He Kōrero Paihama

Possum Research News

Issue 13 May 2000

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Releasing Pigs to Detect Tb: a New Concept

Control operations to eliminate bovine tuberculosis (Tb) from increasingly large areas of New Zealand are reducing possum populations to low densities. However, the success of such control makes it much harder to know if and where Tb still persists, particularly when there are few livestock to indicate the disease's presence. Possum populations can be surveyed directly, but surveys are difficult and costly. An alternative concept is to use other wildlife as indicators or 'sentinels' of Tb's existence.

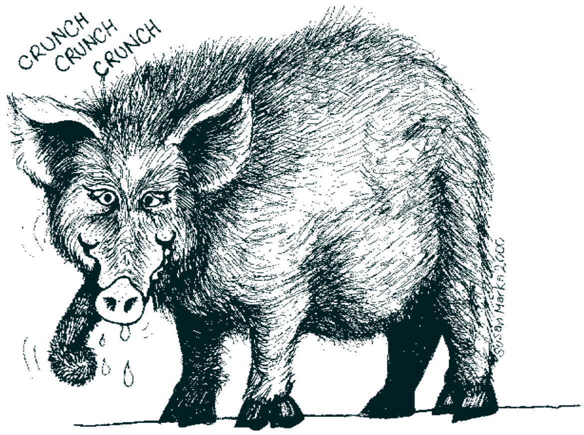
This idea originated following Graham Nugent's and Jackie Whitford's study in the Hauhungaroa Range indicating that most Tb in wild deer is contracted from possums. In 1994, possum numbers in the eastern part of this Range were reduced by aerial poisoning. Most of the Tb infected deer born after 1994 have been shot within or close to the unpoisoned part of the range. However, two infected deer were shot close to areas that had inadvertently missed being poisoned. In one area, an 80-ha gap had been left between two successive poison operations. In the other, a small gap had been deliberately left alongside a stream. A survey of this stream edge site identified infected possums. Hence, the two infected deer pinpointed areas where Tb may have persisted in possums.

But would routinely using species other than possums to determine the presence of infected possums be more cost effective than surveying the possum populations themselves? When animal populations are surveyed for Tb, the probability of finding infection depends on the number of infected

Implanting a radio transmitter prior to release.

animals, population size, sample size, and the 'detectability' of infection. Even assuming 100% detectability at necropsy, one can only ever be 95% confident the disease is completely absent if 95% of the population is surveyed. As possums have small home ranges, collecting possums from 95% of their ranges is impractical.
An alternative is to change the scale of resolution by switching to a sentinel species that has a larger home range than possums, which means fewer animals are needed to effectively cover the survey area. Species which show signs of infection for longer than possums would also be advantageous.

Ferrets, deer, and pigs are all potential indicators. However, ferrets tend to be most abundant on farmland where livestock provide Tb surveillance (through Tb testing) and deer populations tend to have much lower prevalences of Tb than pigs in the same areas. The team have therefore deliberately released pigs in a pilot trial to test the efficacy of pigs as indicators. Groups of four Tb-free radio-tagged wild pigs have been released in areas where about 5% of the possum population is infected with Tb.
The pigs will be relocated and checked every 2 weeks, and one pig in each group will be killed at 1, 4, 7, and 10 month intervals after release and inspected for tuberculosis. This trial will help assess the practicality and cost of the concept.



Some existing data on Tb prevalence in wild pigs suggests that the probability of infection in this trial is likely to be quite high, perhaps 50%. Simulation of possible trial outcomes shows that if the true probability of infection in pigs is greater than 20%, the likelihood of no pigs being infected (i.e., a zero result) is very low (Fig.1). In other words, a zero result will indicate that fewer than one pig in five becomes infected after 6-7 months exposure to an infected possum population, which would mean the sensitivity of pigs as indicators is far lower than hoped for. Regardless of that possible outcome, the movement data will help managers interpret the occurrence of Tb in feral pigs by enabling them to identify 'probable radii of infection' around the kill sites of infected pigs. This will enable managers to better target their possum control efforts to known foci of infection, and so contribute to the improved cost-efficiency of ongoing efforts to eradicate Tb.

