LINCOLN UNIVERSITY
*Te Whare Wānaka O Aoraki*

# Cholecalciferol as an alternative toxin for the control of bait-shy possums in the Mackenzie Basin

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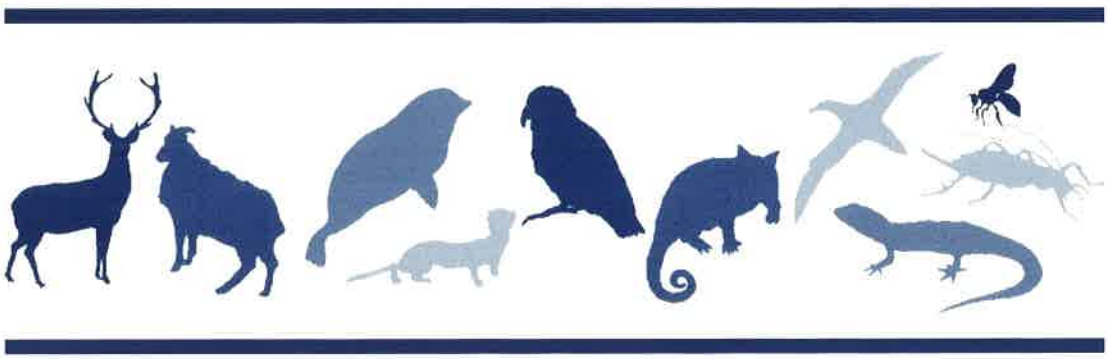
Prepared for: Weeds & Pests Division, Landcare



**Lincoln University Wildlife Management Report**

**No. 3**

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# CHOLECALCIFEROL AS AN ALTERNATIVE TOXIN FOR THE CONTROL OF BAIT-SHY POSSUMS IN THE MACKENZIE BASIN

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# 1. SUMMARY


## 1.1 Project

A field trial was undertaken between January and March 1993 to evaluate the use of the toxin cholecalciferol for control of possums (*Trichosurus vulpecula*) in the MacKenzie Basin. The work was done in an area containing possums that exhibited bait-shy behaviour towards standard sodium monofluoroacetate (1080) baits. The trial was undertaken by staff from Manaaki Whenua - Landcare Research, Christchurch, with assistance from the senior author of this report.

## 1.2 Objective

- To assess the effectiveness of cholecalciferol as a toxin for control of free-ranging, bait-shy possums in the MacKenzie Basin.

## 1.3 Methods

- After 3 weeks of prefeeding, 0.08% wt/wt 1080 bait was applied for 1 night to remove non-shy possums from a 3.5 km transect of feeder stations.
- After 3 further nights of prefeeding, the remaining possums were exposed to 0.4% wt/wt cholecalciferol baits in the feeder stations for 11 nights.
- The % kills achieved by the two toxic applications were assessed from changes in take of non-toxic bait at the feeder stations, and by monitoring the survival of 20 possums that were radio-collared before the control work began.

## 1.4 Results

- The % kill of possums resulting from the 1080 application was estimated as 31% from the change in bait take, and as 20% from the mortality of radio-collared possums.
- Neither the bait take nor the radio-tracking data revealed any measurable kill of possums as a result of the cholecalciferol treatment, despite a substantial amount of toxin having disappeared from the feeders.

## 1.5 Conclusions

- Although previous pen trials suggest that cholecalciferol may be a suitable alternative to 1080 for possum control, further work is required to establish an effective protocol for its use in the field.

## 1.6 Recommendations

- A trial should be conducted to determine the amount of 0.4% cholecalciferol bait consumed by individual possums in the field. (This will establish whether the failure of the trial reported here was due to rejection of the baits or low susceptibility to the toxin).
- This trial should be repeated with 0.8% cholecalciferol, to allow a preliminary assessment of the relationship between toxin loading and bait acceptance.
- Toxicity of cholecalciferol in the field should be assessed using 10 radio-tagged wild possums that have been fed 16g of 0.4% bait, and 10 fed 16g of 0.8% bait.

