USE OF SUBACUTE AND CHRONIC TOXICANTS TO CONTROL SODIUM MONOFLUOROACETATE (1080) BAIT SHY POSSUMS

J.G. ROSS¹, G.J. HICKLING¹ and D.R. MORGAN²

¹ Department of Entomology and Animal Ecology, P.O. Box 84, Lincoln University

² Manaaki Whenua - Landcare Research, P.O. Box 31-011, Lincoln

ABSTRACT

Aversions to sodium monofluoroacetate (1080) in cereal bait can persist in sub-lethally poisoned possum (*Trichosurus vulpecula*) populations. We investigated whether 'shy' possums could be controlled with an alternative toxicant (cholecalciferol or brodifacoum) and/or an alternative bait material (apple paste). Some shy possums (40%) were killed when exposed to 1080 in apple paste, whereas the alternative toxicants killed 70% when in cereal bait and 100% when in paste. These results demonstrate that 1080 bait shy possums can be controlled using alternative toxicants, provided the onset of poisoning symptoms is subacute or chronic. Effectiveness will be enhanced if the bait matrix is unfamiliar.

Keywords: brushtail possum, bait shyness, sodium monofluoroacetate, brodifacoum, cholecalciferol

INTRODUCTION

Aversions caused by sub-lethal doses of the toxicant sodium monofluoroacetate (1080) can persist in captive possums for at least 2 years, during which time such possums remain averse (or 'shy') to 1080 bait. O'Connor and Matthews (1995) suggest that when shyness has been induced with cereal 1080, captive possums cannot be successfully controlled by reapplying cereal bait, regardless of the toxicant used. Similarly, Morgan *et al.* (1996) suggest that changing the bait matrix is a promising way of overcoming shyness to 1080 baits. However, cereal baits containing toxicants such as brodifacoum appear to be successful in controlling shy possums in the field, where it seems that possums eat progressively more bait at each night's exposure until eventually the cumulative dose becomes lethal (Henderson *et al.* 1997).

Assessments of possum behaviour with captive animals in pens and free-ranging animals thus suggest different, but perhaps complementary, approaches for how best to combat 1080 shyness. The objective of this study was to determine the role of two alternative toxicants – cholecalciferol and brodifacoum – in combating 1080 shy behaviours in possums, with a view to recommending alternative bait formulations that shy populations would accept.

METHODS

Animal husbandry

Wild-caught possums were housed in indoor cages at Landcare Research's captive animal facility at Lincoln and were acclimatised to captivity for 6 weeks prior to the trial. Possums were fed a range of fruit and vegetables, provided *ad libitum*. The trial aimed to mimic non-prefed aerial application of cereal-based pellet baits, so no cereal-based food was provided during acclimatisation.

Induction of bait shyness

After acclimatisation each possum was weighed and fed 1g of 0.08% 1080 bait per kg live weight in a cereal RS5 pellet obtained from Animal Control Products (ACP) Ltd, Waimate containing 0.1% cinnamon obtained from Bush, Boake, Allen (BBA) Ltd, Auckland and Levanyl Green dye obtained from Bayer Ltd, Wellington. Normal diet and free access to drinking water were maintained on the day of dosing. This dose level was

used because it expected to cause low mortality (LD₂₀ dose R. Henderson, unpubl. data) and high levels of bait shyness amongst the survivors.

After one week, shyness was assessed by re-exposing each possum to a further 1 g of 0.08% 1080 bait. If the possum ate the entire bait it was presented with a further two baits over the next two days. If the possum continued to eat toxic bait on its third re-exposure it was removed from the trial. Possums taking more than one re-exposure to develop bait shyness were distributed equally amongst the subsequent treatment groups.

Alternative bait and toxicants

Once the possums were confirmed as shy they remained on the vegetable diet for a further week. They were then re-weighed and allocated to six treatment groups balanced for weight, each consisting of 9–11 possums.