This work is funded by the Animal Health Board.

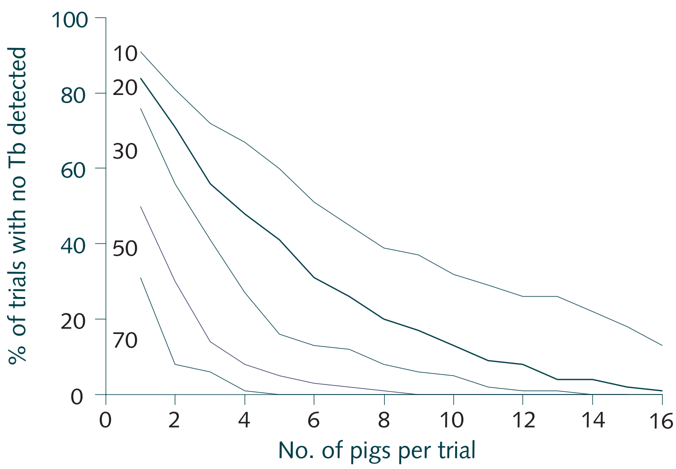


Fig. 1. Percentage of trials that would fail to detect Tb by chance alone for a range of sample sizes. Each line represents a different true probability of infection.

***Graham Nugent**, **Nigel Young** and **Jackie Whitford** work on the epidemiology of Tb in wildlife and on the impact of possums on indigenous ecosystems.*

Guest Editorial

For our Christmas holiday my son Karl and I spent a week in a little visited corner of the central North Island's Tongariro Forest. We based ourselves in an ingeniously constructed open-plan 'hut' sited in a sunny clearing ringed by young kahikatea. It was a wonderful time and perhaps the ideal place for 2000 AD father-son bonding. Native birdlife was refreshingly conspicuous; we delighted in the sights and sounds of tūi, shining and long tailed cuckoos, grey warblers, fantails, tomtits, kererū, kingfishers and kākāriki. At night ruru haunted the clearing.

All this was a welcome contrast to the daily routine I experience as a conservation bureaucrat, and occasional lobbyist, roaming the traffic-congested acres of tar and cement in downtown Wellington. Since returning I have yet to dislodge the urge for an extended Thoreauvian time-out in such a place so I, too, can try living deliberately, learning what the forests have to teach.

Before unpacking our gear we swept the hut's crude bench clear of rodent droppings and possum pellets – reminders that despite the wonder of the place, nature here was not unsullied. But no possums were heard that night and a roam through the tawa-podocarp forest next day suggested possum numbers were relatively low. Possum palatable species in the canopy were in reasonable health and we came across a live partly-grown northern rātā hugging a big mataī. Good news indeed in a forest that has been hammered by possums over the years, with mature rātā dying out back in the 1950s.

Later, DOC advised me that the western quarter of Tongariro forest was covered by a regional council aerial 1080 drop 3 years ago.
My observations of bird numbers, possum densities and canopy health have no scientific validity but coincide with observations of others who know the forest today far better than I. Interestingly, DOC's local staff suspect that the vastly improved rates of mistletoe pollination in the uplands of Tongariro National Park could be partly due to increases in populations of tūi and bellbird in the 1080-blitzed lowland forests of the adjacent Tongariro Forest. After spending yet another year defending the use of aerial 1080 in the media and in response to calls from worried members of the public taken in by anti-1080 claims, it was highly reassuring to experience a forest where the benefits of possum control were so obvious. It is an experience all who are concerned for the future of our indigenous biodiversity should have.

The use of toxins to protect nature is not a simple story, of course.
It has unexpected twists. Some pest managers have been switching from aerial 1080 to higher cost brodifacoum bait stations to appease the 1080 opponents. But brodifacoum is persistent and is now turning up in livers of animals further up the food chain. However, stoat deaths through secondary poisoning from brodifacoum are a compensatory boon for native birdlife. For me, my Tongariro experiences reinforce the need for pest control methodology to be based on the best scientific and practical conservation management advice rather than capitulating to ill informed lobbies.

