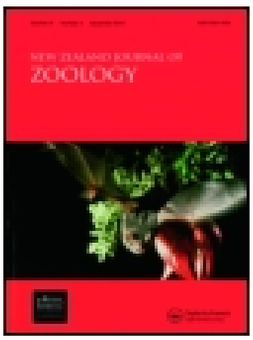

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Responses of stoats to scent lures in tracking tunnels

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Abstract Scent lures made from the anal sac secretions of stoats (*Mustela erminea*) in a long-life formulation increased the number of visits by stoats to footprint tracking tunnels set near the shoreline of Lake Waikaremoana. Lures derived from female stoats received a similar number of visits to those derived from males. Blank lures with no active ingredient did not attract stoats. Most of the lures remained intact and active for about seven weeks in summer. Rodents were unaffected by the lures, being neither repelled by the scent of stoats, nor attracted to the edible casein-based carrier compound. Our results suggest that scent lures could be useful for indexing stoat populations. Trials are needed to compare the effectiveness of lures and bait, and to determine seasonal changes in lure attractiveness. Problems of supply of the active ingredients will need to be overcome.

Keywords stoat; *Mustela erminea*; rodents; scent; lure; anal sac secretion; attractiveness; longevity; abundance estimates; tracking

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INTRODUCTION

Stoats (*Mustela erminea*) are a serious threat to hole-nesting and flightless birds in mainland forests of New Zealand (McLennan et al. 1996; O'Donnell 1996). Effective means of directly measuring changes in stoat abundance are required to assess changes in stoat abundance over time, the average density of animals during a sustained control operation, and rates of re-invasion.

The Department of Conservation is developing a standardized footprint tracking method for monitoring mustelid populations based on the system used by King (1994) and Innes et al. (1995). Tracking rates are often too low to be statistically useful for assessing changes in mustelid abundance (JAMcL unpubl. data). This problem may be overcome by adding meat baits (Murphy et al. in press), but fresh meat has a short shelf life and its attractiveness may be affected by hunger levels of the target animal. A slow-release lure that carries a social odour rather than a food odour as the active ingredient may produce more consistent responses in mustelids.

Scent station indices have been used to index population densities of other mammals (Roughton & Sweeny 1982; Conner et al. 1983). Anal sac secretions offer a potentially attractive scent for stoats. Stoats use this scent to communicate individual identity, providing an association between the resident animal and its territory (Erlinge 1982). Ferrets (*mustela furo*) scent mark their territories with anal sac secretion in a similar way to stoats (Clapperton et al. 1988; Clapperton 1989), and scent lures have been successfully developed for ferrets (Clapperton et al. 1989, 1994).

The long-life formulation used for the ferret lures is not commercially available in New Zealand. An alternative, bioerodable, casein-based material, known as Albert® is proving to be extremely effective as a matrix for the slow-release delivery of attractants to certain Crustacea (ADW unpubl. data).

The aims of the present study were to determine whether or not stoat anal sac secretion odours are attractive to stoats and how long they remain

attractive in tracking tunnels when formulated into Albert®. We also assess the effect of the lures on tracking rates of rodents.

MATERIALS AND METHODS

We established a transect line along 8 km of the southern coastline of Lake Waikaremoana, Urewera National Park, New Zealand (38°46′S, 177°02′E) between Whakenepuru Bay and Paengarua Bay. The transect line ran along a terrace between 1 and 10 m of the waterline. The habitat consisted of toetoe (*Arundo conspicua*) and tall fescue grasslands, rocky shore, and regenerating shrublands, backed by lowland podocarp/tawa and beech forests. No stoat trapping was being conducted on the southern side of the lake. We placed 41 tracking tunnels c. 200 m apart along the transect. The tracking tunnels had been baited with peanut butter and set for rodents on one or two nights each month during the previous three years.

