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Charles T. Eason
Forest Research Institute

David R. Morgan
Forest Research Institute

B. Kay Clapperton
PO Box 772, Whangarei, New Zealand

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TOXIC BAIT AND BAITING STRATEGIES FOR FERAL CATS

CHARLES T. EASON and DAVID R. MORGAN, Forest Research Institute, PO Box 31-011, Christchurch, New Zealand

B. KAY CLAPPERTON, PO Box 772, Whangarei, New Zealand

ABSTRACT: To improve feral cat control we developed a dry pelleted toxic bait and evaluated the potential of lures. A polymer fish meal bait was preferred by cats from a range of bait types tested. L-alanine further increased bait acceptance by cats in pen trials and catnip may have the potential to increase field acceptance and target specificity. An oral LD₉₀ of 0.38 mg/kg was established for sodium monofluoroacetate (1080) in feral cats voluntarily eating surface-loaded baits. Acute toxicity to cats of warfarin, cholecalciferol, and gliflor was tested. However, because the cat proved highly sensitive to 1080, we recommend its use at a dose of 2 mg per cat bait. In preliminary field trials of bait acceptance using non-toxic polymer bait (without flavours or attractants), marked with the plasma marker iophenoxic acid 50% of 39 cats caught within 3 weeks of laying the baits were marked. Subsequently polymer bait, surface coated with 1080 was used in the successful eradication of feral cats from Matakoho Island (37 ha) Whangarei Harbour, New Zealand.

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INTRODUCTION

The establishment of feral populations of the house cat (*Felis catus*) in New Zealand has contributed to the extinction of at least six endemic bird species and over 70 localised subspecies (Merton 1978). Feral cats have depleted populations of indigenous lizards and birds in both Australia and New Zealand and on numerous island habitats throughout the world (Jones 1977, Dilks 1979, Karl and Best 1982, Apps 1983, Rauzon 1985, Veitch 1985, Berruti 1986, vanRensburg and Basher 1988, Fitzgerald 1990). Feral cats are difficult to control as they are solitary predators and are often sparsely distributed, making targeting of control programmes difficult. Eradication of feral cats from Little Barrier Island, New Zealand, was achieved only after sustained effort over 3 years, primarily by the use of traps and fresh fish baits (Veitch 1985). In New Zealand, compound 1080 (sodium monofluoroacetate) in fresh fish bait is used to control cats (Veitch 1985). The bait is usually injected with 1080 solution and is laid by hand. This practice is potentially hazardous to the operators and time-consuming, and the bait remains palatable for only 2-3 days.

This paper details the development of a dry pellet bait specifically for use in feral cat control. A dry pellet bait which is sought after by cats and remains palatable for 2 or more weeks is seen as an improvement on the use of fresh fish. A range of studies are described: 1) the screening of lures, baits, and flavours in a colony of captive feral cats; 2) field trials of lures and bait acceptance; 3) the suitability and effectiveness of 1080 and alternative toxins. The acute toxicity testing of 1080 in feral cats has been described in full elsewhere (Eason and Frampton 1991), so the results are described only briefly within the context of the overall development programme.

METHODS—PEN TRIALS

Seventy feral cats were captured in cage-traps, transferred to 5 m wide x 25 m long open pens, and held for an acclimatization period of 2 months.

Lure Bioassays

The relative attractiveness of odours as lures was tested by placing odour materials on cotton wool in perforated plastic containers placed on metal stakes approximately 30 cm

above the ground at stations 0.5 m apart in the cats' home pen. The time spent sniffing at odour stations was recorded over a 15-min observation period at dusk. A total of 15 candidate lures was screened in pen studies, these included catnip (*Nepeta cataria*), cat mint (*Nepeta mussinii*), and matatabi (*Actinidia polygaria*) as fresh plant material and as a variety of oils and chemical extractions; urine, 4 mercapto-4-methylpentanone (a compound known to be responsible for the odour of "aged" tom-cat urine (Joulain and Laurent 1989), and a variety of food flavours.

Visits to odour stations by semi-feral cats at rubbish dumps were monitored at three locations. Odour stations were mounted on wire stakes 10 cm above the centre of tracking tiles spread with marking chalk. Only those lures which showed promise in the pen studies were evaluated in field trials.