Despite experiencing a forest alive with birds, I came away from Tongariro deeply troubled and anxious for its future. Not one palatable tree or shrub species was regenerating successfully in the forest areas Karl and I visited. Broadleaf seedlings were common on the forest floor but none were taller than about 30 cm. Nor were any fuchsia, hīnau, five finger, māhoe, patē or raurēkau saplings found. Red deer had stripped the forest understorey of every palatable species and were feeding on seedlings and fallen leaves. Horopito abounded and tree ferns were also a big winner, occupying large areas of the hill slopes. Fortunately the podocarps and tawa were also shunned by deer, and were regenerating well, though rutting stags had killed a couple of pole rimu.

Unless deer numbers are taken down to very low levels in this forest, the possum control operations will provide only temporary protection. As the palatable species in the canopy age and die out, they will not be replaced. Many of them provide vitally important foods for native birds and invertebrates. They may also play key roles in forest regeneration cycles.

Tongariro forest is sick. If it dies, it will be because conservation managers and politicians have focused on the control of possums but ignored the equally serious threat to forest health posed by deer. I believe pest managers need to reconsider the introduction of helicopter shooting and 1080 operations targeting deer despite opposition from deer hunters.

Forest health can only be secured if conservation managers control both the pests that menace the canopy and those that menace the forest understorey. The impacts of deer, goats, pigs and wallabies need to be addressed with the same urgency as those of the possum. The politics of appeasement practiced by 'relationship managers' in conservation agencies will disinherit Karl's generation of the wondrous diversity of Tane's forests.

***Kevin Smith** is Conservation Director, Royal Forest and Bird Protection Society of New Zealand Inc.*

Can Wild Deer Infect Possum Populations with Tb?

Wild deer are a major reservoir of bovine tuberculosis (Tb) as over 40% of some populations are infected with the disease. Wild deer usually live alongside possum populations. Where these are controlled, the level of infection in the deer population falls over the next five or so years because very few young deer become infected. This decline indicates that most of the Tb in deer populations comes from possums, and that infected deer can survive for several years. Because they are a potential source of reinfection for possums, a key question for Tb management is whether infected deer pose a significant threat to successful possum control. Graham Nugent and his team are assessing part of that risk by identifying what happens to infected deer carcasses.

Anecdotal evidence indicates that, although primarily herbivores, possums occasionally scavenge dead animals, making this a possible route of Tb transmission. To confirm this, Graham's team put meat baits in high-altitude mountain beech forest and lower altitude grassland / scrub near Kaikoura. Baits were placed in containers coated with an adhesive so that feeding animals could be identified from fur stuck in the glue. Possum traps, placed halfway between baits, indicated high densities at both sites (Table 1). In the beech forest, 20-29% (depending on season) of meat baits were apparently eaten by possums, and a trap-catch of 66-87% was recorded. Far fewer baits were taken per possum trapped (particularly in winter) in the more diverse scrub / pasture habitat where possum numbers were lower. These results indicate firstly that many possums eat meat baits, but also that other possums encounter baits but do not eat them.

"Hard" evidence of possums scavenging deer carcasses was obtained using video cameras set up alongside whole and part carcasses of deer. In a trial at Kaikoura in summer 1999, no possum touched the 'baits', although a number of possums came to within 0.5m of them – the team believes they may have been deterred by the bright white spotlight used to allow filming. However, in a subsequent trial at Kaikoura using a red spotlight, all three baits were fed on by possums. In this instance, some possums did not approach the baits, while others came up and sniffed at them. Most of those that fed did so only briefly, but one or two possums fed for extended periods on the baits on several different occasions over at least two weeks. Interestingly, possums only fed on a whole carcass after the skin was cut open. Prior to that, possums only sniffed at the carcass.