Each group received one of six treatments, involving three toxicants (0.08% 1080 obtained from ACP Ltd; 0.6% cholecalciferol obtained from ICI, Lower Hutt, and 0.002% brodifacoum obtained from Landcare Research, Lincoln) in two bait forms (cereal RS5 pellets with Levanyl Green dye and 0.1% cinnamon lure, and undyed apple paste obtained from ACP Ltd with 0.4% jaffa lure obtained from BBA Ltd). The two bait matrices were equally palatable to naive possums (J. Ross unpubl. data) and all toxic bait concentrations were determined by laboratory assay. The cholecalciferol bait was intended to have a toxicant loading of 0.8%, however the cereal bait was only 0.6% when assayed so the paste was diluted to the same concentration to enable comparison; this may have reduced the effectiveness of this toxicant.

Possum survival and the amount of bait eaten were monitored daily for two weeks for the 1080 and cholecalciferol treatments. As brodifacoum is a slow-acting toxicant, consumption of this bait was monitored for four weeks and survival for eight weeks.

RESULTS

Mortality

All 1080 shy possums failed to eat a lethal dose when re-exposed to 1080 in a familiar cereal bait matrix. In contrast, the cholecalciferol and brodifacoum toxicants in a familiar matrix were relatively successful, killing 64% and 73% of shy possums respectively (Table 1). The difference in kill between these toxicants and 1080 was highly statistically significant (Fisher Exact test; $P = 0.0003$).

In the unfamiliar apple paste, 1080 killed 40% of possums previously made shy with 1080 in a cereal bait (Table 1). Brodifacoum and cholecalciferol in apple paste both had 100% success in killing the 1080 shy possums; this increase in kill resulting from the change in bait matrix was also statistically significant (Fisher Exact test; $P = 0.024$).

TABLE 1: Numbers of 1080 cereal bait shy possums killed by alternative toxicants in familiar and unfamiliar bait bases.

Treatment	No. of possums	Numbers dying	Mortality
1080 in cereal pellet	10	0	0%
Cholecalciferol in cereal pellet	11	7	64%
Brodifacoum in cereal pellet	11	8	73%
1080 in apple paste	10	4	40%
Cholecalciferol in apple paste	9	9	100%
Brodifacoum in apple paste	9	9	100%

Bait consumption

Possums confirmed as shy retained this shyness when re-exposed to 1080 cereal bait in the subsequent trial. The mean amount of bait eaten on the first night was negligible (0.63 g) with the subsequent nightly consumption reducing further (Table 2). Shy possums also exhibited shyness to the cholecalciferol cereal bait, with little consumption on the first night (0.92 g) and a decline in consumption thereafter. The mean consumption of

brodifacoum in cereal on the first night (6.6 g) was considerably higher than for the other two toxicants and consumption increased on subsequent nights.

As with 1080 cereal bait, the bulk of the 1080 paste consumption occurred on the first night. However, the mean amount of 1080 paste consumed on that night (10.5 g) was higher than for any of the cereal baits. Mean nightly consumption then reduced over the next 13 nights (Table 2). The 1080 shy possums exhibited a low level of shyness to the cholecalciferol paste, consuming a mean of 26.2 g on the first night. Mean nightly consumption reduced markedly thereafter. The 1080 shy possums also showed no initial aversion to the brodifacoum paste, with consumption remaining relatively high throughout the trial.

TABLE 2: Consumption of various toxic baits by captive possums over a four week period. All possums had previously survived a sub-lethal dose of 1080 (0.8 mg/kg body weight) in cereal. Means are presented $\pm$ SE; sample size in brackets.