## 2. INTRODUCTION

This report describes a field trial undertaken between January and March 1993 to evaluate the use of the toxin cholecalciferol as an alternative toxin to sodium monofluoroacetate (1080) for the control of free-ranging brushtail possums (*Trichosurus vulpecula*) in the MacKenzie Basin. This is an area that has seen repeated use of low-strength (0.02% wt/wt) 1080 baits for the control of rabbits. Earlier trials in the area indicate that few possums are killed by such operations (Thomas *et al.* 1993), apparently as a result of behavioural resistance (bait or toxin "shyness") induced by the exposure to sublethal baits. One possible strategy for control of possums in such areas is the use of an alternative toxin such as cholecalciferol.

This trial forms part of a larger study to evaluate alternative toxins to 1080 for possum control. The trial was undertaken by the Weeds and Pests Division of Manaaki Whenua - Landcare Research, Christchurch, with assistance from the senior author of this report. Preceding the trial, the junior author and staff from Lincoln University had assessed the status of the possums in the study area and confirmed that many were "shy" to standard (0.08% wt/wt) 1080 baits (G. Hickling, unpublished data).

This report was originally prepared as an assignment for the Applied Ecology course at Lincoln University, and is reformatted here as a report to Maanaki Whenua - Landcare Research.

## 3. BACKGROUND

Pen studies (Ross *et al.* 1987; Thomas 1992) suggest that possums can develop bait "shyness" after eating a sublethal amount of 1080, such as the 0.02% 1080-carrot baits used for rabbit control. This shyness could result in low % kills of possums, especially in rabbit-prone areas such as the MacKenzie Basin.

Cholecalciferol (Quintox $^{R}$), manufactured by Wellcome NZ Ltd., was developed in Australia as a rat and mouse bait to combat shyness to anticoagulant baits (Bell Laboratories 1991). It acts by mobilising stored calcium in the body, thereby causing hypercalcaemia and eventual heart failure (Eason 1991). Recent research produced an estimated $LD_{90}$ for possums of 20 - 50 mg/kg cholecalciferol (Eason 1991), which indicates that possums are more sensitive to the compound than other mammals such as cats, dogs and rats. Non-target bird species are unlikely to be susceptible to cholecalciferol poisoning (an oral $LD_{50}$ of >2150 mg/kg has been reported in the mallard duck; Eason 1991), although is no comparable data for indigenous species as yet.

Pen trials suggest that cholecalciferol shows considerable promise as an alternative toxin to 1080 for possum control. It is highly toxic, and palatable, when incorporated into cereal bait

($LD_{95}$ of 27mg/kg). On initial exposure to the toxin, penned possums show no preference for non-toxic bait over 0.4% wt/wt cholecalciferol bait (Eason *et al.* 1992). After consuming a lethal dose, possums become anorexic (R. Henderson, pers. comm.), a "stop-feed" effect that reduces the costs associated with excess consumption of bait by lethally-dosed possums.

Cholecalciferol is suitable for registration by the Agricultural Compounds Unit and, in contrast to 1080, could registered for unsupervised use in bait feeders by farmers and other land managers. After reviewing a range of potential toxins, Eason *et al.* (1992) recommended that cholecalciferol showed the most promise as an alternative to 1080.

This trial was designed to extend pen investigations of cholecalciferol into the field, with particular emphasis in the control of possums in a population that was shy of 1080 bait.

## 4. OBJECTIVE

- To assess the effectiveness of cholecalciferol as a toxin for control of free-ranging, bait-shy possums in the MacKenzie Basin.

