to a statistician when she got back to work and was told that it was very unlikely the tunnels with peanut butter were tracked by chance. This meant to us that peanut butter does indeed encourage tusked wētā to enter tracking tunnels. However, too few tunnels were tracked in the 10-tunnel trial with cat food and Marmite™ to provide a meaningful result.

Stormy weather prevented Rob from landing on Red Mercury Island for a month, and then he telephoned after collecting the cards, elated. We had feared that the cards would be messed up by innumerable footprints, but the ink had dried before the cards became illegible (we later found the ink usually dried within two or three days). Rob said it looked like tusked wētā footprints were in all but four tunnels on Red Mercury Island, and 16 of those on Korapuki Island had large footprints. Corinne later confirmed that all these tunnels had indeed been tracked by tusked wētā.

The tunnels on Red Mercury Island showed that tusked wētā were present at Lunch Bay and extended up to 250 m along the Trig Track past the junction with the Trig Track, and at least as far as the tunnels were set along the Roly Poly Bay Track (150 m) and the von Luckner's Bay Track (300 m). Most of the 16 tunnels tracked on Korapuki Island were located towards the east and west of where the grids had been located, and few were tracked in the middle or near the hut.

We, of course, wished we had brought more tunnels and set them further along the tracks. We determined not to make that mistake again. Both results showed us that tracking tunnels baited with peanut butter were the best way to detect tusked wētā. The only drawback was that it involved two visits: one to set the tunnels and one to collect the tracking cards. The one huge advantage is that they can be set to cover large areas more efficiently than searching at night or scrape-searching, so tracking tunnels became our main monitoring method from then on.

The upshot

A Mercury Islands Tusked Weta Recovery meeting was held soon after the April 2008 field trip, and I reported finding the large framework on Korapuki Island. It had angered us that someone had camped illegally on the island, so I reported that we had dismantled it. Chris Green immediately started laughing and told us he had built it during his last visit with David Towns as something to occupy his free time between taking samples. Good to know that others can sometimes become bored in such a special place.

MAHI PŌRANGI

How did we show that peanut butter attracts tusked wētā into tracking tunnels? We alternated tunnels baited with peanut butter with non-baited tunnels and collected the tracking cards the next day. We then applied more peanut butter to the baited tunnels and exchanged them with the non-baited tunnels by physically moving them. This ensured that non-baited tunnels could not become contaminated with traces of peanut butter odour by adsorption on the plastic tunnel walls.

The tunnels were then left out during the second night, and the cards were collected on the third day. Baited and non-baited tunnels had therefore been used at each location.

Corinne gave the results to a statistician who analysed them (using a non-parametric unpaired t-test). The answer consisted of various numbers, the most important of which was the probability value (or p–value) of 0.0011. This meant there was only about one chance in a thousand (well, 11 chances in 10,000 if you want to be precise) that the result could have been due to chance alone. So peanut butter (the only difference) was extremely likely to have encouraged tusked wētā to walk through the tracking tunnels.

Well, we got there in the end, but by a circuitous route. You can understand why Māori sometimes use the term mahi pōrangi – meaning literally 'mad work' – for science.

I invited Corinne to join the Recovery Group as an expert on the use of tracking tunnels for monitoring wētā. It was only appropriate because it was her idea. Before I had a chance to introduce her, though, someone asked her why she was there. She explained she was helping us use tracking tunnels for monitoring tusked wētā and was told,

*"That's a ****** stupid idea. It'll never work."*

But it did work, and we were able to monitor much larger areas than we could by searching at night or scrape-searching.

Tracking tunnels are now used routinely for monitoring wētā. It is such an obvious method that several people have told me since that they've known about it for years. Yeah right! Yes, they would have seen wētā footprints, but how would they know what made them?[165] Wētā footprints were only identified after Corinne made wētā walk through tracking tunnels in the laboratory, and this led her to develop tracking tunnels for monitoring wētā.

165 Pim de Monchy was the exception as explained above.

CHAPTER 28

RESCUED FROM EXTINCTION

Monitoring with tracking tunnels

Once we confirmed that tracking tunnels were suitable for monitoring tusked wētā, we used them annually up to 2012 to verify where the insects were becoming established. This was done between February and April, when the weather is normally settled and pleasantly warm, although it can be hot and humid in the bush, and the sea has warmed up. Our trips, as always, coincided with the new moon, so the nights were dark.

Rob Chappell, Corinne Watts, Danny Thornburrow, and I collaborated on all these field trips. Robbie Price was also part of our team in 2009 and 2010 but spent 2011 and 2012 convalescing at home after a serious accident on his bicycle – a consequence of enthusiastic speed and a boardwalk slippery with wet leaves.

Monitoring Red Mercury Island in March 2009

Our purpose was to survey how far tusked wētā had dispersed on Red Mercury Island, so we set tracking tunnels around the entire island. We didn't use tracking tunnels on Korapuki Island, Ohinau Island, or Stanley Islands in 2009 because the progeny of the wētā we released in 2007 would not be large enough to distinguish their footprints from those of ground wētā. However, we still intended to scrape-search on them to see if juveniles were present and thereby confirm that the insects had reproduced successfully.

Once we established ourselves in the hut on Korapuki Island, Rob took us to Lunch Bay on Red Mercury Island where we installed and set 39 tunnels, spaced 100 m to 150 m apart, along the entire lengths of the tracks that encircled the island (the Link, Falkert's Folly, Te Awa, and von Luckner tracks), and along the Trig and Roly Poly Bay Tracks.

We worked together, so Corinne, Danny, and Robbie became familiar with the tracks. Even so, it took most of the day to set the tunnels because the tracks became increasingly overgrown through disuse the further we went from Lunch Bay. Some trees with track markers had also fallen over, which delayed us while we searched for them.[166] Furthermore, the bundles of tracking tunnels poked out the tops of our backpacks and frequently and unexpectedly snagged on vegetation, jerking us and sometimes bringing us to sudden stops. Leading at the front, Rob and I soon began cursing with increased vehemence until our packs were empty, but the others endured everything stoically.

Next morning, we scrape-searched 162 m^2 at the release site at Lunch Bay and uncovered seven adult tusked wētā, four juveniles, and five empty chambers. Then, after lunch, we scrape-searched 45 m^2 amongst the meshwork of tree roots at the release site on Ohinau Island and found two adult tusked wētā. This was unexpected because the insects we released there in 2007 should have died of old age. They must have developed more slowly than we thought or lived longer as adults because there wasn't enough time for their progeny to develop into adults, even if the eggs hatched quickly. I had hoped to find juveniles, though, but perhaps none were present where we searched.

We realised that adults could also be present on Korapuki Island, so Corinne and I retrieved the tracking tunnels we had stashed under the hut the previous year and installed them 30 m to 50 m apart, so that most of the island was within 50 m of a tunnel.

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Rob, Robbie, and I collected the cards along the Trig track, Te Awa Track, and the von Luckner Track two days later while Corinne and Danny saw to the Link, Falkert's Folly, and the Roly Poly Bay tracks. We left the tracking tunnels in place so we could use them again the following year.