Bait Preferences

Preferences for eight different bait types, five types of proprietary dried cat food, and 21 flavours were compared in a series of trials by offering groups of six feral cats 200 g of four different treatments. As one of the four treatments, a particular type of dried cat food was always presented as a control against which other treatments could be compared. Treatments were placed in metal trays in three feeding stations and rotated over a 3-day period so that all treatments had occupied each position in each station. Weights eaten were recorded daily and treatments replenished before rotation.

Toxicity Testing of 1080 in Feral Cats

Forty-eight cats were allocated to six groups for toxicity testing. All the cats were weighed and sexed. Individually housed cats were presented with a polymer bait (manufactured specifically for this programme by Du Pont, Texas, USA, and proved palatable to cats in bait preference assessment) surface-loaded with 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, or 1.6 mg 1080 solution per bait at the Forest Research Institute (FRI). The baits were allowed to dry before use. Mince (2-5 g) was offered with the toxic bait, the two items being placed 20-30 cm apart. The time taken for cats to eat the bait was noted, and only those animals that ate the whole bait were

included in the analysis. These animals were observed for symptoms, and the approximate time to death was recorded.

Toxicity Testing for Alternatives to 1080

Groups of three cats were intubated under light ether anaesthesia with a range of concentrations of warfarin, cholecalciferol, and gliftor, all formulated in carboxy-methyl cellulose and administered at a dose volume of 2 ml/kg. The acceptance and toxicity of cyanide gel (Trapper's Cyanide, Christchurch), used extensively by possum (*Trichosurus vulpecula*) hunters, was also evaluated by smearing it onto fresh meat and presenting it to feral cats that had been fasted overnight.

METHODS—FIELD TRIALS

Non-toxic Bait Acceptance

Predetermined trapping lines covering a minimum of 3-5 km in three distinctly different locations, two on the Chatham Islands, 100 km east of NZ, and one in the MacKenzie Basin of the South Island, were cleared of possums (which may have consumed the trial bait) by laying cyanide baits and lures. After 2-3 days heaps of 12-15 non-toxic cat baits marked with iophenoxic acid (1 mg/bait) were placed at c. 30-m intervals along the lines (= c. 1 kg bait/km). After approximately 7 days, animals were trapped along the lines, and blood samples were taken for detection of the bait marker using standard methods of analysis (Eason and Batcheler 1991). Trapping continued for 4 weeks.

Toxic Bait Trial

A cat eradication programme was undertaken on Matakoho Island, in a North Island harbour. Initially, non-toxic cat baits were placed in bait stations for 3 weeks. Tracking tiles were used to record animal prints and bait take was monitored. Catnip leaves were rubbed on baits at half the bait stations. Baits surface-coated with L-alanine and 1080 were then placed at the stations for 2 nights and bait take was measured. A follow-up operation used non-toxic baits, sardine baits, and traps to check for the presence of cats.

All the experiments were conducted in accordance with National Animal Ethics Guidelines and had Animal Ethics Committee approval.

RESULTS AND DISCUSSION—PEN TRIALS

Lure Bioassays

Cats spent significantly more time at odour stations containing catnip plant material than at other odour stations. Catnip contains nepetalactone, a substance known to be attractive to cats (Tucker and Tucker 1988). Catnip was more attractive than either the most favoured food odour (fish-oil) or social odours such as urine ($p < 0.05$) (Fig. 1). Even the urine of oestrous females was less attractive than catnip. Similar results were obtained in field trials (Table 1).

Bait Preference

A wide range of baits were unpalatable compared with commercially available cat food. These included a cat bait manufactured by Animal Control Products (ACP), Wanganui, New Zealand. However, only the Du Pont bait manufactured specifically for this programme was comparable to commercially available cat food (Fig. 2 a and b). Of the flavours tested, L-alanine proved to be clearly superior to all others