## 5. METHODS

### 5.1 Study Area

The study area at Stony Creek, in the south-east MacKenzie Basin, consisted of a valley dissected by a creek bed approximately 3.5 km in length. Vegetation was sparse, consisting mainly of scattered matagouri (*Discaria toumata*) and sweet briar (*Rosa rubiginosa*) along the valley sides, with introduced grasses along the creek margin. Stony Creek itself was lined with willow trees (*Salix spp.*) that provided food and nest sites for possums. Rock outcrops and small areas of scree were present along the length of the study area. Possum abundance in a similar area has been estimated at 0.4-0.6 per hectare (Hickling *et al.* 1990). Stony Creek had been poisoned for rabbits in July 1991 with 0.02% wt/wt 1080 carrot, and many possums in the area exhibited 1080 bait-shyness (G. Hickling, unpublished data).

### 5.2 Bait take and radio telemetry assessment

The efficacy of two toxic treatments was assessed using changes in the take of non-toxic bait at feeder stations, and the mortality of possums fitted with radio-collars before control.

On 29 January 1993, 22 bait feeders holding 1 kg each of pelleted cereal bait were established at 160 m intervals on a 3.5 km transect along the creek margin. Initially, these were filled with non-toxic RS5 1.5g baits with 0.1% cinnamon essence. For 3 days starting 30 January,

66 "Soft-catch" traps were set daily along the same transect, and 20 trapped possums were fitted with small radio-transmitters.

The % kills from two toxic treatments (see 5.3) were estimated by comparing the non-toxic bait consumption over 3-day periods before and after each treatment, using the following equation:

$$\% \text{ Kill} = (1 - \text{POST/PRE}) * 100$$

where PRE = total pre-toxin consumption
POST = total post-toxin consumption

A second estimate of % kill was obtained by relocating the radio-collared possums and establishing the proportion that had died after each treatment.

### 5.3 1080 and cholecalciferol poisoning

On 16 February the feeders were refilled with non-toxic bait and the take monitored for 3 nights. Toxic 0.08% wt/wt 1080 bait was then applied to the feeders for 1 night (19 February) to remove non-shy possums from the vicinity of the transect.

The 1080 bait was then removed and replaced with non-toxic bait, and on 23-24 February the 20 radio-collared possums were relocated.

Beginning 16 March, non-toxic take was measured for a further 3 nights, and the radiocollared possums were relocated. The surviving possum population was then exposed to 0.4% wt/wt cholecalciferol baits in the feeder stations for 11 nights (19 - 30 March). Toxic bait consumption was measured after the 1st, 10th and 11th nights.

The radio-collared possums were relocated at the end of cholecalciferol treatment (29 March) and again two weeks later (14 April). Finally, non-toxic bait take was monitored for another 3 nights (14-16 April).

## 6. RESULTS

The % kill of possums resulting from the 1080 application was estimated as 31% from the change in bait take (PRE = 11.85 kg, POST = 8.22 kg) and as 20% from the mortality of radio-collared possums (4 of 20 dead).

Neither the change in bait take (PRE = 8.22 kg, POST = 8.10 kg) nor the radio-tracking data (0 of 16 dead) indicated any measureable kill of possums as a result of the cholecalciferol

application.

These results are summarised in Figure 1. Raw data for the radio-tracking is presented in Appendix 1, and non-toxic bait takes pre and post the cholecalciferol treatment are given in Appendix 2.

Before the toxic treatments began, the take of non-toxic bait at the 22 feeders was averaging 4.0 kg per night. During the 1-night 1080 treatment, a total of 3.22 kg of toxic bait was consumed. These values can be compared to a 1.0 kg take on night 1 of the cholecalciferol treatment, and a 1.6 kg take for the 10 nights therafter (i.e., a mean of 160 g/night; see Appendix 2).