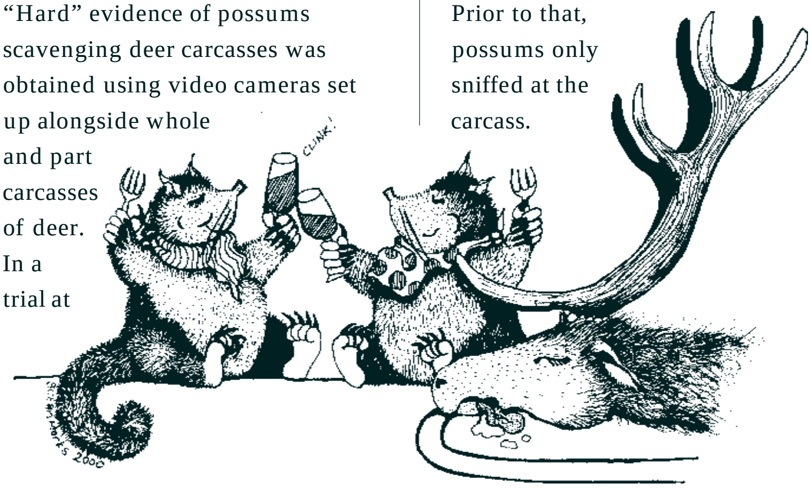


Table 1. *Percentage of meat baits believed to have been taken by possums, and % trap catch in two grids at Kaikoura. The low summer trap-catch in the scrub/pasture grid reflects wet weather.*

	Mountain beech		Scrub / pasture	
	Bait take	Trap catch	Bait take	Trap catch
Winter 1998	29%	66%	3%	58%
Summer 1999	20%	80%	10%	13%
Winter 1999	27%	87%	7%	57%

A further trial in mountain beech forest in central Canterbury recorded instances both of possums feeding for extended periods on part carcasses with the skin partially removed, and of encounters where possums did not feed or avoided carcasses completely. However, in nearby pine forest, none of the few possums that encountered carcasses fed on them at all. In a further trial on the West Coast, possums were not seen at any of three carcasses being monitored.

Although qualitative, these trials make it plain that possums may scavenge deer carcasses, especially where part of the carcass such as the head (the most common site of infection in deer) has been left by a hunter. Infected deer are a reinfection risk to possum populations where intensive control has cleared them of the disease. The risk is higher where possum populations recover to high densities before all infected deer have died or been eliminated.

This research was funded by the Foundation for Research, Science and Technology.

Graham Nugent, Ivor Yockney, Jackie Whitford *and* ***Nigel Young*** *work on the epidemiology of Tb in feral deer and wild pigs.*

What Happens to Populations of Trees Browsed by Possums in Westland's Upland Rain Forests?

The spectre of grey crowns of dead or dying kāmahi and southern rātā throughout many of the upland forests of central Westland evoke powerful emotions. The death of these trees is widely believed to result from browsing by possums. However, sometimes the patterns of tree death indicate factors other than possums are involved. The central Westland upland area is very dynamic, with many forests receiving at least 6000 mm of rainfall / yr and growing on geologically unstable schist close to the Alpine Fault where natural disturbances, especially landslides, are a major influence on forest systems.

Dead standing stems of southern rātā in the Kokatahi valley. These trees died in the 1950s, yet these spars persist until today.

Table 1: *Dates of possum colonisation, population peaks and control operations in four Westland upland forested valleys*

Catchment	Colonisation	Peak of population	Control by aerial poisoning
Taramakau	1950s (?)	1970s	1970, 1974
Kokatahi	1923	1950s	1959, 1961, 1966
Whitcombe	1912	1980s (?)	1984
Copland	1924, 1930	1970s	1986

A more comprehensive view of the long-term changes in tree populations in Westland is now possible through the remeasurement of trees permanently marked in these forests by New Zealand Forest Service staff in the 1970s. This is a better means of assessing tree death than asessment from a single point in time, since spars of some species, including southern rātā, persist for many decades after tree death, giving rise to overestimates of mortality.

Peter Bellingham and his colleagues have been working with census data of trees (≥10 cm diameter) available from four valleys in Westland (Table 1). Using data collected over 14 – 27 years, he has calculated the annual mortality and recruitment rates (i.e., growth of smaller stems to become adults) of three species of trees whose foliage is browsed by possums, i.e., kāmahi, southern rātā, and Hall's tōtara (Fig. 1).