I thought I was reasonably fit despite spending much of my time in front of a computer or commuting to work on a train, but I quickly realised that Rob and Robbie were far fitter. Rob was a volunteer fireman who participated (among other strenuous activities) in the Fireman Sky Tower Challenge (a race to the top wearing a full protective kit). Robbie, Corinne, and Danny seemed to spend most of their

166 Steve Bolton (Department of Conservation, Whitianga) suspects the galvanised nails used to attach the markers had killed the trees. He now uses stainless steel nails.

Seaward cave entrance to the lagoon at Korapuki Island.
Photo: Rob Chappell

spare time training for competitive bicycle races. It was easy to keep up when we set the tunnels because the vegetation growing along the tracks slowed us, but it was a different matter collecting the cards. The track had been trampled and was easily followed, so Rob and Robbie soon forged ahead and left me struggling but not quite gasping to keep up. I realised I'd be left behind again and again, so from then on, whenever I could, I got ready before everyone else in the morning so I could take the lead (not easy to do when Rob was present – these were his islands) and set a leisurely pace for the day.

It took three hours to collect the tracking cards the following day, then we spent two hours scrape-searching 209 m² at the release site on Korapuki Island. Tusked wētā occupied much the same area on Red Mercury Island as they had in 2008, but there was no sign of tusked wētā on Korapuki Island. We finished in the late afternoon and took the rest of the day off.

We began with a swim in the lagoon and dried off in the sun on the northern beach. Sometime later, we realised that Robbie was missing and assumed he had gone for a long walk. He returned at dusk, elated at having scaled the steep-sided pinnacle that towers above the cave into the lagoon. He confessed that he had to sit for a while when he reached the top to calm down before he could work out how to get back down. (Note to self: amend the Health and Safety Plan so it clearly states that everyone must let me know their intentions).

Heartened by success, he announced he was going to try to circumnavigate the island the next day without swimming. I couldn't imagine how he could climb over the entrance to the cave into the lagoon without rock climbing equipment because the seaward cliff is smooth and vertical. We earnestly persuaded him not to attempt it – none of us wished to try to rescue him if he failed to return, or worse, scrape him off if he fell onto rocks.

We ended the day with a long leisurely wine and cheese on the beach.

The fourth day was our last. We unanimously decided to leave setting tracking cards on Double Island, Ohinau Island, and Stanley Island until 2010 because we were anxious about work mounting up in our offices. So, after breakfast, we collected the tracking cards on Korapuki Island (leaving the tracking tunnels in place), packed up, and left. None of the cards were tracked by tusked wētā, but we were not unduly disappointed because we expected the first-generation juveniles to be too small for their footprints to be identifiable.

A monitoring fiasco in April 2010

Our intentions in 2010 were to run tracking tunnels on Korapuki and Red Mercury Islands and to install and run them at the release sites on Ohinau and Stanley Islands. The forecast was marginal, but Rob thought we might be able to land on some of the islands, so off we went. However, it was so rough when we arrived that we could only get ashore on Korapuki Island. We baited the tunnels scattered over the island, set up a grid of 16 tunnels near the hut, and then returned to the mainland. It was pointless staying when the weather was not forecast to improve for at least six days.

Rob and I collected the tracking cards 13 days later, but none were tracked by tusked wētā. We wondered if perhaps the skinks and geckos that are so abundant on Korapuki Island had eradicated them.

The successful monitoring trip of March 2011

We were blessed with fine weather at the start of this field trip, so we accomplished what we couldn't in 2010 – running the tracking tunnels on Red Mercury Island and Korapuki Island and installing and running tracking tunnels at the release sites on Stanley Island and Ohinau Island. We also intended to scrape-search whenever we had time, and Rob needed to go to Middle Island to collect the tracking cards he had set there on March 24, 2009, and reset the tunnels. This was well overdue.

We now worked so efficiently in pairs that we installed and/or set the tunnels on Korapuki Island, Stanley Island, and Ohinau Island within the first three days despite three glitches.

The first glitch occurred the day after we arrived. Rob couldn't find any tracking tunnels on Middle Island – they must have blown away – so, he returned to Whitianga overnight to get new ones while Corinne, Danny, and I stayed on Korapuki Island. We set the existing tunnels and then set up a 4 x 4 grid of tunnels spaced 10 m apart, to the south of the hut, hoping to increase the chance of detecting tusked wētā because we had found no sign of them in 2009 and 2010.

Rob returned on Thursday morning and installed and set 15 tunnels on Middle Island while Corinne, Danny, and I scrape-searched 76 m^2 at the release site on Double Island. Tusked wētā were still doing well there because we uncovered six adults, 25 juveniles, and six empty chambers.

The second glitch occurred on Friday. Corinne and Danny volunteered to install tunnels on Stanley Island because they had never been there and wanted to see what the island was like. So, Rob and I took them to the start of the steep access onto the island (which was hidden amongst the tangle of exposed roots of pōhutukawa trees fringing the shore) and explained that the track at the top eventually became a route as the undergrowth petered out. We assured them it was well marked. They couldn't get lost.

Rob and I, meanwhile, installed 10 tunnels at the release site on Ohinau Island before returning to collect Corinne and Danny. They told us they couldn't find the Amphitheatre and had only installed (but not set) 15 tunnels at the Birdcage Site. We were astounded! How could they have missed it? Both were experienced at working in the forest. Unbelievable!

So, Rob and I went back the next day and set up the tracking tunnels at the Amphitheatre site after leaving Corinne and Danny on Red Mercury Island to set the tunnels there. We discovered that a gang of volunteers had done a superb job of clearing the path on Stanley Island but had inexplicably curved it uphill about halfway along the island and ended it abruptly on the ridge that forms the backbone of the island. We had to go back quite a way to find the marked route, which we only found because we knew roughly where to look, so it was little wonder Corinne and Danny had missed it.

We set up 10 tracking tunnels at the Amphitheatre and found one adult male tusked wētā resting within the leaf litter when we scrape-searched 72 m^2. Then we set the tunnels at the Birdcage Site and scrape-searched 72 m^2 there without success. Meanwhile, Corinne and Danny on Red Mercury Island were dismayed to find that the ink had dried in most of the bundles of tracking cards, so they abandoned setting tunnels and started scrape-searching multiple plots of 72 m^2 near the release site at Lunch Bay. We went ashore when we returned for them and helped scrape-search another 12 plots of 72 m^2 but didn't find any tusked wētā.

So, Rob went back to the mainland yet again that evening to get fresh tracking cards while we chose to stay on Korapuki Island. When he returned the next morning, the sea had become too rough to get ashore on Red Mercury Island, so, with no other monitoring to do, he went back to his office again. He invited us to go with him, but we elected to stay on Korapuki Island after he assured us that he could return the following day. We wanted to see if we could find some tusked wētā by searching with spotlights at night.[167] There were ample provisions if he couldn't get us off, and we had brought some office work to keep us occupied.

We soon tired of office work though and then spent the afternoon doing a properly designed scrape-search survey. This consisted of searching 32 plots, each 3 m x 3 m (a cumulative area of 288 m^2), scattered randomly over the flat area south of the hut.[168] We uncovered two tusked wētā, which pleased us immensely because we had not found any in 2009 or 2010. That night, we also saw an adult male while searching with spotlights. We were very pleased as well as relieved that tusked wētā had survived on Korapuki Island.