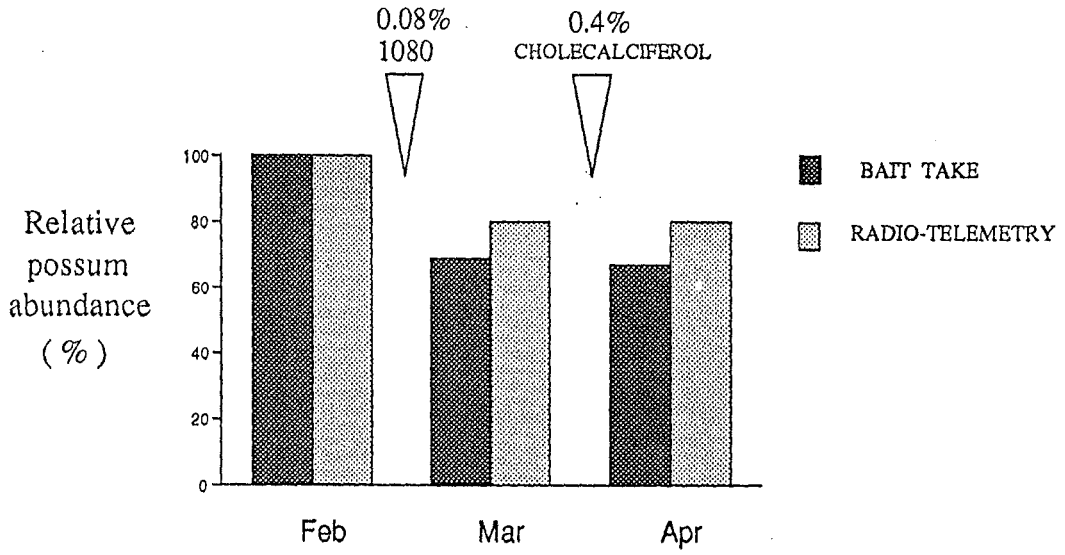


**FIGURE 1:** Relative reductions in possum numbers at Stoney Creek after successive 1080 and cholecalciferol treatments.

## 7. DISCUSSION

Although both of the population assessment methods had potential bias, they provide independent estimates of % kill. The similarity of these estimates thus gives us some confidence that the monitoring has accurately represented the outcome of this trial.

The low (20-30%) kill achieved by 1080 is not cause for undue concern, for several reasons. First, a single night is not sufficient to poison all non-shy possums, as less than half of a local population may visit a feeder station on any given night (G. Hickling, unpublished data). Second, the Lincoln University behaviour trials had exposed at least part of the local population to 1080 bait in December 1992. This would have killed some non-shy possums and enhanced, or induced, shyness in others. Nevertheless, this trial demonstrates that given the right set of circumstances the majority of possums in a population can become resistant to standard bait feeder control techniques.

In contrast, the lack of any measurable cholecalciferol kill is surprising. The lethal dose of of 0.4% cholecalciferol bait is thought to be about 16 g for possums (R. Henderson, pers. comm.). If so, the take of 2.6 kg over the 11-day period represents about 160 lethal doses disappearing from the feeders. This probably exceeds the *total* number of possums using the feeders : at 0.5 possums/ha (Hickling *et al.* 1990) there may have been up to 200 possums within 500 m of the feeders, and if non-toxic take averaged 50-100 g/possum/night (Hickling *et al.* 1990) then some 30-50 possums may have been visiting the feeders each night.

The possibility that non-toxic bait was mistakenly used in the toxic phase of the trial, or that the toxin degraded once in the feeders, can be ruled out. First, there was a clear "stop-feed" effect after the first night of the cholecalciferol treatment, confirming that the bait contained an active ingredient. Second, although cholecalciferol is known to degrade in the presence of heat or ultra-violet light, trials on bait brought back to the pens confirmed that it retained its expected toxicity (R. Henderson, pers. comm.).

Although it is possible that nocturnal non-target species (e.g. hedgehogs and rodents) consumed some of the toxic bait, these species were very infrequent visitors to all of the stations observed during the Lincoln University study. Substantial bait take by diurnal species (e.g., birds, rabbits, livestock) also seems unlikely, although this should be checked in future studies.

A further possibility is that a few possums ate very large amounts from the feeders before dying, leaving the rest to eat small, sublethal doses. This also seems unlikely as toxic bait take was spread evenly among the 22 widely-spaced feeders (see Appendix 2).