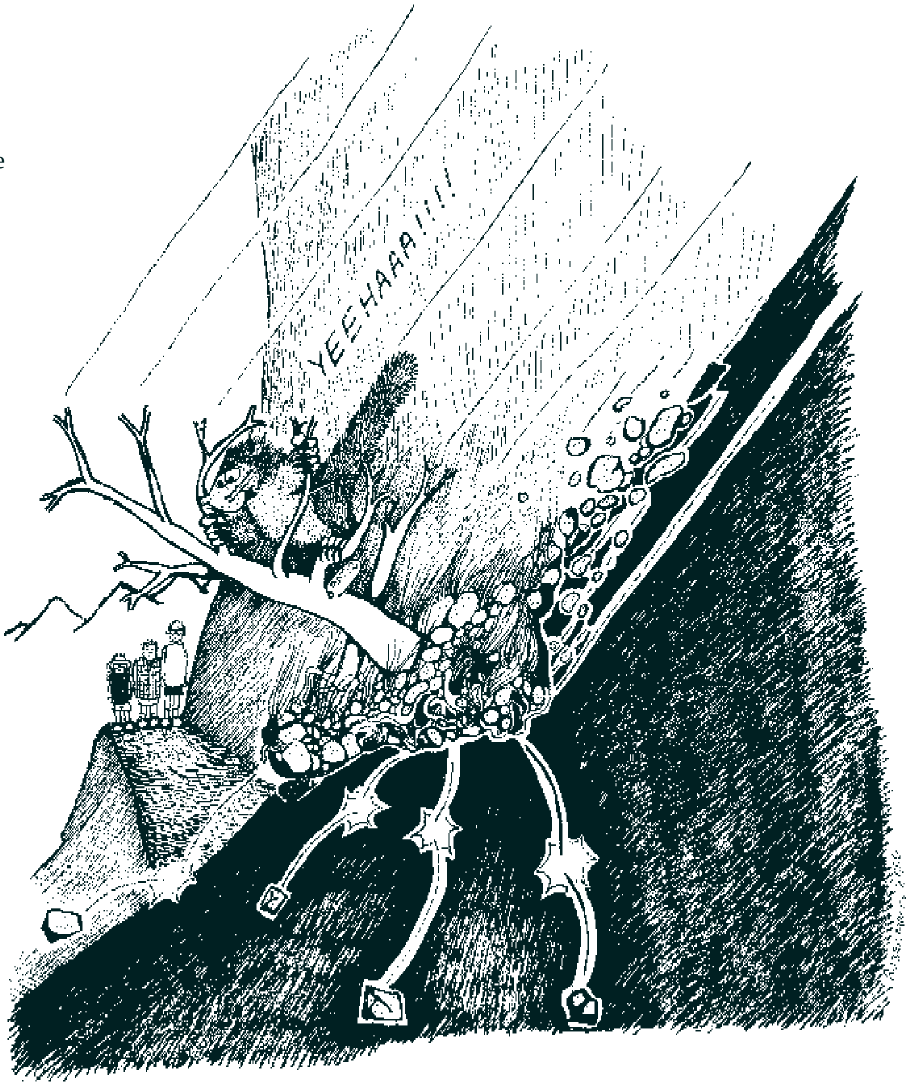
Peter's results show that populations of kāmahi are being maintained in all four valleys, including the Kokatahi Valley which is considered to be the text-book case of forest dieback in New Zealand. In each valley, recruitment of kāmahi matches or exceeds mortality, so while locally mortality may be high, elsewhere in each valley new stems are entering the population.

For southern rātā, mortality rates dramatically exceed recruitment rates only in the Kokatahi valley, but some recruitment occurs in all four valleys. Earlier studies have identified that southern rātā is dependent on disturbance for widespread recruitment, and Peter expects that much of the recruitment in these valleys is related to past disturbance. Indeed, recent research from southern rātā forests on the Auckland Islands suggest that southern rātā stands there die back over time (and in the absence of possum browsing) to be replaced by shrublands, perhaps on a cyclical basis.

In stark contrast to mortality of kāmahi and southern rātā, mortality of adult Hall's tōtara has been high in all four valleys, with

Fig. 1: *Annual mortality and recruitment rates of stems ≥10 cm diameter at 1.4 m of three tree species in permanent plots in upland forests in four Westland valleys.*

little if any compensatory recruitment. Although early studies of these forests did not consider Hall's tōtara to be threatened by possums, there is now good evidence to indicate this species is in decline.



