

Induced 1080 Bait-shyness in Captive Brushtail Possums and Implications for Management

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Abstract

We determined the probable cause of possums becoming 'shy' towards 1080 bait, a growing problem in the control of this pest. Captive possums ($n = 131$) were offered sublethal baits (1 or 2.5 g) followed by lethal (6 g) baits two days later. Most possums became bait shy and the proportion becoming shy appeared to be related to the size of the initial sublethal dose. Most of a group of survivors retested after three months with toxic pellets were still shy. Shyness was not overcome by changing to a different mask (orange) or toxin (brodifacoum), but changing to both a different bait base (carrot) and mask (orange) resulted in most shy possums eating a lethal quantity of bait. Possums therefore appeared to learn to recognise the bait base as the cue for avoiding poisoning. More shy possums than naive possums rejected non-dyed, non-masked, non-toxic pellets, confirming that shy possums recognised the bait base. Green dye appears to act as a secondary cue for avoiding pellets as a higher percentage of 'shy' possums than naive possums rejected dyed baits.

Introduction

Since 1956, pest-control agencies in New Zealand have used aerial poisoning with 1080 baits to reduce possum (*Trichosurus vulpecula*) populations. Early control involved repeating these operations on a 5–10-year cycle as the population recovered. Now, with the predicted need to keep populations at a low density to eliminate bovine tuberculosis from possums (Barlow 1991), initial 'knockdown' operations are usually followed by 'maintenance' operations annually or even more frequently. There is growing evidence that such operations reduce the effectiveness of 1080 by inducing learned aversion (i.e. 'shyness') towards baits (Hickling 1994). Such aversion has been found in other pest species for 1080 and other toxins (Prakash 1988).

We used captive possums to confirm whether shyness to 1080 baits can be induced, to determine whether it persists for at least three months, to determine whether using different types of bait can overcome the shyness, and to identify the cues from which possums develop shyness.

Methods

Possums were captured in North Canterbury at sites where there was no record of 1080 having been used. After acclimatisation in individual cages for six weeks, 131 possums were used in a series of trials carried out in three stages.

Stage 1—Induction of Shyness

Possums were randomly allocated to two groups. Each possum in the first group ($n = 42$) was offered a single 1-g piece of a No. 7 cereal pellet bait (Animal Control Products Ltd, Wanganui) containing 0.1% cinnamon flavour [Bush Boake Allen (New Zealand) Ltd, Auckland] as a mask for 1080 (Morgan 1990), 0.075% V200 green dye to meet legal requirements for identifying toxic baits and reducing non-target hazards (Bayer NZ Ltd, Auckland) and 0.13% 1080 (concentration determined by gas chromatography assay). This represented a mean dose of 0.4 mg 1080 per kg body weight, much less than the estimated LD_{50} of 1.5 mg kg^{-1} (Morgan *et al.* 1986). Each possum in the second group was offered a 2.5-g piece of

bait (mean dose of 1.0 mg kg⁻¹). More possums ($n = 89$) were allocated to this group because we expected a high mortality and wanted similar numbers of survivors from the groups for further testing.

Two days after the initial dose, all surviving possums (excluding those that refused or only partially ate sublethal baits) were offered two, potentially lethal, 6-g No. 7 toxic (0.13% 1080) pellet baits to establish whether they had become shy towards the bait. Shyness is here defined as refusing or nibbling (i.e. taking <1 g) bait.

Stage 2—Persistence and Management of Shyness

After a further three months, surviving possums were put into four groups and offered different bait treatments. Those that had received the initial 0.4 mg kg⁻¹ dose of 1080 (Group 1, $n = 14$) were offered two full-size 6-g green-dyed cinnamon 1080 No. 7 pellets to determine whether they were still shy of the original bait type offered. Alternative bait types were tested on possums that received the higher initial dose since this was likely to give more persistent and stronger shyness in survivors. Survivors of the 1.0 mg kg⁻¹ initial dose were randomly allocated into the other three groups. Members of Group 2 ($n = 14$) were each offered two 6-g 1080 No. 7 green-dyed pellets that contained 0.1% 'Jaffa' orange flavour (Bush Boake Allen Ltd), an effective alternative mask to cinnamon (Morgan 1990). Members of Group 3 ($n = 13$) were each offered two 6-g carrot baits surface-coated with 0.16% 1080 (determined by assay), 0.1% orange and 0.075% green dye. Members of Group 4 ($n = 7$) were each offered daily for five days 300 g of Talon 20 p (ICI Crop Care Ltd, Richmond), which is a cereal pellet containing the anticoagulant toxin brodifacoum, cinnamon and green dye. Four control groups (each comprising five naive possums) were used to test the response of non-shy possums to each of these treatments.