The tracking tunnels were made of corrugated plastic, mounted onto a wooden base. Each tunnel contained a plastic tray with a central pad soaked in a ferric reagent and a piece of tracking paper at each end covered in a tannic acid solution (modified from King & Edgar 1977). We removed the anal sacs from ten female and 17 male stoats that had been kill-trapped and frozen for up to 19 months before dissection. We unfroze and pooled the anal sac material of individual males and females and then extracted the secretions by maceration twice with diethyl ether, keeping the sexes separate. The solvent was finally thoroughly expressed from the tissue mass. We dried the ether extract with anhydrous magnesium sulphate and then concentrated it by the slow distillation of solvent to produce extracts of clear light-yellow oils. These extracts were then compounded into a proprietary bioerodable casein-based matrix (Albert®) and fabricated into solid cubes (25 × 25 × 3 mm) that contained c. 1% w/w anal sac secretion extract. We stored the lures frozen in sealed tin cans, labelled as male or female scent, until use.

We attached the scent lures by a wire twist-tie in a central position inside the wall of every second tracking tunnel along the transect line. The lures alternated male and female scent. We checked the tunnels after a week, and then every 3–4 weeks (Table 1). At each visit we removed the tracking papers and replaced them if used, and checked the ink pads, lures and tunnels. We also noted signs of disturbance to the tunnels and lures. We identified tracks by matching them with a reference collection of prints, established from animals caught in kill-traps at Lake Waikaremoana. The majority of prints were easily differentiated by size and numbers of toes. Anal sac secretion-impregnated Albert® lures ('active' lures) were tested between 4 December 1997 and 17 March 1998. They were then replaced by Albert® lures with no active ingredient ('Non-active' lures) and the trial continued until 19 May. Data were analysed using Chi-square tests for independence ($P = 0.05$).

RESULTS

In total, we recorded stoat prints 30 times in 19 of the 41 tunnels. Rats (probably *Rattus rattus*) left prints 19 times and mice (*Mus musculus)* 73 times (Table 1). In the first tracking period we recorded stoat prints 19 times in tunnels with 'active' lures and only three times in tunnels without lures ($\chi^2 = 13.25$, d.f. = 1, $P < 0.001$). Eleven of the stoat prints were in tunnels containing female stoat scent lures and the other 8 in tunnels containing male stoat scent lures ($\chi^2 = 0.88$, d.f. = 1, N.S.). The lures did not affect rat and mouse tracking rates ($\chi^2 = 0.10$, d.f. = 1, N.S.; $\chi^2 = 1.84$, d.f. = 1, N.S., respectively). We found stoats prints in one tunnel three times, and in three other tunnels twice each. Stoat tracking rates had reduced markedly by the end of January, i.e., after seven weeks (Table 1). Most (>90%) of the lures remained intact for about seven weeks. The remainder softened and then collapsed after 4–6 weeks, or disappeared without trace. All but one of the 15 rat prints were recorded during the first month, while mouse prints (n = 24) were present on every tracking period apart from the first one. Tunnels were disturbed 31 times, mainly by possums' (*Trichosurus vulpecula*) tipping the tunnels over or pulling out the plastic trays. They did not discriminate between the lured and unlured tunnels (n = 14 and 17, respectively; $\chi^2 = 0.25$, d.f. = 1, N.S.). A stoat left a scat on the top of one lured tunnel.

In the second trapping period, comparing 'non-active' lures and no lure, only eight stoat prints were recorded, three without lure and five with blank lure (Table 1). These tracking rates (0.24 and 0.38 per 100 tracking nights [TN], respectively) were much closer to that recorded in the control tunnels between December and mid March (0.15 per 100 TN) than in the 'active' lure tunnels (0.94 per 100 TN). There were four rat prints, three without lure and one with

lure. Of the 49 mouse prints recorded, 23 were in tunnels without lure and 26 with lure.

DISCUSSION

The scent lures used in this study increased visits by stoats to tracking tunnels. The attractiveness of the lures to stoats contrasts with the failure of synthetic lures used in previous trials on stoats (Clapperton et al. 1994; Dilks et al. 1996), but is consistent with the successful use of natural-product and synthetic lures for ferrets (Clapperton et al. 1989, 1994). We still need to compare the effectiveness of lure and bait.