167 The wētā could be disturbed by us when we searched at night but we ignored this because we were only going to search for one night and we planned to leave the tunnels set for at least another four nights.

168 We used a table of random numbers and two long tape measures to locate the position of each plot.

The weather deteriorated overnight, preventing us from collecting the tracking cards on the other islands, so we collected them on Korapuki Island and ended the field trip early. Tusked wētā footprints were in five of the tunnels spread over the island and in 12 of the grid of 16 tunnels near the hut. This confirmed, yet again, how effective tracking tunnels were for detecting tusked wētā when compared with scrape-searching.

Rob, Corinne, and Danny collected the cards from Stanley Island three days later: all 10 at the amphitheatre were tracked by tusked wētā (this included three tunnels set 30 m apart along the access track), but only four tunnels were tracked at the birdcage site. None of the five tunnels spaced 30 m apart along the track towards the Amphitheatre was tracked.

Rob collected the cards on Ohinau Island by himself on March 17 and reported that all 10 were tracked by tusked wētā. Then Rob, Lesley McKay, and I collected the cards on Red Mercury Island 36 days after we finished the field trip. Tusked wētā had increased their range considerably since 2010. They now extended just over the hill on the Roly Poly Bay Track, were present 50 m further along the Te Roroi Stream track than previously and occupied the entire length of the von Luckner track.

Another successful monitoring trip in 2012

It was a warm, sunny start to the 2012 field trip on March 15, but the sea was choppy. The northerly that created this was forecast to strengthen during the day, but Rob once again was willing to chance getting ashore on all the islands.

Our first chore was to set the tunnels on Stanley Island and add extra tunnels along the tracks leading to and from the release sites so we could find how far the wētā had extended their range. We then had lunch and set the tunnels on Red Mercury Island. While we were doing this, the wind gradually increased, and the waves breaking on the beach on Korapuki Island had become much larger when we returned. So, Rob dropped us ashore and then took the *Kuaka* further out than usual and double anchored it for the night. We still had three hours of daylight left, so we set the tunnels on Korapuki Island.

Rob became increasingly anxious that the waves and the strong wind blowing onto the beach might cause the anchors to drag along the sandy bottom, so we all went down to the beach to assess the situation. The *Kuaka* was bobbing and swinging about erratically, and every time a wave lifted the bow, the boat was snibbed forward by the anchor ropes. We imagined that these jerks could well cause the anchors to plough along bit by bit through the sand. We understood Rob's concern.

Robust skink. Photo: Rob Chappell

Rob subsequently checked the boat every half hour or so until it was almost dark. He then forsook a comfortable bunk and pitched a tent just inside the edge of the bush where he could watch the boat during the night. He went to bed fully dressed, wearing his diving booties so he could sprint down the beach the instant he heard the boat scrunching onto the gravel. What he dreaded, though, was a slight change in wind direction, which could drive the boat onto rocks flanking the bay. He was so terrified of being woken by loud clanking as the stern smashed repeatedly onto the rocks that he got no sleep. The anchors, however, held.

South-westerly waves also developed overnight, which prevented us from setting the tunnels on Ohinau Island on Monday. There was nothing else for us to do until we collected the tracking cards on Wednesday, and as the strong northerly had not abated, Rob returned home again. He didn't fancy another sleepless night anxiously watching the boat. He, of course, also invited us to go back with him, but we chose to stay and search for wētā again at night.

After Rob left, we began surveying the flat area south of the hut by scrape-searching randomly located 3 m x 3 m plots. We only searched 16 plots before it got too dark to continue and had found a single adult tusked wētā, one juvenile, and three empty chambers, so we gave up the idea of doing more the next day. We could see we would probably find too few wētā to get a reasonable estimate of their density unless we searched very many more plots of 9 m^2 or started again and scrape-searched much larger plots, and we didn't want to do either.

Rob arrived at 11 am on Tuesday with sandwiches and fruit slices for lunch. He then took us to Ohinau Island, where we rearranged the tracking tunnels (and added four new ones) so they formed a single line of tunnels spaced 30 m apart that passed through the centre of the release area. This line extended 240 m to the north of the release area and 180 m to the south. Next, we collected the cards on Stanley Island but couldn't land on Red Mercury Island, so we returned to Korapuki Island. The weather was not forecast to improve in the next few days, so we ended the field trip and left the next morning.

We collected the cards from Korapuki Island and Ohinau Island in early April but couldn't get onto Red Mercury Island. Rob eventually collected them by himself in May.

Corinne, who always measured the footprints carefully to ensure the identifications were correct, gave us the tracking results soon after Rob sent the cards to her. Nineteen tunnels near the hut on Korapuki Island were tracked, and all were within 100 m of the hut (as were 15 tunnels tracked in 2011). All the tunnels at the release sites on Stanley Island were tracked, but the insects had only expanded their ranges by 30 m at each location. In contrast, all the tunnels on Ohinau Island were tracked except for two at the northern end, so tusked wētā now range out from the release site for 180 m to the north and 180 m to the south. On Red Mercury Island, the wētā had expanded their range only slightly since 2011: they occupied the same areas of the von Luckner and Roly Poly Bay Tracks as they had previously but they had increased their range along the Trig Track by 200 m and were now present along the first 100 m of the Link Track from its junction with the Roly Poly Bay Track.

In the meantime, Rob had found no tusked wētā footprints in the tracking tunnels he had set repeatedly on Cuvier Island, so we began to suspect that those translocations had failed. This, however, is part of the story in Chapter 29.

View to the west of Middle Island (left foreground) with Korapuki Island behind and Green Island to the right.
Photo: Rob Chappell

Time to move on

The tusked wētā released on Korapuki, Stanley, and Ohinau islands had successfully reproduced, and by 2012, first-generation island-born insects were frequently tracked on all of them. Our experiences on Double and Red Mercury Islands gave us confidence that they would also become established on these other islands, so the Mercury Islands Tusked Weta Recovery Group decided it was an appropriate time to finish the project. This freed up both our time and the remaining funding for other conservation projects: there is always just so much to do, and resources are always limited.

From now on, we would rely on sightings by visitors to the islands to confirm long-term survival. Department of Conservation staff, for example, monitor all the islands for rat incursions several times a year using tracking tunnels, and researchers and other groups occasionally survey nesting seabirds on them.

The information we wanted was forthcoming, and we published the results when we were sure the insects were well established on all but Cuvier Island.[169] Rob was told of encounters with tusked wētā – usually sightings of adult males – on all the islands many times until he retired in 2017.[170] The insects were also sufficiently abundant on Double Island, Red Mercury Island, and Stanley Island in March 2021 for some to be translocated (wild-to-wild translocations) from each island to Great Mercury Island (Ahuahu) (Chapter 30).

Recently (April 2025), Ben Gordon (Department of Conservation, Whitianga) told me that tusked wētā are now widespread on Double Island, Korapuki Island, Stanley Island, and Red Mercury Island. They are so abundant on Korapuki Island that visitors occasionally step on them accidentally, and they are "spreading across [Ohinau Island] and are found further from the release site every year."

As luck would have it

I believe that tusked wētā were dying out on Middle Island when I searched for them there, and I now think they are locally extinct there, although I'd be delighted to be proved wrong.[171] I also believe that if we had not intervened when we did, then Mercury Islands tusked wētā would now be extinct. It was a close-run thing, but we had a lot of luck.