Stage 3—Cues for Bait Rejection

Shy possums were offered further non-toxic pellets to determine the cues from which baits were recognised and rejected. Because some possums had eaten sublethal amounts of bait in the previous trials, their shyness was probably reinforced. Therefore, possums were put into two groups ($n = 15$), each containing equal proportions of possums that were still shy (60%) (i.e. ate no bait) and those that were 'reinforced' (40%) for tests. Possums in one group were offered two 6-g non-dyed non-toxic No. 7 cereal pellets with no cinnamon, and possums in the other group were offered two 6-g non-toxic pellets containing 0.075% Bayer V200 green dye and no cinnamon. These treatments were also offered separately to two groups ($n = 15$) of naive possums.

The study was conducted with the approval of the Landcare Research Animal Ethics Committee.

Results

Stage 1—Induction of Shyness

Only two of the 42 possums offered the initial 1-g 1080 pellets refused the bait (5%) and none was killed. Of the 40 possums offered the second dose two days later, 43% refused the bait, but no possums refused their normal food; that is, they were bait-shy, not unwell (Fig. 1). In contrast, proportionally more (13%) of the possums initially offered 2.5-g 1080 pellets refused them (although the statistical comparison was not significant, $\chi^2 = 2.3$, d.f. = 1, $P = 0.13$), proportionally more (36%) were killed ($\chi^2 = 20$, d.f. = 1, $P < 0.001$); and of those offered the second dose two days later, proportionally ($\chi^2 = 11.8$, d.f. = 1, $P < 0.001$) more (82%) were shy (Fig. 2). The proportion of possums that became shy therefore appeared to be dependent on the size of the sublethal dose received.

Stage 2—Persistence and Management of Shyness

After three months, most possums in Group 1 were still shy of cinnamon 1080 pellets (Fig. 1). Neither changing the mask to orange (Group 2) nor the toxin to brodifacoum (Group 4) overcame shyness. However, bait refusal was significantly reduced when carrot 1080 bait masked with orange (Group 3) was offered, as 77% of possums were killed compared with 23% for the other three treatments combined ($\chi^2 = 11.8$, d.f. = 1, $P < 0.001$).

In the four naive control groups, all but one possum (offered orange 1080 pellet) ate lethal quantities of bait, confirming that the low proportions killed in Groups 1, 2 and 4 were the result of shyness and not of other factors (Table 1).

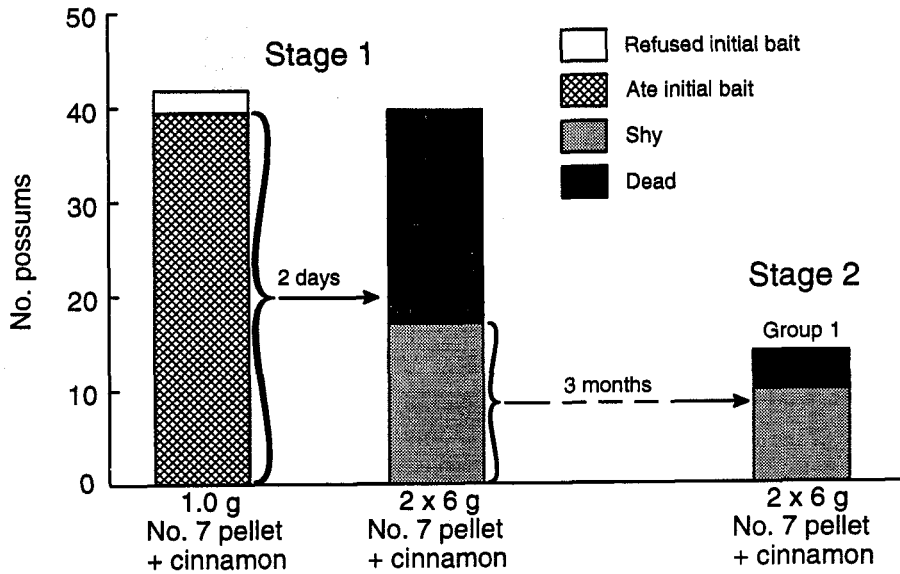


Fig. 1. Initial response of possums to 1-g cinnamon pellets and subsequent responses to 6-g pellets after two days (i.e. Stage 1, confirming shyness was induced) and after three months (i.e. Stage 2, confirming shyness persists). All baits contained 0.13% 1080.