Other conclusions of local forest mortality can be drawn from the history of possums at all four sites (Table 1). In particular, it appears that the simultaneous decline of adult Hall's tōtora across all four valleys occurred independently of possum colonisation and timing of peak numbers. If the current mortality and recruitment of Hall's tōtara had been maintained following possums peaking in numbers in the Kokatahi valley in the 1950s, there would have been no trees left to measure in the most recent census in 1995! Furthermore, stands of dead Hall's tōtara were observed in Westland National Park before colonisation by possums. Likewise, it appears that the different histories of possum controls in the four valleys, using broad-blanket applications of 1080 (Table 1), have not had any effect in influencing mortality of Hall's tōtara.

These data should not be taken to mean that forests dominated by kāmahi, southern rātā, and Hall's tōtara are not affected by possums. It is clear that possum browsing can cause the death of individuals of some tree species, and can severely depress the reproductive output of others (such as hinau and nikau). Furthermore, through predation they can reduce the populations of seed dispersers (e.g., kererū) of some trees. Peter's study has demonstrated that in the upland valleys of Westland, the long-term effects of possums on tree populations are difficult to detect and disentangle from natural processes of disturbance. Against that, there is irrefutable evidence that populations of Hall's tōtara are in decline in these forests, and future research and management should focus on understanding and protecting these stands.

This work was funded by the Foundation for Research, Science and Technology and the Department of Conservation.

Peter Bellingham, Rob Allen *and* ***Susan Wiser*** *work on the dynamics of indigenous forests.*

Spotlight on Sperm: Targets for Possum Biocontrol

Immunocontraception is a form of biological control based on making animals infertile. Scientists at Landcare Research and the Co-operative Research Centre for the Conservation and Management of Marsupials (Marsupial CRC) are developing immunocontraceptive vaccines that target specific possum sperm and egg proteins. Immunization with such vaccines cause the possum's immune system to produce antibodies against its own sperm or eggs, and these antibodies interfere with reproduction.

Merrilee Harris and Sandra Jones have concentrated on identifying sperm proteins in possums and other marsupials that are suitable targets for immunocontraception. Targeting sperm proteins has the potential to reduce the fertility of males as sperm within the male reproductive tract could be rendered infertile. Antibodies made by vaccinated females could also inactivate fertile sperm entering the female reproductive tract, thus increasing the effectiveness of the vaccine. By targeting a number of sperm and/or egg coat proteins, researchers also expect to reduce the likelihood of animals failing to make antibodies in response to the vaccine.

Maximising the effectiveness of the immunocontraceptive vaccine in these ways is particularly important, as ecological models have shown that 70-80% of female possums need to be infertile to successfully reduce New Zealand's possum population.

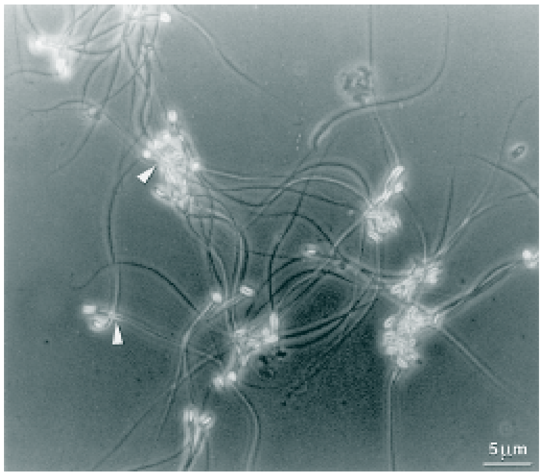


Fig. 1. *Antibodies stop sperm swimming by agglutination.*

For a sperm protein to be an effective immunocontraceptive target it must be on the sperm surface during transport in the male and/or female reproductive tract, or exposed during the fertilisation process. Antibodies generated against the protein must also be able to interfere with some aspect of sperm transport, maturation and/or fertilisation.

Characterising specific possum sperm proteins through an immunoblot technique.