It was fortunate that the critical threat status of the insect was recognised in 1990 and 1991, and that efforts to mitigate this began soon afterwards (Chapter 4).

It was fortunate that Chris Winks was chosen to develop the captive-breeding programme because this was the keystone to our success.[172] He developed an amazingly productive rearing method just when we needed it to breed from three of the last tusked wētā seen on Middle Island.

It was fortunate that we caught the three fertile wētā when we did.[173] We believed many more were present when we collected them because of their very cryptic

169 Stringer *et al.* (2013).

170 I took voluntary redundancy in June 2012 when the Department of Conservation was restructured.

171 Tusked wētā were abundant between March 1991 and June 1994 when Mary McIntyre researched them (Chapter 3). Rob subsequently spent nine nights searching Middle Island and saw four females (one in November 1995, two in February 1998, and one in April 1998; Chapter 4). We saw the last four between September 1998 and January 2001.

172 I have borrowed this term from the keystone species concept in ecology.

173 The fertile insects were two juvenile females caught by Rob in February 1998 and the juvenile male we caught in September 1998.

behaviour. Had we known they were amongst the last seen on Middle Island and that none were detected with tracking tunnels after they were captured, then we may not have caught them. It would certainly have been an agonising decision to make either way. If we had not caught them, then I think tusked wētā would now be extinct. What would you have done?[174]

It was fortunate that the male and two of the three females were fertile because infertility was common amongst tusked wētā. One female produced numerous eggs, one laid a few, and the last female caught was infertile. Chris also reported that the first-generation insects he bred in captivity produced only small numbers of infertile eggs. Had the male or both females we caught been infertile, then tusked wētā may well be extinct.

It was fortunate that our experimental translocations succeeded. If they had failed, and insect translocations often do, usually for unknown reasons,[175] then we may not have had enough insects to try for another translocation, and Mercury Islands tusked wētā would likely have gone extinct.

Overall, we were very lucky that most of what we did worked well[176] and the Mercury Islands tusked wētā is now likely to survive well into the future. This has been described as an "outstandingly successful conservation story" (Nelson *et al*., 2019).

174 Heath (1987) discusses the pros and cons after "I saw, dead in ethanol, a strange and magnificent weta of a new genus and species from one of our offshore islands." This was a Mercury Islands tusked wētā. There are also published codes of practice for translocating insects (e.g. Invertebrate link (JCCBI) (2010)).

175 Bellis *et al.* (2019).

176 The release-saucers were only partially useful, and tusked wētā failed to become established at the Paint-Shed Site, Cuvier Island (Chapter 29). This was the only release site I selected: Rob chose the other release-sites where tusked wētā survived and reproduced.

CHAPTER 29

CUVIER ISLAND

The first translocation

Rob Chappell organised the releases of tusked wētā on Cuvier Island and their subsequent monitoring. The island is further from Whitianga than the Mercury Islands – about 15 km further from the marina in Whitianga – and he often went there to maintain the buildings where the lighthouse keepers once lived and to help with other conservation programmes. He usually did the tusked wētā work during these trips to reduce costs, and I was only available to help on three occasions.

Rob and Wendy Davis (Department of Conservation) translocated the first 34 tusked wētā in mid-April 2008. These were the last of the 334 wētā that Chis Winks had reared after 100 were released on each of Korapuki, Stanley, and Ohinau Islands (Chapter 26). The release site was in a forest alongside a stream near a decrepit pump-house and is over a kilometre from the lighthouse keeper's buildings. The pump (now long gone) once supplied water to a Second World War army radar installation and living quarters (long abandoned) at the top of the island.

Rob subsequently monitored the insects using tracking tunnels. He set them in mid-October 2008 and collected the cards six and a half weeks later, then reset the tunnels and collected the cards in late November. We expected the insects would be large juveniles by then, but no cards were tracked. Rob then ran the tracking tunnels on nine more occasions between October 2009 and July 2011, but again, no cards were tracked. In contrast, tusked wētā were thriving on the other islands by 2011. We hoped the insects had moved elsewhere on Cuvier Island, but worried that 34 might have been too few to initiate a founder population.

The first time I helped Rob was in mid-April 2010. We stayed overnight in one of the lighthouse keepers' houses and set the tracking tunnels soon after we arrived. Then, that night, we searched the track and the release site but found no tusked wētā. We only saw the spiny hind legs of tree wētā projecting from two holes in tree trunks. Tree wētā frequently do this for long periods before either emerging if the night is suitable or retreating into their holes.

We collected the cards the next day before returning to Whitianga, but there were no tusked wētā footprints.

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My second visit was a day trip to collect tracking cards that Rob had set five months previously in October 2010.[177] The headland where the lighthouse was situated sheltered us from a stiff northwester, so Rob put me ashore with two barrels of gear at the Landing Block. He then went around to Fairchild Bay and anchored while I hauled the barrels up to the buildings. Fairchild Bay opens to the north and was taking the full force of the wind, but Rob anchored there because a southerly change was forecast, which would make it difficult to depart from the Landing Block.

Once Rob had rowed ashore in the inflatable dinghy, we walked to the release site and collected the tracking cards, but yet again, none were tracked by tusked wētā. We reset the tunnels with new cards and replaced the peanut butter and returned to the lighthouse keeper's buildings, where I loitered in the sun while Rob fixed damaged plumbing on a rainwater tank.

The wind was still blowing from the north and had increased in strength when Rob finished, so the *Kuaka*, below us, was now bobbing and jerking about on a confused sea caused by waves reflecting off the surrounding steep-sided rocks. Rob clambered down with the barrel containing his tools and launched the dinghy. Meanwhile, I began carrying my barrel along the path that sidles around the hillside to the top of the old tramline (described in Chapter 24). I had only got a short way along when I noticed that Rob was having trouble getting out to the *Kuaka*, so I sat down to watch – it was sunny and pleasantly warm despite the wind, and thick kikuyu grass provided comfortable seating.

Rob was halfway out to the *Kuaka* and was kneeling in the bow of the dinghy using a single oar as a paddle while the stern swung irregularly this way and that: an oar or rowlock must have broken. The wind was so strong that Rob was making excruciatingly slow progress and was being drenched with spray every so often. I watched him give up, turn around, and get blown quickly back to shore. He then stripped off, put his clothes in the barrel, threw the barrel back into the dinghy, and swam out to the *Kuaka*, towing the dinghy by its painter. It must have been unpleasant because he was swimming into gusts of spray blown off the wave tops, but he got there.

Once aboard the *Kuaka*, he pulled the inflatable onto the stern, dressed himself, and started the engine. I watched as he ran the boat back and forth, heading in

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177 The ink dries in about three days after the tunnels are set and no more footprints are recorded.

various directions, but it snubbed against the anchor rope each time: the anchor was stuck. He eventually freed it and roared off around the point. I realised he would be in a bad mood by now and even more annoyed if he had to wait for me at the Landing Block, so I hurried down the 50 m or so of steep tramline and arrived at the steps just as he reached them.

Fairchild Bay, Cuvier Island. View east from beneath the lighthouse keeper's buildings. Photo: Rob Chappell

Choppy waves superimposed over a low, lazy northeasterly swell met us when we emerged from the lee of the headland, but travelling back to Whitianga that day was truly pleasurable. The sun sparkled on the sea at our backs while the strong wind, from the port quarter, was now reduced to a breeze by our forward motion.