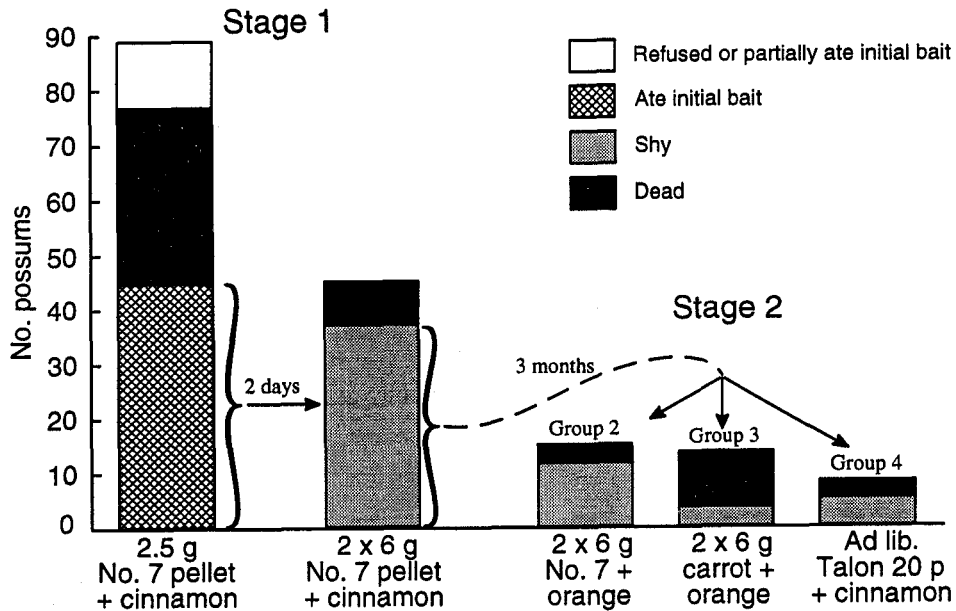
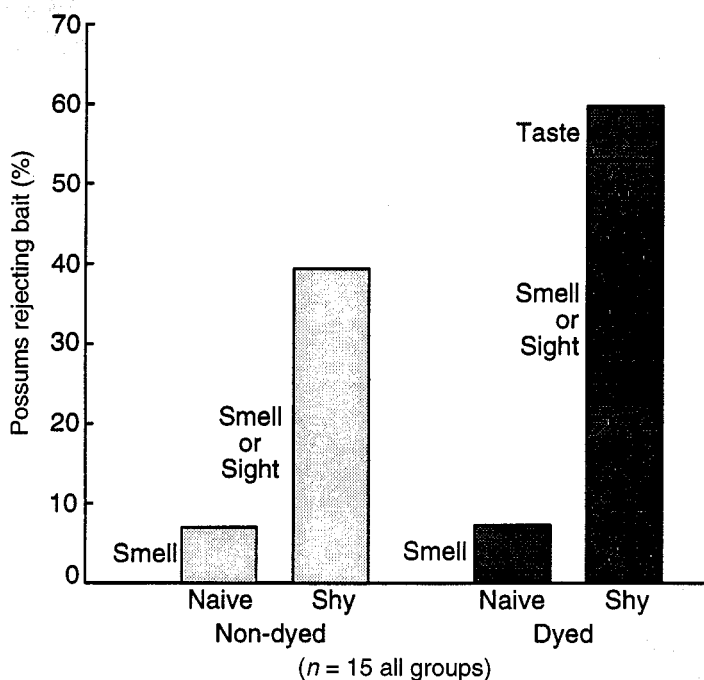


Fig. 2. Initial response of possums to 2.5-g cinnamon pellets and subsequent responses to 6-g pellets after two days (i.e. Stage 1, confirming shyness was induced) and to different bait types after three months (i.e. Stage 2, confirming shyness persists). No. 7 pellets and carrot contained 0.13% and 0.16% 1080, respectively.