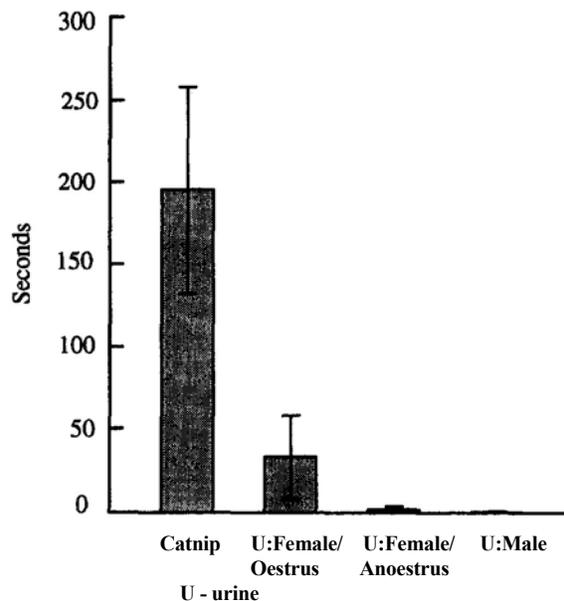


Figure 1. Odour preference for catnip ($p < 0.001$) indicated by mean time (\pm SE) spent at odour stations during 15 minutes' observation at dusk ($n = 3$ males and 3 females).

Table 1. Total number of visits by cats to odour stations adjacent to rubbish tips ($p < 0.05$).

Catnip plant	Urine	Fish-oil	Water
25	13	12	11

(Fig. 3), reaffirming reports that cats preferred the flavours of amino acids, such as L-alanine and L-proline, over sweet flavours (Beauchamp 1977). When applied to baits, L-alanine further enhanced acceptance. L-alanine (at a concentration of up to 1% w/w) applied to the surface of the baits significantly increased bait consumption (Fig. 4).

Catnip alone also appeared to increase bait consumption, and when used in combination with L-alanine the effect was additive (Fig. 5). Catnip in plant form, therefore, not only acted as the most potent attractant tested, eliciting the typical behavioural responses described elsewhere (Tucker and Tucker 1988), but also appeared to increase bait consumption when rubbed onto the surface of the polymer baits. This may be because licking and chewing behaviour are part of the catnip response (Tucker and Tucker 1988). Catmint plant, however, reduced bait consumption when rubbed over the surface of the baits (Fig. 6). We concluded that something else in the catmint plant must be unpalatable, which therefore negated the attractive effect of the nepetalactone.

Toxicity Testing of 1080 in Feral Cats

Of the 48 cats presented with bait, 38 ate the bait within 1 hour (Table 2). Of the other 10, one partially ate the bait but six did not eat the mince or the bait, indicating that they were probably either disturbed by the presence of an observer or were not hungry. There was no indication that 1080 on the surface of the bait deterred cats as animals that did not eat the toxic baits were distributed across all dose groups. An LD_{90} value of 0.35 mg/kg was calculated using standard probit analysis.

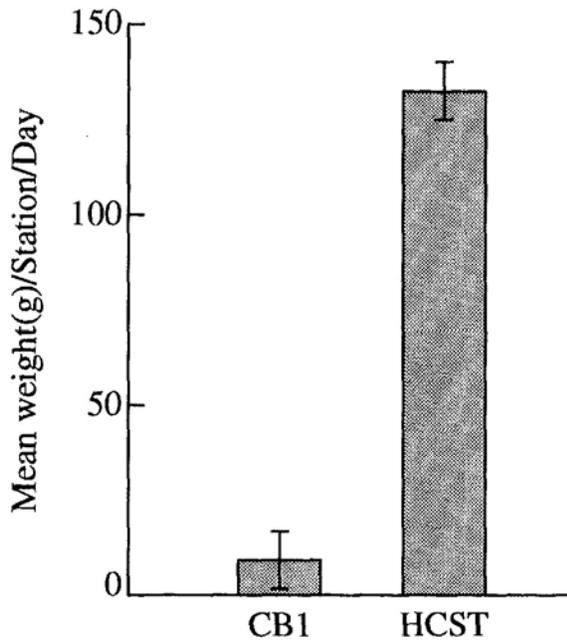


Figure 2a. Preference results from a comparison of a proprietary cat bait, CB (Cat Bait, ACP, Wanganui) and commercial cat food, HCST (Happy Cat Sardine and Tuna, Arnott-Harper NZ Ltd, Auckland), indicated by mean weight consumed (\pm SD).