The ocean was alive that day: fish splashed around us, and numerous seabirds soared near the surface. These birds seemed particularly numerous near the horizon. At one point, we saw what looked like a pair of black shark dorsal fins, but a broad dark shadow appeared beneath them as we got closer, and we realised it was a huge ray that was lifting the tips of its wings out of the water. A couple of flying fish erupted in front of our bow, and we watched them glide away and splash back into the sea. I associate flying fish with the tropics, but I had occasionally seen them before on a previous trip to the Mercury Islands. Several rafts of diving petrels, varying from a few birds to many dozens, rested peacefully on the surface. We also passed several 'workups' where the surface boiled as thrashing fish frantically tried to escape predators below while numerous gannets and other birds that dived in from above. Rob tried to teach me how to recognise the various petrels and shearwaters as we went. The differences between them can be quite subtle, and I found them hard to distinguish, especially when silhouetted against the sky. I still cannot recognise many of them.

A second translocation

By July 2011, Rob had no evidence that tusked wētā had survived on Cuvier Island, so the Mercury Island Tusked Weta Recovery Group decided to try again in September 2011. They planned a wild-to-wild translocation because Chris Winks had long finished captive-rearing.

The translocation was done over two consecutive days. First, Rob took Bridget Baynes, Andy Wills (both Department of Conservation), and me to Double Island to collect up to 100 tusked wētā by scrape-searching about 400 m^2 on the ledge where we had released them in 2000 and 2001. This area is less than one-tenth of the ledge, so by limiting the search area, we expected to remove fewer than 10% of the wētā from the island. We expected that this would not adversely affect the population on Double Island. In the end, though, we only captured 75 wētā because we only had time to scrape-search about 350 m^2 before we had to return to Whitianga.

We installed the insects in individual holding containers and packed these into larger plastic transfer boxes, which we left on Double Island overnight. This avoided jostling the insects by transporting them back and forth to Whitianga. We, of course, only left them on the island because Rob was certain the weather would remain settled enough for us to get ashore the next day to retrieve them. As it turned out, he was correct, and Rob, Tansy Bliss, Andy Wills (both Department of Conservation), and I recovered the transfer boxes the next morning.

Once on Cuvier Island, we released 30 wētā along a small gully running uphill from the lighthouse buildings (we referred to this as the paint-shed release site because it was the building nearest the gully) and released 45 wētā alongside the stream near the decaying pump-house shed where the first 34 had been released.

Rob later set 11 tracking tunnels at the paint-shed site and six at the pumphouse site and checked and reset them several times, but none were tracked by tusked wētā until April 2012. On that occasion, he found tusked wētā footprints in two tracking tunnels, one at the pump-house site and another at the paint-shed site. Unfortunately, the timing meant that these footprints could have been made by insects we had released during the wild-to-wild translocation rather than by their progeny or the progeny of the 34 released at the pump-house site 3.8 years earlier.

Rob set tracking tunnels on Cuvier Island for the last time in November 2016 and found tusked wētā footprints in four of 16 tunnels he set along the Pumphouse steam but no tunnels were tracked at the Paint-Shed Site. Their footprints have, however, been found recently at the Pumphouse Site but not at the Paint-shed Site,[178] so the species is now established on Cuvier Island.

178 Steve Bolton and Ben Gordon (both Department of Conservation) (2025), personal communications.

CHAPTER 30

A SECURE FUTURE

We completed what we set out to do by establishing self-perpetuating populations of tusked wētā on four Mercury Islands, on nearby Ohinau Island (Chapter 28) and on Cuvier Island (Chapter 29). However, these six islands are relatively small (27 ha to 225 ha[179]) and we were concerned that they were not large enough for the insects to survive in perpetuity.

Why the uncertainty? All tusked wētā alive today – assuming they are locally extinct on Middle Island – are the progeny of a single male and two females. Even worse, these originated from a small population with restricted genetic diversity, the result of numerous genetic bottlenecks caused by droughts. So, could inbreeding eventually doom the insects to extinction? I didn't know, so I asked Danne Gleeson, a geneticist who worked at Landcare Research Ltd., for advice. She assured me that all is well while the populations are expanding: the problem occurs when all the available habitat is occupied. Our strategy, then, was to release tusked wētā on as many islands as we could – and the larger the better – and hope that enough mutations would accumulate as the populations expanded for the species to become sufficiently genetically diverse to assure their long-term survival.

The problem of low genetic diversity had nagged away at Rob and me right from the start, and we had occasionally mentioned how good it would be if tusked wētā could be introduced to Great Mercury Island because the island is huge (1872 ha). We didn't know how much was covered in native bush, but we nevertheless thought it fitting, even if there was a small area of bush, because tusked wētā would then be present on all the Mercury Islands where they once lived. However, we were sure it would never happen because the island is part beef and sheep farm and part pine plantation, and rats and feral cats (which also eat wētā) were present.

179 Korapuki Island 18 ha, Double Island (Moturehu) 27 ha, Kawhitu or Stanley Island 100 ha, Ohinau Island 143 ha, Cuvier Island (Repanga Island) 194 ha, Red Mercury Island (Whakau) 225 ha.

Undercliffs on Great Mercury Island (Ahuahu). Red Mercury Island is visible behind West Double Island on the horizon. Tusked wētā were released under the Pōhutukawa forest (dark green), low on the talus slope beneath the cliffs. Photo: Theo Van Noort

Ahuahu: completing the translocations

The unexpected

The owners of Great Mercury Island (Ahuahu) began eradicating mammalian predators in 2014 so they could later reintroduce the native fauna that once lived there. This was done in partnership with the Department of Conservation. The eradication was successful, and the island was declared rat- and cat-free in 2016. Then, much to our great delight, we were told that tusked wētā was one of the first two species to be translocated there.[180]

180 A large ground-active spider was translocated onto Ahuahu at the same time.

A total of 112 tusked wētā [181] were released at two locations (Undercliffs and Peach Cove) on Ahuahu in March 2021, and Sir Michael Fay, one of the owners, rang me with the news that six tusked wētā had just been found at Undercliffs on March 25, 2023. It made my day. Rob rang me soon after to share the news – it made his day as well.

Large wētā footprints were also found in tracking tunnels at Peach Cove, so both releases were initially successful.[182]

A brief visit to Ahuahu

I was only involved in the following preliminary assessments before the translocations to Ahuahu. Pete Corson (who was organising the translocations) and Rob Chappell had chosen two release sites and then invited me to give a second opinion. I had every confidence that Rob would have chosen eminently suitable areas, as he had invariably done in the past, but I had never been on Ahuahu, so it was just too good an opportunity to miss. I accepted with alacrity.

At the time, Dave Roscoe, a retired pharmacist, was a volunteer in the laboratory at the Head Office of the Department of Conservation, identifying and photographing the innumerable tiny native land snails that live in leaf mould and humus. Dave is extraordinarily enthusiastic about snails and desperately wanted to survey Ahuahu when I told him I was going there. I was looking for a way to thank him for all the work he had done, so I asked if he could be included, and Pete readily agreed.