Table 1. Effectiveness of different baits at killing possums given a sublethal bait three months prior, and naive possums

Significant differences as shown by Fisher's exact test

Group	Treatment	No. killed (%)		Probability of significant difference
		Previously ate sublethal baits	Naive (i.e. control)	
1 (<i>n</i> = 14)	Cinnamon 1080 No. 7 pellet	4 (29)	5 (100)	<0.01
2 (<i>n</i> = 14)	Orange 1080 No. 7 pellet	2 (14)	4 (80)	<0.05
3 (<i>n</i> = 13)	Orange 1080 Carrot	10 (77)	5 (100)	>0.5
4 (<i>n</i> = 7)	Cinnamon brodifacoum Talon pellet	2 (29)	5 (100)	<0.05

**Fig. 3.** Rejection of non-toxic pellets by naive and shy possums, and senses used as indicated by refusal to eat bait (smell or sight) or nibbling of less than 1 g of bait (taste) (i.e. Stage 3, cues for bait rejection).

Stage 3—Cues for Bait Rejection

Although only one naive possum (7%) in each group was shy towards non-dyed or dyed pellets, significantly more shy possums refused or nibbled both non-dyed pellets (40%; $\chi^2 = 4.7$, d.f. = 1, $P < 0.05$) or dyed pellets (60%; $\chi^2 = 9.6$, d.f. = 1, $P < 0.01$) (Fig. 3). This supported the finding that some possums learned to avoid baits by recognising the bait material itself (i.e. the bait base). The greater proportion of shy possums that refused or nibbled dyed pellets (compared with non-dyed) suggests that some possums may recognise the pellets only when dye is included, but this result was not statistically significant ($\chi^2 = 1.2$, d.f. = 1, $P = 0.27$).

Since most shy possums rejecting bait ate none at all, smell or sight was used to recognise baits, while one shy possum that nibbled the dyed bait presumably recognised it mainly by taste. Two naive possums also rejected bait by smell or sight as it was not tasted.

Discussion

This study confirmed that sublethal poisoning of possums with cinnamon-flavoured 1080 pellets induces shyness that persists for at least three months. Another recent study suggests that such shyness may persist in some possums for at least 15 months (Hickling 1994). (We intend to retest for shyness in possums used in our cage study 12 months after initial baits were eaten.) Furthermore, our results showed that in possums shyness was towards two similar types of bait (i.e. orange-flavoured 1080 pellets and cinnamon-flavoured brodifacoum pellets). Neither a change in the mask alone nor a change in the toxin alone overcame shyness. This suggests that possums associate the bait base (cereal pellet) with the sublethal effects of 1080. This conclusion is supported by the finding that toxic carrot bait was readily eaten by possums shy towards cereal bait, although it is not clear from our results to what extent the effectiveness of the carrot bait was enhanced by using orange as a mask. Additionally, although some possums become shy towards the plain (i.e. not masked or dyed) pellets, our limited data together with that from a field study (Hickling 1994) suggest that others become shy towards only dyed pellets. The importance of dye as a possible cue for possums' avoidance of pellet baits therefore requires further examination and, if confirmed, the sensory mechanism (i.e. smell, sight or taste) should be determined so that ways of overcoming the avoidance can be developed.

The simplest way of avoiding the development of bait-shyness is to minimise the likelihood of possums finding only sublethal baits in the 0.5–1.5 h that elapses between possums eating a 1080 bait and stopping feeding (Morgan 1990). This can be achieved by implementing high standards of bait preparation to avoid production of small sublethal baits and by distributing baits adequately to ensure that all possums readily encounter baits. However, even with high standards of bait preparation, it seems inevitable that some possums will encounter and eat only sublethal baits.

One option for targeting possums that develop shyness after initial control using cinnamon-flavoured 1080 pellet baits could be to switch to orange-flavoured carrot bait for maintenance control. However, if maintenance control is to be sustained at intervals of 12 months or less, a range of options may be required for preventing the development of shyness in possum populations.

Shyness is likely to develop towards other commonly used 1080 baits such as fruit paste and carrot if sublethal quantities are eaten. Therefore, to minimise the development of shyness, control strategies should integrate methods suitable for maintenance control, such as trapping and shooting, in rotation with toxic baiting.

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