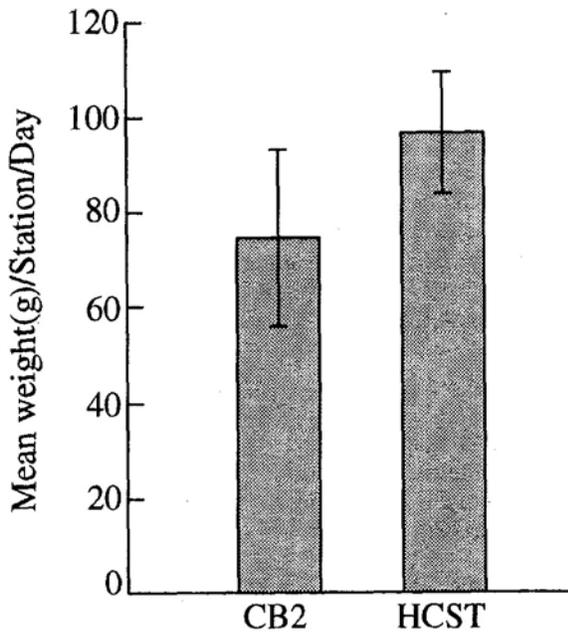


Figure 2b. Preference results from a comparison of polymer cat bait CB2 (Du Pont, Texas, USA) and commercial cat food, HCST (Happy Cat Sardine and Tuna, Arnott-Harper NZ Ltd, Auckland), indicated by mean weight consumed (\pm SD).

Our results indicate that a bait containing 2 mg of 1080 should be sufficient to kill all cats weighing up to 5 kg. Our study showed the cat to be very sensitive to 1080, and slightly more susceptible than expected from earlier publications (Ward 1946, Ward and Spencer 1947, McIlroy 1981).

Of the alternative toxins tested, warfarin and cholecalciferol had inconsistent effects (<90% mortality even at doses of 80 and 200 mg/kg, respectively). Only one out of six fasted cats ate any of the bait containing cyanide; this cat immediately spat the bait out and, although showing some signs of

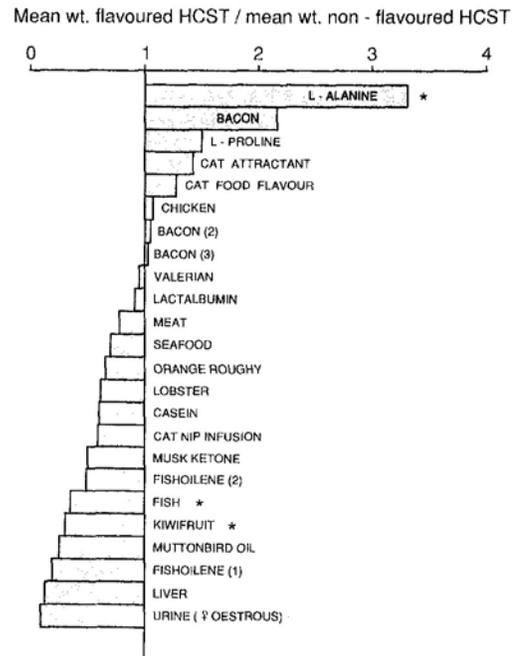


Figure 3. Preference for a range of flavours applied to commercial dried cat food. Weights consumed of flavoured varieties are expressed as a proportion of the weight consumed of the non-flavoured variety in each trial. The * indicates a significant difference compared with non-flavoured ($p < 0.05$).

Table 2. The acute toxicity of 1080 in wild cats (mg/kg).

Dose (mg/kg)	Number cats eating baits	Number died	Per cent mortality
0.1–0.19	5	0	0.0
0.2–0.29	11	4	36.4
0.3–0.39	9	7	77.8
0.4–0.49	8	8	100.0
0.5–0.59	1	1	100.0
0.6–0.69	2	2	100.0
0.7–0.79	2	2	100.0

intoxication, eventually recovered. Cats were susceptible to gliflor, which like 1080 is metabolised to fluorocitric acid (Technical Guide for the use of gliflor—Ma Zhang-xing, Associate Professor, Shanxi Academy of Agricultural Sciences, China). Gliflor was highly toxic to cats at doses above 3.75 mg/kg, hence 15 to 20 mg per bait would be suitable to ensure a swift onset of symptoms and death (Table 3).