After we had unpacked and settled into the very comfortable and well-appointed visitor lodge on Ahuahu, Pete walked us over to Undercliffs on the northern coast. The release site they had chosen was a grove of Pōhutukawa trees growing on a talus slope below a high cliff. Huge boulders were scattered beneath the trees, and deep leaf litter and humus had accumulated between these rocks. This was heaven to Dave, and he immediately began collecting samples of the top humus layer. He did this by first sieving off the dead leaves using an old, battered wire-mesh rubbish basket and then he collected the fine-sifted material in plastic bags. These were destined to be searched by him back at the lab under a binocular microscope.

181 72 female and 38 male tusked wētā were released on Ahuahu: 49 from Double Island, 38 from Stanley Island and 27 from Red Mercury Island. (Personal communications from Theo Van Nort and Peter Corson).

182 Theo Van Noort, personal communication, April 4, 2023.

Undercliffs was an ideal habitat for tusked wētā, especially as the underlying soil was quite moist. We returned later that night and thoroughly searched the area using spotlights just in case tusked wētā had survived. I thought it extremely unlikely, but you never know: we had to check. The only wētā we saw were two large tree wētā.

The next morning, Sir Michael arrived in a Range Rover (with the number plate *THE BOSS*) and drove us to Peach Cove. We followed a farm road up through an old plantation of pine trees and stopped at a small clearing on the edge of a vertiginously high cliff. I peered cautiously over the edge at an irregular band of partly submerged boulders that ran along the foot of the cliff. The boulders were huge, although they looked about the size of sand grains from where we were: the cliff was impressively high. I found it quite unsettling standing near the edge (the boulders showed that the cliff was slowly crumbling), and I was relieved when we climbed back into *THE BOSS* and continued into the forest.

We eventually emerged onto a grassy knoll above Peach Cove, but our way down was blocked by a wide band of tall kanuka saplings. I assumed we would walk the rest of the way, but Sir Michael assured us there was a track through. He had driven down it recently, so it had to be there somewhere. Pete volunteered to try to find it and soon beckoned us down as he disappeared into the vegetation. I expected to get out and follow him, but Sir Michael drove after him, flattening everything in front as we went. At one point, Pete started gesticulating and yelling, '*Keep left, keep left, there's a ravine to your right,*' but we emerged safely on a lower grass slope and parked a few metres above a small creek that drained into an idyllic bay fringed with white sand.

Pete led me upstream to several damp areas, and I agreed that they looked eminently suitable for releasing tusked wētā. We turned around and walked back until we were stopped by Dave and Sir Michael. They were on their hands and knees in the stream, with faces close to the bank, carefully scrutinising it. They had cleared loose leaves from a small area and were completely absorbed in their search for micro-snails. It looked like they had settled in, so we skirted around their legs and continued downstream towards the beach. We intended to sunbathe, but they emerged soon after us. Sir Michael (with muddy patches on the knees of his trousers), with Dave in tow (also with muddy patches), announced that we should eat as it was long past lunchtime. How Sir Michael persuaded Dave to stop searching was beyond me, because I know from experience that it's almost impossible to pry him away once he becomes engrossed in snail work.

Back at *THE BOSS*, we were treated to hot coffee and a delicious lunch that Sir Michael's wife had kindly made for us. Then it was time to return to the visitor lodge. The way back up through the kanuka saplings looked even more daunting than when we arrived. We now faced flattened trees that had sprung back a bit, so their tops projected towards us, so we would be going against the grain, as it were. No problem for Sir Michael, though. He accelerated and crashed into the saplings. We held on with white knuckles as we burst through, accompanied by a cacophony of cracking and snapping beneath the vehicle and the screeching of branches scraping along the sides. I surreptitiously checked the paintwork when we arrived back at the lodge and was surprised to find it undamaged.

That night, after dinner, Sir Michael arrived with two bottles of Coleraine from Te Mata Vineyards – the perfect way to end a field trip in style.

A surprise visit to Red Mercury Island

"We're off to Red Mercury" Rob said when he telephoned me in October 2018. *"We want to see if there are enough tusked wētā to take some off to translocate onto Great Mercury Island. Want to come?"*

I most certainly did. I saw it as a chance to set the tracking tunnels (which we had left in place) to find how far the wētā had dispersed since our last visit in 2012.

The trip was combined with a Department of Conservation survey of Whitaker's and robust skinks (to confirm whether they had survived their translocations). We had the luxury of being transported by helicopter (courtesy of Sir Michael), so we were independent of the sea conditions. Even so, our planned four-night visit was reduced to two nights because of an approaching storm. The pilot rang us on the second day and gave us the option of leaving later the next morning or staying. If we stayed, he said he had no idea how long it would be before he could take us off again. We decided to leave.

Jo Pearce, James Russell (both from the University of Auckland), Pete Corson, and I had spent much of that second day baiting the tracking tunnels along the Trig, Te Awa and von Luckner Tracks. The tracks were now heavily overgrown, so we spent most of our time trying to find our way along them. We planned to collect the cards the next day, bait the tunnels along the Roly Poly track and the Link and Falkert's Folly tracks and collect the cards from those before we left on the fourth day. But, as the trip was shortened, we only had time to get up at dawn and collect the cards from the tunnels we had baited and then help pack up camp and haul or drag everything up two steep

An adult male tusked wētā found foraging by our tents at Lunch Bay, Red Mercury Island.
Photo: Rob Chappell

slopes to the helicopter landing pad on the southwestern tip of the island. So, after setting the trap that first day, we had no further work to do, so we took a brief coffee break and walked over to Roly Poly Bay to see how the others were getting on digging in pitfall traps to monitor the lizards.

All of us spent the first half of both nights searching with spotlights. Jo, James, Pete and I mostly searched for tusked wētā while Rob and Steve Bolton (Department of Conservation) hunted for skinks at Roly Poly Bay. Everyone reported seeing numerous half-grown juveniles and adult tusked wētā wherever they went, although most people stayed within the area between the Te Roroi Stream and Roly Poly Bay.

The next morning, James, Pete, and I collected the cards before we left the island. The night had been quite chilly, so I expected few tunnels to be tracked, but I was pleasantly surprised to find that tusked wētā footprints were in 18 of the 41 tracking tunnels. Furthermore, the tracked tunnels were interspersed irregularly between untracked tunnels along the entire length of the tracks. This indicated that tusked wētā had probably spread throughout the island and were now well-established. People searching at night also saw them frequently over a large area around Lunch Bay, so Rob and I agreed that a hundred insects could easily be removed for translocation without harming the resident population.

A last wakeup

The call of a female Little spotted kiwi, close to my tent, woke me sometime before dawn on our last night on Red Mercury Island. Another female called way off in the distance and was answered by the male kiwi nearby. Then, for the next twenty minutes, all I heard was the sound of small waves breaking on the boulder beach, maybe 50 m away, and the **kak-kak-kak-kak-kak** of seabirds wheeling about above me. They were probably little shearwaters or grey-faced petrels leaving the island because we had seen lots on the ground at night. Should I go down to the beach and watch? No, I was too comfortable and I had seen the spectacle many times before: I was content to imagine perhaps up to ten or so at a time, flying effortlessly, rising and dipping while soaring in wide curves and circles before eventually going out to sea. Their calls slowly became less frequent until they tailed off… then a kākā gave its harsh call, and it was repeated a little fainter as it flew off. A morepork close by called soon after and was answered by two others away in the distance. A long period followed, when all I could hear were the small waves breaking and ending with a short but beautiful dawn chorus provided by bellbirds.[183]

By then, I could make out things in my tent – it was getting lighter – and the spell was broken when Steve Bolton, who had pitched his tent near mine, began opening barrels and rustling plastic as he packed up. It was time to reluctantly wriggle from my warm sleeping bag, pack my gear, and help Jo, James, and Steve collect the tracking cards.