To date, Merrilee and Sandra have identified a number of novel marsupial sperm proteins with immunocontraceptive potential. One protein on the surface of wallaby sperm appears to be involved in sperm maturation in males. Antibodies against this protein are also able to agglutinate live sperm (Fig. 1), thereby stopping them from swimming and thus reaching the egg. Another protein has been identified that helps sperm penetrate the egg coat during fertilisation. Ongoing research aims to clone the genes encoding these proteins and identify their possum equivalents.

Early immunisation trials designed to show the efficacy of immunocontraceptive vaccines, demonstrated that vaccinating female possums with whole sperm reduced the number of young born by 80%. Interestingly, antibodies in the serum of these infertile possums bound to only one sperm protein, suggesting that this protein was responsible for the reduced fertility. Merrilee and Sandra have characterised this protein and now aim to clone its gene.

These researchers have also cloned a gene encoding the possum version of another sperm protein that successfully reduces the fertility of a number of placental mammals. Interestingly, this protein has a possum-specific region, which is not found in the equivalent proteins in placental mammals. Such species-specific regions can be targeted by vaccines to ensure that the immunocontraceptive is harmless to humans and other animals. The possums ability to make antibodies against this possum-specific region will therefore be investigated.

By testing the ability of each of these sperm proteins to reduce possum fertility, researchers hope to prove the efficacy of targeting sperm proteins for biocontrol, and plan to extend this research to genetically engineering a vaccine that contains both sperm and egg protein sequences. By these methods it is hoped that extremely effective immunocontraceptive vaccines will be produced that are able to reduce the fertility of both male and female possums.

This work is funded by the Marsupial CRC.

***Merrilee Harris** and **Sandra Jones** work on inhibitors to reproduction in possums.*

Can Parasites Help us to Control Possums?

In the October 1995 issue of Possum Research News, Phil Cowan reported on surveys underway in New Zealand and Australia to look for parasites that could be important biological control agents for reducing possum numbers. A team led by Phil Cowan (Landcare Research) and Mark Ralston (AgResearch) have now sampled about 200 possums from each of 16 areas in New Zealand, either where possums had originally been released from Tasmania or Victoria / Southern New South Wales, or where they had been released later. Possums were also sampled in each State in Australia.

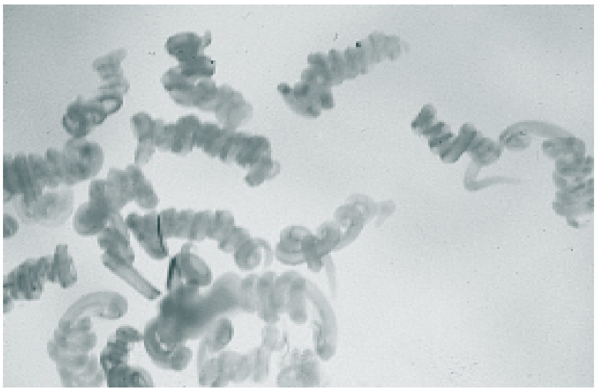
After more than 3000 necropsies, the team now knows that New Zealand possums are host to a very limited range of parasites. They include five species of fur mites, and two nematodes (roundworms), a coccidian parasite and a tapeworm that live in the possums intestinal tract. All of these species occur only in possums. In addition, in farming areas possums become infected with intestinal nematodes more commonly found in sheep, goats and rabbits.

Although possums in Australia carry many more species of parasites, most of them also occur in other animals. The only possum-specific parasite found in Australian possums and missing from New Zealand possums is another roundworm, *Adelomena trichosuri*, that lives in the appendix. Strangely, it is the commonest parasite in Australian possums!

Dosing possums to remove existing parasites.

The distribution of parasites in possums in New Zealand is also rather odd. Although the two possum-specific nematodes are common throughout the North Island, they are absent from all possums in the South Island except around Invercargill. Even odder, possums on Stewart Island have no parasites!