An alternative scenario is that the possums did eat supposedly "lethal" doses of cholecalciferol, but did not succumb to these doses. This would imply that pen-based estimates of toxicity are, for some unknown reason, overstated.

A 50% possum kill has been achieved in the Hawkes Bay region using an identical cholecalciferol bait specification as that used in this trial (C. Frampton, pers. comm). Two obvious differences between the trials are that the possums were not pre-fed at Hawkes Bay, nor had they been poisoned in recent years (annual trapping had been employed instead). This suggests that behavioural responses to novel baits differed in the two trials, but the exact nature of these differences remains unclear.

Pen trials indicated that there was no initial preference between non-toxic bait and cholecalciferol (C. Frampton, pers. comm), and acute toxicity and dose-ranging studies at the Rangiora Animal Facility indicated that an $LD_{95}$ of 27mg/kg was the optimum concentration required to kill possums. Toxicity is influenced various factors, including animal health and nutrition. The captive animals were fully acclimatised and gaining weight before the pen trials proceeded, but stress might still have influenced their susceptibility to the toxin. Administration of cholecalciferol was via an intragastric cannula with the possums under light anaesthesia, which is not directly comparable to a field situation in which a possum has a choice of whether or not to feed. Therefore, it is possible that free-ranging possum populations are less susceptible to the lethal dose estimated using penned possums.

Therefore, the key direction for future field research is to distinguish between two scenarios for the failure of this trial : failure of possums to consume bait *versus* lack of toxicity of the bait once ingested. Several potential solutions to the problem are evident (increased toxic loading, increased cinnamon loading, altered pre-feed schedules, etc.) but until the correct scenario is established it will not be possible to develop an efficient "critical path" for future field trials.

## 8. RECOMMENDATIONS

- A trial should be conducted to determine the amount of 0.4% cholecalciferol bait consumed by individual possums in the field. (This will establish whether the failure of the trial reported here was due to rejection of the baits or low susceptibility to the toxin).

- This trial should be repeated with 0.8% cholecalciferol, to allow a preliminary assessment of the relationship between toxin loading and bait acceptance.

- Toxicity of cholecalciferol in the field should be assessed using 10 radio-tagged wild possums that have been fed 16g of 0.4% bait, and 10 fed 16g of 0.8% bait.

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## 9. ACKNOWLEDGEMENTS

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# 11. APPENDICES

## 11.1 Radio-tracking data for Stoney Creek possums.

| Caught at bait feeder | Radio frequency (AVM) | Sex / age | 23 Feb Dead/Alive | 24 Feb Dead/Alive | 18 Mar Dead/Alive | 29 Mar Dead/Alive | 14 Apr Dead /Alive |
|---|---|---|---|---|---|---|---|
| 1. | 2 / 10 | M / A | A | A | A | A | A |
| | 2 / 11 | F / A | A | A | A | A | A |
| | 3 / 1 | F / A | A | A | A | A | A |
| 2. | 2 / 5 | - / I | A | A | A | A | A |
| 4. | 1 / 4 | M / I | D | | | | |
| | 3 / 5 | M / A | - | - | - | A | A |
| 6. | 2 / 3 | F / A | A | A | D | | |
| 7. | 2 / 3 | F / I | A | A | D | | |
| | 1 /12 | F / A | - | A | A | - | A |
| 9. | 1 /10 | F / A | A | A | A | A | A |
| | 2 /12 | M / A | A | A | A | A | A |
| 10. | 1 / 9 | F / I | - | - | A | A | A |
| | 2 /10 | M / A | - | - | A | A | A |
| 11. | 1 / 5 | M / I | A | A | A | A | A |
| | 2 / 8 | | | | A | A | A |
| 13. | 2 / 7 | M / I | A | A | D | | |
| 14. | 1 / 1 | M / A | A | A | A | A | A |
| | 3 / 4 | | | | | A | A |
| 17. | 2 / 2 | - / I | - | - | A | A | A |
| 20. | 3 / 1 | M / I | - | A | A | A | A |