183 Sir Joseph Banks describes the bellbird dawn chorus when he awoke aboard the *Endeavour* in Ship Cove on the January 17, 1770 (Beaglehole 1963) as "… [they] seemed to strain their throats with emulation perhaps; their voices were certainly the most melodious wild musick I have ever heard, almost imitating small bells but with the most tuneable silver sound imaginable …"

Saved from extinction

The purpose of translocating tusked wētā was to increase the number of populations from the original single small one on Middle Island and increase the area the species occupied. The aim was to reduce the likelihood of Mercury Islands tusked wētā going extinct. Tusked wētā now live on Cuvier Island (Repanga Island), Double Island (Moturehu), Kawhitu or Stanley Island, Korapuki Island, Ohinau Island, and Red Mercury Island (Whakau). As a result, the threat status of this insect has been substantially reduced. Tusked wētā were classified as "Nationally Critical – Category A, First Priority Species for Conservation Action" by the Department of Conservation (Molloy, Davis and Tisdall, 1994) when I joined the Mercury Islands Tusked Weta Recovery Group in 1998: it is now classified as "Not Threatened – Naturally Uncommon" (Trewick, Johns, Hitchmough, Rolfe and Stringer, 2016).

The recent successful translocation of tusked wētā onto Great Mercury Island (Ahuahu) – after the owners had eradicated all the mammalian predators – makes it even more certain that Mercury Island tusked wētā have a secure future.

Job well done! *Rob Chappell (right) and Ian Stringer relaxing with a mug of beer (Rob) and a cup of wine (Ian) at Roly Poly Bay, Red Mercury Island. Photo: Greg Sherley*

Some of the microsnails collected by David Roscoe on Great Mercury Island.
Clockwise from top left: Discocharopda eta*, Tornatellinops novoseelandicus, Cytora torquillum, Pseudosuccinea columella, Therasiella tamora, Laoma nerissa.* Bars indicate 1 mm.
Photos: David Roscoe

APPENDIX 1

LIST OF FIELD TRIPS

The field trips led by Ian Stringer (Ian S.) and/or Rob Chappell (Rob C.) relating to work with Mercury Islands tusked wētā (MITW). Field trips made by Rob Chappell before September 1998 are not included. ACO = release-saucer (=artificial cover object), Red M. Is = Red Mercury Island, MITW = Mercury Islands tusked wētā. 'Tracking tunnels' can refer to setting and/or collecting tracking cards.

Trip No.	Dates	Personnel	Purpose of trip
1	22–23 Sept 1998	Ian S. Rob C.	Introduction to Middle Is.
2	24 Nov – 1 Dec 1998	Ian S., Suzanne Bassett, Hayden Hewitt.	Night search, Middle Is.
3	14–19 Apr 1999	Ian S., Megan Mclean, Marieke Lettink.	Night search, attractant trials, Middle Is.
4	18–28 June 1999	Ian S., Avi Holzapel, Richard Parrish: Paul Barrett, Glenice Hulls.	Night search, attractant trials, Middle Is.
5	8–12 Sept 1999	Ian S., Rob C., Lisa Sinclair, Carl McGuiness.	Check release site, Red M.Is..; night search, Middle Is.
6	3–10 Nov 1999	Ian S., Yvette Cottam, Jarn Godfrey.	Night search. Pitfall trap trial, Middle Is.
7	6–11 Feb 2000	Ian S., Maree Hunt, Jens Jorgensen.	Prep. release site; build cage, Night search, Red M, Is.; Night search, Middle Is.
8	30 Apr – 5 May 2000	Ian S., Rob C., Maree Hunt, Barry Brickell.	Night search, release 50 MITW, Red M. Is.; Release 28 MITW, Double Is.
9	18 May 2000	Rob C., Chris Winks, Paul Barrett.	Release 16 MITW, Double Is.
10	24 May 2000	Rob C.	Check ACOs, Double Is. & Red M.Is.
11	16 Aug 2000	Rob C.	Check ACOs, Red M. Is.
12	24–30 Sept 2000	Ian S., Rob C., Halema Flannagan, Malcolm Wood.	Night search, Middle Is.; Release 17 MITW Red M. Is.
13	14 Nov 2000	Rob C.	Check ACOs, Red M. Is.
14	20 Nov – 1 Dec 2000	Ian S., Cathy Lake, Megan McLean: Suzanne Bassett, Miranda Oliff.	Night search, Middle Is.
15	21–27 Jan 2001	Ian S., Rob C., Grant Blackwell, Phillip Eades.	Night search, Middle Is.; Check ACOs, Double Is. & Red M. Is.

Trip No.	Dates	Personnel	Purpose of trip
16	22–26 Apr 2001	Ian S., Rob C., Mathew Wong, Mark Fraser.	Release 8 MITW Double Is.; Check ACOs, Night search, Red M. Is.
17	7 Jun 2001	Rob C., Ian S.	Check ACOs, Red M. Is.
18	22 Sept 2001	Ian S., Rob C., Suzanne Bassett, Paul Barrett.	Release 13 MITW, Double Is., Check ACOs, Double Is.& Red M.Is.
19	11–14 Oct 2001	Ian S., Rob C., Richard Parrish, Katrina Hansen.	Night search, Middle Is.; Check ACOs, Double Is. & Red M. Is.
20	11–14 Dec 2001	Ian S., Rob C., Richard Overwijnk, Graeme Murtagh.	Night search Middle Is.; Check ACOs, Double Is.
21	31 Mar 2002	Rob C., Chris Winks.	Release 4 MITW Red M. Is.
22	13–19 Apr 2002	Ian S., Rob C., Kahori Nakagawa, Darryl Gwynne.	Night search Middle Is., Check ACOs, Double Is. & Red M. Is.
23	23 Sept 2002	Rob C., Ian S.	Check ACOs, Double Is. & Red M. Is.; Release 15 MITW Red M. Is.
24	2–7 Mar 2003	Ian S., Matthew Low, Leigh Marshall.	Check ACOs, Night search, Red M. Is.
25	29 Mar – 2 Apr 2003	Ian S., Rob C., Corinne Watts, Katie Cartner.	Night search Middle Is.: Release 2 MITW Red M. Is., Check ACOs, Double Is. & Red M. Is.
26	2 Apr 2003	Rob C., Ian S.	Night search Middle Is., Check ACOs, Double Is.
27	7–9 Sep 2003	Rob C., Leigh Marshall, Graham Ussher.	Search for MITW while catching tuatara for translocation (to Motutapu Is.), Middle Is.
28	17–23 Oct 2003	Rob C., Graeme Ussher, Jonathan Ruffell, John Potter.	Search for MITW while catching tuatara for translocation (to Motutapu Is.), Middle Is.
29	4–8 Apr 2005	Ian S., Rob C., Greg Sherley, Esta Chappell.	Night search Middle Is. & Red M. Is.; Scrape search Double Is.: Check ACOs, Red M. Is.
30	3 May 2005	Rob C., Chris Winks, Kaye Rabarts.	Night search, Middle Is.
31	12 May 2005	Rob C., Chris winks.	Night search, Middle Is.
32	26–29 Sep 2005	Rob C.	Night search, Middle Is.
33	30 Sept – 2 Oct 2005	Ian S., Larry Field.	Night search, Middle Is.
34	2–8 Dec 2005	Rob C., Andrea Brandon, Dave Hammond, Leticia Williams.	Night search, Middle Is.
35	30 Jan – 4 Feb 2006	Rob C, Esta Chappell.	Night search, Middle Is.
36	3 May 2006	Rob C, Chris Winks, Melissa Thompson.	Scrape search, Double Is.
37	8 Jul 2006	Rob C, ABC Catalyst crew, Chris Winks, Melissa Thompson.	Scrape search; ABC filming MITW, Red M. Is.
38	22 Jan 2007	Rob C., Esta Chappell.	Night search, Middle Is.