Symptoms of 1080 poisoning included disorientation, uncoordinated movements, and occasional vocalisation. These symptoms were less severe than expected as the cats

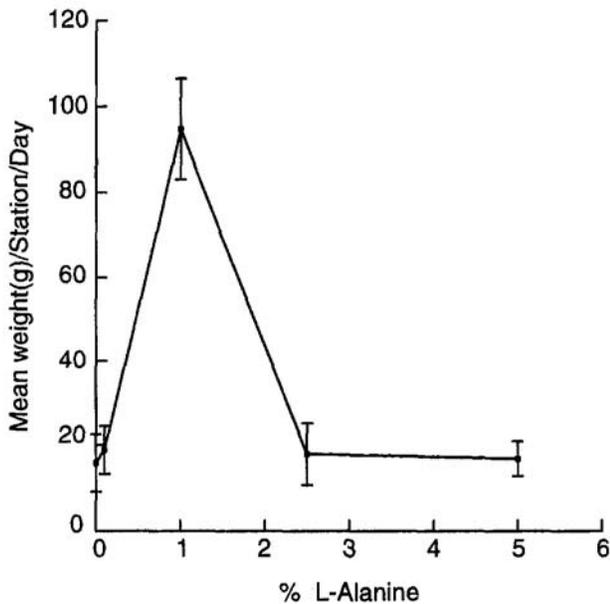


Figure 4. Consumption (mean \pm SD) of polymer cat bait (Du Pont, Texas, USA) with and without L-alanine surface coated on baits (\pm SD) over a range of 5% w/w.

became lethargic and subdued before death. The onset of symptoms and time to death was dose-dependent and at doses of 1 mg and above, death occurred within 12 hours. This would appear preferable to the more protracted effects of warfarin or cholecalciferol.

FIELD TRIALS

Non-toxic Bait Acceptance

A total of 17 cats were trapped on one site on the Chatham Island, seven on the other site, and 15 in the MacKenzie Basin.

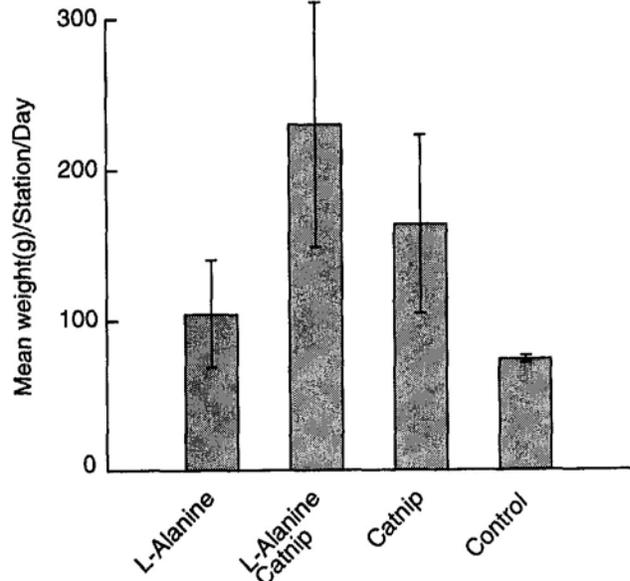


Figure 5. Consumption (mean \pm SD) of polymer cat bait with L-alanine and catnip.

During the first week after baiting, three out of three cats caught were marked, and these had extremely high plasma concentrations of iophenoxic acid, indicating the consumption of a large number of baits. One cat from the first site on the Chatham Island ate c. 150 baits, equivalent to c. 300 g of bait. Fifty percent of cats caught within 3 weeks of laying the bait (n=19) had been marked. On the second site on the Chatham Island, where trapping did not begin until after 3 weeks, five of the seven cats caught were marked.

In the high rainfall of the Chatham Island the polymer baits

Table 3. A synopsis of the comparative toxicity of 5 vertebrate pesticides to feral cats.