The equal success of male and female stoat lures is not surprising, given that both male and female stoats use anal sac secretion as a means of scent marking their territories (Erlinge 1982). It would be useful to know if there are seasonal differences in the responses of stoats to the lures. Male stoat anal sac secretions have stable individual chemical profiles at different times of the year (Erlinge 1982), but female secretions have not been analysed. In ferrets, in which anal sac secretions and social structures are similar to those of stoats, there is no chemical indicator of oestrous state in female anal sac secretions (Clapperton et al. 1988). Male stoats scent mark with anal sac secretions most frequently in spring, but both sexes perform anal drags all year round (Erlinge 1982).

The lack of a difference between the tracking rates of the 'non-active' lure and no lure indicate that it was the stoat scent rather than the casein-based material itself that was attracting the stoats, but tracking rates were so low that it would have been difficult to detect any differences between control and 'non-active' lures. The trials need to be repeated with more tracking tunnels, or in an area and time with a larger stoat population.

Scent lures also have potential as attractants in traps. Anecdotal evidence suggests that baited traps that have recently caught a stoat are more successful than clean baited traps. We have tested the lures described in this study as additional attractants in egg-baited traps on a heavily-trapped stoat population (Clapperton, McLennan & Woolhouse, unpubl. data). Only 3 of the 11 stoats captured were trapped in lured traps. These trials need to be repeated, and more information collected about the responses of different individual stoats (e.g., males and females, resident adults and dispersing juveniles) to anal sac scent.

Albert® proved to be an effective alternative to the plastic rope used in previous trials for the slow-release of mustelid anal sac lures. The caseinate polymer provided lures that were active for at least seven weeks. Dried out lures could be re-activated by squeezing them to release more odour. Lures in tunnels placed in shady positions appeared to retain their scent longer than those in full sun. The

Table 1 Stoat, rat and mouse tracking rates in tunnels with and without stoat scent lures and numbers of tracking nights (n) at Lake Waikaremoana, December 1997–May 1998.

Tracking period	n		Number of tunnels with prints					
			Stoat		Rat		Mouse	
	Lure	No lure	Lure	No lure	Lure	No lure	Lure	No lure
'Active' lure								
4–9 Dec	105	95	5	0	4	4	0	0
9 Dec–6/7 Jan	570	571	6	1	3	3	2	4
6/7 Jan–21 Jan	290	289	5	0	0	0	1	1
21 Jan–4 Feb	266	294	1	1	0	0	5	1
4 Feb–16 Feb	228	252	1	0	0	0	2	1
16 Feb–16 Mar	560	560	1	1	1	0	5	2
Total	**2019**	**2061**	**19**	**3**	**8**	**7**	**15**	**9**
'Non-active' lure								
16 Mar–6 Apr	441	420	2	2	0	1	6	4
6 Apr–20 Apr	294	280	0	0	0	0	5	5
20 Apr–6 May	336	304	1	0	1	2	10	6
6 May–18 May	252	228	2	1	0	0	5	8
Total	**1323**	**1232**	**5**	**3**	**1**	**3**	**26**	**23**

reduction in tracking rates after seven weeks may have been because the lures were no longer providing adequate scent. It is possible, however, that the stoats lost interest in them, or that stoat abundance declined.

The lures did not affect rat and mouse tracking rates, so tunnels containing stoat lures can still be used to provide indices of rodent abundance. 'Albert' on its own does not appear to be a strong attractant for rodents.

Difficulties in procuring real stoat anal sac secretion as the active ingredient of these lures could be a major limitation to the wider use of these lures in stoat monitoring and control. Careful bioassaying to determine the attractive components of anal sac secretions for stoats could result in a successful synthetic lure for stoats, as it did for ferrets (Clapperton et al. 1989).

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