Trip No.	Dates	Personnel	Purpose of trip
39	28 Jun 2007	Rob C., Chris Winks, Sarah Wells, Alison Fraser.	Release 51 MITW, Korapuki Is.
40	1 Jul 2007	Rob C., Ian S.	Release 49 MITW, Korapuki Is.
41	18 Jul 2007	Rob C., Ian S., Oliver Overdyck, Leslie McKay.	Release 50 MITW, Stanley Is.
42	20 Jul 2007	Rob C., Ian S., Dan Rapson, Kaye Rabarts.	Release 50 MITW, Stanley Is.
43	24 Nov 2007	Rob C., Ian S., Joe Davis (Ngati Hei), Lesley McKay.	Release 100 MITW, Ohinau Is.
44	1–8 Apr 2008	Rob C., Ian S., Corinne Watts, Danny Thornburrow, Robbie Price.	Night search, Middle Is.; Tracking tunnel trial, Double Is., Korapuki Is.; Scrape-search, Double Is., Korapuki Is., Ohinau Is., Red M. Is., Stanley Is.
45	16-Apr 2008	Rob C., Wendy Davis.	Release 34 MITW, Cuvier Is.
46	3 May 2008	Rob C.	Night search, Middle Is.
47	8 May 2008	Rob C.	Tracking tunnels, Korapuki Is. & Red M. Is.
48	15 Oct 2008 / 29 Nov 2008	Rob C., Wendy Davis. Antoinette Jehy, Letticia Williams, Natasha Priddle.	Tracking tunnels, Cuvier Is.
49	9 / 24 Mar 2009	Rob C.	Tracking tunnels, Middle Is.
50	13 / 24 Mar 2009	Ian S., Rob C., Corinne Watts, Danny Thornburrow, Robbie Price.	Tracking tunnels, Korapuki Is. & Red M. Is.; Scrape-search, Korapuki Is., Ohinau Is.
51	8 Oct 2009	Rob C, Andy Wills, Letticia Williams.	Tracking tunnels, Cuvier Is.
52	24–25 Feb 2010	Rob C., Lesley McKay.	Night search, Cuvier Is.
53	8 / 21 Apr 2010	Ian S., Rob C., Corinne Watts, Danny Thornburrow.	Tracking tunnels, Korapuki Is.
54	26 Apr 2010	Rob C., Ian S.	Check ACOs, collect one MITW, Red M. Is.
55	30 Jul 2010	Rob C.	Tracking tunnels, Cuvier Is.
56	27 Oct 2010	Rob C.	Tracking tunnels, Cuvier Is.
57	1–8 Mar 2011	Ian S., Rob C., Corinne Watts, Danny Thornburrow.	Tracking tunnels, Double Is., Korapuki Is., Middle Is., Ohinau Is., Red M. Is., Stanley Is.; Scrape-searches, Double Is., Korapuki Is., Red M. Is., Stanley Is.
58	11 Mar 2011	Rob C., Leslie McKay, Corinne Watts, Danny Thornburrow.	Tracking tunnels, Cuvier Is. & Stanley Is.
59	26–27 Mar 2011	Rob C., Ian S., Corinne Watts, Danny Thornburrow.	Tracking tunnels, Stanley Is.
60	6 Apr 2011	Rob C.	Tracking tunnels, Middle Is.

Trip No.	Dates	Personnel	Purpose of trip
61	30–31 May 2011	Rob C, Steve Bolton, Michael Hook, Nick Hammond, Brian Shields.	Night search, tracking tunnels, Cuvier Is.
62	24–30 Jul 2011	Rob C.	Tracking tunnels, Cuvier Is.
63	7–8 Sep 2011	Rob C., Ian S., Andy Wills, Bridget Baynes, Tansy Bliss.	Translocation; 75 MITW from Double Is. to Cuvier Is.
64	9 Sept 2011	Rob C., Ian S., Leslie McKay.	Tracking tunnels, Middle Is.
65	22 Sept 2011	Rob C.	Tracking tunnels, Middle Is.
66	2 Dec 2011	Rob C.	Tracking tunnels, Middle Is.
65	20 Dec / 23 Jan 2012	Rob C.	Tracking tunnels, Middle Is.
66	21 Dec / 24 Jan / 16 Feb 2012	Rob C.	Tracking tunnels, Green Is. & Middle Is.
67	31 Jan 2012	Rob C., Bridget Baynes, Andy Wills.	Tracking tunnels, Cuvier Is.
68	15 / 21 Mar, 6 Apr, 4 May 2012	Ian S., Rob C., Corinne watts, Danny Thornburrow.	Tracking tunnels, Korapuki Is., Ohinau Is., Red M. Is., Stanley Is.
69	7 / 17 Feb 2012	Rob C., Rex Williams, Genevieve Spruge.	Tracking tunnels, Cuvier Is.
70	16 Feb / 21 Mar / 4 May 2012	Rob C.	Tracking tunnels, Middle Is.
71	4 / 5 May 2013	Rob C.	Tracking tunnels, Middle Is.
72	21 Oct / 24 Nov 2015 / 12 Feb 2016	Rob C., Mike Bell, Claudia, Nicky Munro (nee Millar), Liz Whitwell.	Tracking tunnels, Middle Is.
73	22 Apr / 3 May 2016	Rob C., Mike Bell, Claudia, Nicky Munro (nee Millar).	Night search, tracking tunnels, Cuvier Is.
74	3 May / 5 Jul 2016	Rob C.	Tracking tunnels, Middle Is.
75	20 Oct 2016	Rob C., Liz Whitwell, Brian Shields.	Tracking tunnels, Cuvier Is.
76	21-24 Nov 2016	Rob C., Elaine Holden, Dave Hammond, Kudaho Wereho, Hugh Gordon, Brian Sheilds.	Tracking tunnels, Cuvier Is.
77	17 Oct 2017	Rob C.	Tracking tunnels, Middle Is.
78	9–11 Oct 2018	Rob C., Ian S., James Russell, Jo Peace, Peter Corson, Steve Bolton.	Survey MITW, Red M. Is.

APPENDIX 2

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