Compound	Why tested	Outcome	Pro's	Con's
1080	<ul style="list-style-type: none"> to define: • minimum required • humaneness 	<ul style="list-style-type: none"> • cats very sensitive • swift death • bait accepted 	<ul style="list-style-type: none"> • potent and effective • 2 mg 1080 sufficient for 5-kg cats 	
Cholecalciferol	<ul style="list-style-type: none"> • unknown toxicity 	<ul style="list-style-type: none"> • large dose required LD₉₀ >200 mg/kg 		<ul style="list-style-type: none"> • inconsistent • slow
Warfarin	<ul style="list-style-type: none"> • toxicity unclear 	<ul style="list-style-type: none"> • large dose required LD₉₀ >80 mg/kg 		<ul style="list-style-type: none"> • inconsistent • slow
Cyanide	<ul style="list-style-type: none"> • unknown acceptance 	<ul style="list-style-type: none"> • bait rejected 		<ul style="list-style-type: none"> • present formulation no value
Gliflor	<ul style="list-style-type: none"> • toxicity 	<ul style="list-style-type: none"> • cats susceptible (LD₉₀ approx. 4 mg/kg) 	<ul style="list-style-type: none"> • potent and effective like 1080 • possible alternative should 1080 no longer be available 	<ul style="list-style-type: none"> • not registered in NZ

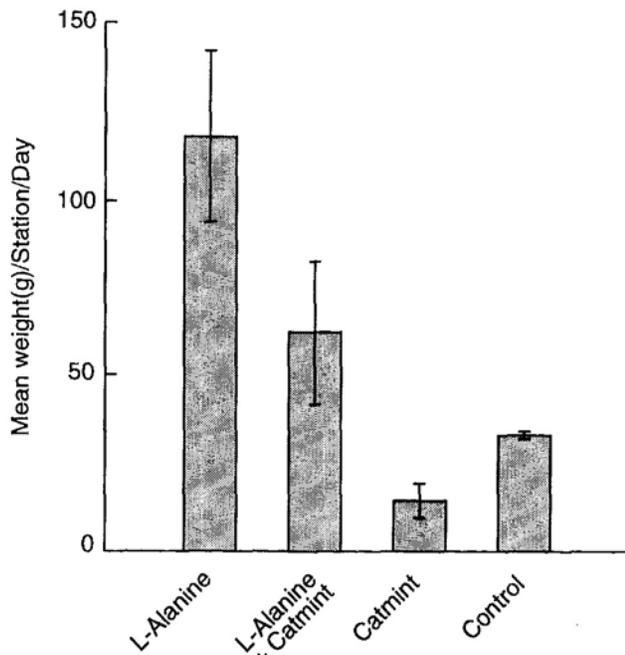


Figure 6. Consumption (mean \pm SD) of polymer cat bait with L-alanine and catmint.

became mouldy after 1-2 weeks, and this may have effected palatability later in the trial. Nevertheless, the results are encouraging. Firstly, bland baits were tested and we anticipate a better response with L-alanine and catnip-treated baits. Secondly, in these preliminary studies the baits were placed on a single line; bait broadcast more widely should be more accessible to more cats. We have partially overcome the lack of specificity of 1080 by minimising the amount of 1080 required. This specificity should be increased by making the baits more sought after by cats. During the field trials blood samples taken from non-target species showed that most hedgehogs (*Erinaceus europaeus*) had eaten the baits. A small number of weka (*Gallirallus australis*) (3 out of 31) had also eaten baits. Possums, rabbits (*Oryctolagus cuniculus*), ferrets (*Mustela turo*), and harrier hawks (*Circus approximans*) had not.

Toxic Bait Trial

The Matakoho Island cat eradication programme was successful. During the 3 weeks of pre-feed, signs on the tracking tiles indicated that cats visited bait stations. Baits disappeared both during the pre-feed and poison baiting. Patterns of bait take indicated that there were probably five cats on Matakoho Island. Follow-up monitoring with non-toxic baits, tracking tiles, and traps showed that the cats had been removed. The full details of this project will be reported elsewhere (Clapperton et al. 1992). The catnip on the pre-feed baits did not increase bait take. This may be because the few cats on the island were not catnip-responders (Tucker and Tucker 1988). As a result of this discrepancy, further pen studies are underway to check the results of our original bait palatability studies.

CONCLUSIONS

The polymer cat baits (Du Pont, Texas, USA) were accepted by feral cats in pens and field trials. Surface coating with L-alanine increases the consumption (palatability) of this bait, and the bait appears to be a suitable carrier for 1080.

Catnip showed the greatest potential as a lure, and it might be effective incorporated into or smeared on baits, or placed in cat bait stations.

Results from pen and field trials are sufficiently encouraging to recommend further field trials on non-toxic and toxic bait and a range of baiting strategies, including bait stations. The DuPont polymer technology produces high-quality, highly palatable long-life bait, and it is hoped that these will become commercially available in the near future.

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