Treatment	Bait eaten per night ¹ (g)		Total eaten per possum (g)	Days to death	No. surviving
	Night 1	Nights •2			
1080 in cereal	0.63 $\pm$ 0.4	0.17 $\pm$ 0.04	2.9	-	10 (10)
Cholecalciferol in cereal	0.92 $\pm$ 0.8	0.31 $\pm$ 0.11	18	6-36	3 (11)
Brodifacoum in cereal	6.62 $\pm$ 3.5	12.5 $\pm$ 1.12	281	18-23	3 (11)
1080 in paste	10.5 $\pm$ 4.7	3.64 $\pm$ 0.56	43	1	6 (10)
Cholecalciferol in paste	26.2 $\pm$ 6.6	3.06 $\pm$ 0.68	42	4-15	0 (9)
Brodifacoum in paste	28.3 $\pm$ 8.7	12.3 $\pm$ 1.86	320	15-28	0 (9)

¹ Until death

DISCUSSION

Cholecalciferol and brodifacoum were chosen for this trial because they had been identified as the most promising of 18 toxicants trialed by Eason *et al.* (1994). An important difference between these two toxicants and 1080 is the speed of onset of poisoning symptoms. The acute onset of symptoms to 1080 poisoning can enable the animal to associate cause and effect (Ottoboni 1984) so that survivors are likely to develop bait shyness. With the anticoagulant brodifacoum the symptoms are chronic and far less noticeable, hence the possum is unlikely to associate them with the bait (Buckle 1993). The disadvantage of anticoagulants is that the animal has to eat a large amount of bait in multiple doses, whereas a single dose of 1080 can be lethal. Therefore, anticoagulant bait has to be made available over extended periods. Cholecalciferol is intermediate between acute and chronic and is classified as a subacute toxicant (Pascoe 1983); victims may eat a lethal dose in one sitting but the onset of symptoms is delayed for several days. It is consequently less likely than 1080 to induce shyness (D. Morgan unpubl. data)

This trial suggests that it is possible to kill the majority of 1080 shy possums using a subacute toxicant (cholecalciferol) or chronic toxicant (brodifacoum) in a familiar cereal bait matrix, provided baits are available for an extended period. This contrasts with O'Connor and Matthews (1995) and Morgan *et al.* (1996), who both suggest that the greatest success in overcoming 1080 shyness would be obtained by switching the bait matrix and lure.

There seems little difference in the effectiveness of cholecalciferol and brodifacoum as a means of overcoming 1080 bait shyness. Changing the bait matrix enhanced the effectiveness of the cholecalciferol and brodifacoum toxicants, so that both achieved a 100% kill. In contrast, several possums survived the cholecalciferol and brodifacoum cereal treatments, apparently by avoiding the bait matrix throughout the trial. This shyness to the cereal bait could not be overcome by changing the toxicant. Morgan *et al.* (1996) reported killing only 2 of 7 shy possums with brodifacoum in cereal bait, but the

bait was only presented for five days. In the trial reported here, it took in excess of two weeks for some shy possums to consume a lethal dose of the chronic toxicant (Table 2).

These results highlight the advantage of switching to a subacute or chronic toxicant when trying to poison shy possums. The slow-acting nature of these toxicants, when compared to 1080, means that possums are able to consume sub-lethal doses without associating the bait with the onset of poisoning symptoms. This and the trial by Morgan *et al.* (1996) both suggest that at least some possums are unable to detect the 1080 toxicant once the bait matrix has been changed. Nevertheless, re-exposing 1080 shy possums to 1080 again in a new matrix does not appear to be as effective as using a subacute or chronic toxicant in either the same, or in a new, bait matrix. This suggests either that some 1080 shy possums can detect the 1080, or that they have developed a cautious feeding strategy (Hickling 1994) which results in them eating insufficient bait on the first night of exposure to be killed by any acute toxicant. It would be useful to trial an alternative acute toxicant (e.g. gliflor) in a new bait matrix to test between these hypotheses.

The purpose of this paper is to recommend how best to control 1080 bait shy possums. Switching to a subacute or chronic toxicant in a new bait matrix is the best option. Brodifacoum and cholecalciferol are commercially available in cereal pellets and are marketed as Talon and Campaign respectively. In terms of deciding between the two alternative toxicants, brodifacoum is best avoided if there are concerns regarding the primary and secondary poisoning of non-target species (Eason and Spurr 1995). The commercial development of a paste bait is currently underway (D. Morgan pers. comm.), as are trials to validate these recommendations in the field (Henderson *et al.* 1997).

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