## 11.2 Non-toxic bait consumption before and after the cholecalciferol treatment.

BAIT TAKE (mm)*

| Bait Feeder | 16 Mar 1993. | 17 Mar 1993. | 18 Mar 1993. | | 14 Apr 1993. | 15 Apr 1993. | 16 Apr 1993. |
|---|---|---|---|---|---|---|---|
| 1. | 10 | 0 | 30 | | 60 | 30 | 50 |
| 2. | 20 | 25 | 10 | | 30 | 35 | 30 |
| 3. | 0 | 30 | 35 | | 15 | 5 | 0 |
| 4. | 35 | 25 | 40 | | 5 | 10 | 15 |
| 5. | 15 | 25 | 25 | | 10 | 15 | 15 |
| 6. | 35 | 20 | 20 | | 30 | 15 | 15 |
| 7. | 30 | 35 | 45 | | 30 | 30 | 25 |
| 8. | 0 | 30 | 0 | | 30 | 35 | 45 |
| 9. | 0 | 0 | 0 | | 0 | 0 | 10 |
| 10. | 0 | 30 | 30 | | 40 | 45 | 35 |
| 11. | 15 | 35 | 35 | | 40 | 30 | 55 |
| 12. | - | 25 | 20 | | 30 | 0 | 20 |
| 13. | 30 | 40 | 35 | | 20 | 15 | 10 |
| 14. | 40 | 40 | 30 | | 45 | 20 | 25 |
| 15. | 20 | 5 | 0 | | 0 | 20 | 15 |
| 16. | 10 | 30 | 15 | | 40 | 40 | 25 |
| 17. | 25 | 10 | 25 | | 35 | 60 | 25 |
| 18. | 60 | 10 | 50 | | 25 | 20 | 15 |
| 19. | 55 | 25 | 45 | | 20 | 15 | 30 |
| 20. | 35 | 35 | 15 | | 25 | 10 | 5 |
| 21. | 20 | 40 | 15 | | 0 | 5 | 50 |
| 22. | 55 | 40 | 60 | | 25 | 45 | 50 |
| Total | 510 | 555 | 580 | | 555 | 500 | 565 |
| | | | | | | | |
| Total | | 1645 | | | | 1620 | |

* Multiply by 5 to convert mm to g.

## 11.3 Consumption of 1080 and cholecalciferol bait at Stoney Creek.

### BAIT TAKE (mm)*

| Bait St. #. | 23 Feb 1080 take. (1 night). | 19 Mar Chole take (1 night). | 29 Mar Chole take (10 nights) | Tot. chole take. (11 nights). |
|---|---|---|---|---|
| 1. | 25 | 10 | 25 | 35 |
| 2. | 30 | 0 | 40 | 40 |
| 3. | 50 | 15 | 25 | 40 |
| 4. | 45 | 15 | 10 | 25 |
| 5. | 50 | 5 | 0 | 5 |
| 6. | 35 | 0 | 15 | 15 |
| 7. | 65 | 20 | 5 | 25 |
| 8. | 30 | 15 | 0 | 15 |
| 9. | 20 | 5 | 5 | 10 |
| 10. | 40 | 25 | 10 | 35 |
| 11. | 35 | 10 | 10 | 20 |
| 12. | 5 | 15 | 5 | 20 |
| 13. | 30 | 10 | 10 | 20 |
| 14. | 30 | 10 | 10 | 20 |
| 15. | 20 | 5 | 10 | 15 |
| 16. | 0 | 5 | 10 | 15 |
| 17. | 55 | 0 | 45 | 45 |
| 18. | 5 | 5 | 5 | 10 |
| 19. | 0 | 10 | 30 | 40 |
| 20. | 25 | 10 | 10 | 20 |
| 21. | 10 | 5 | 10 | 15 |
| 22. | 40 | 5 | 30 | 35 |
| | | | | |
| TOTAL | 645 | 200 | 320 | 520 |
| | | | | |

* Multiply by 5 to convert mm to g.