So there is an opportunity to spread these two parasites around in the South Island. But would such action contribute to reducing possum numbers? Phil and Mark's records show that in areas where parasites are absent, possums weigh more and are in better physical condition than in areas where parasites are prevalent. Where parasites do occur, possums with more parasites are in poorer condition than those with fewer parasites. This observation raises a fundamental question: do thin possums have more parasites because of the effects of the parasites or do parasite numbers increase in possums in poor condition? It's important to answer this question because both breeding and survival of possums are related to their condition. If parasite infection reduces possum condition, then parasites could have an impact on possum populations. A field experiment was set up to address this question. A group of possums was caught and regularly dosed with a cocktail of sheep and cattle drenches to remove parasites and the condition of the treated animals compared with that of a group of undosed possums. Unfortunately, the experiment was a failure – as fast as parasites were removed from the dosed possums they became reinfected, so there was never any difference in parasite numbers between the dosed and undosed animals.



Possum-specific gut nematode.

While this was bad news for plans to assess whether possum parasites limit possum populations, it was good news for plans to use one of the possum-specific nematodes, *Parastrongyloides trichosuri*, as a means of delivering biological control to possums. If this parasite is modified for biological control, it should still readily infect possums in the wild. *Parastrongyloides trichosuri* has a free-living life cycle that provides researchers with the opportunity to genetically modify it by injecting DNA into its ovary under laboratory conditions, and then screen and test the modified worms. This parasite normally infects possums by either penetrating their skin or being ingested. Once inside the possum it migrates into the intestine where it lives as an adult worm. Possums, after several exposures to the parasite, develop an immune response to protein produced by the larval parasite. The team has identified the protein and determined its DNA sequence. They now hope to be able to attach other DNA to it, so that when the possum becomes immune to the protein, it will also make antibodies to the newly attached DNA. Such antibodies could interfere with possum breeding and render them infertile. Possum numbers would then decline, as possums that died would not be replaced.

Currently Phil and Mark are looking at the factors that influence the spread of this parasite, while molecular biologists work to develop the modified nematodes. Although the role of the parasite in reducing possum numbers is unclear, it may have a very important role in future biological control as the means of getting a control agent out to New Zealand's tens of millions of possums.

This research is funded jointly by the Foundation for Research, Science and Technology and MAF Policy Division.

__Phil Cowan__ works on possum ecology, Tb and biological control of possums. __Mark Ralston__ works on the epidemiology, immunology and biology of possum parasites.

All You Ever Wanted to Know About Possums in New Zealand

New Book: The brushtail possum - the biology, impact and management of an introduced marsupial. Edited by T.L. Montague

Brushtail possums are currently the most serious vertebrate pest in New Zealand, with over $50 million spent per annum in recent years on their management and research. This is about twice that spent on all other mammal pests. The findings from possum research in New Zealand are presented each year in about 200 formally published papers, unpublished reports, and conference or workshop papers. However, many of these papers and most of these reports are not readily available. Broad-based, suitably referenced synopses of possum research and management are rare. The last significant attempt to summarise the latest research findings and issues related to possum management in New Zealand occurred following the first symposium on marsupials in New Zealand held at Victoria University in 1977.

This new text, produced and edited within Landcare Research pulls together key elements of possum biology, ecology and management. It contains 25 chapters grouped into possum biology, impacts, control and management, the benefits of control, and options for future management. Each chapter also provides a detailed listing of the most relevant publications and unpublished management reports, which makes the 'grey press' available to a wider audience than currently is the case. The 25 chapters bring together the work of 41 different biologists, forest ecologists, sociologists, modellers and pest managers currently working on possums in New Zealand. In addition there is a Ministerial forward, an editorial introduction, a summary of possum related legislation, and a possum fact sheet.

The text is written with the lay reader in mind, and provides a much needed update on the biology and management of the possum in New Zealand. It is essential reading for all researchers and pest managers wanting to keep abreast with the latest information available on this troublesome animal, and will provide a substantial reference listing for those seeking more detailed study.

Price: $59.95 (incl GST, handling and postage, airmail extra)

Available in July from:
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A Selection of Recent Possum-Related Publications

Cowan, P.; Walmsley, A.; Kirk, D.; Lee, S.M.; Young, P. 1999: Plant-derived vaccines for possum fertility control. In: G. Sutherland (Ed.), Advances in the biological control of possums. The Royal Society of New Zealand, Miscellaneous Series 56: 24-27.

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