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Sustained Release Long-life Lures and Bait Consumption Motivators for Rats

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ABSTRACT: All current vertebrate pest control and detection devices require a lure to be effective. Even advanced multi-kill and multi-species technologies that can work remotely for extended periods without maintenance require lures to be effective. We have developed, over the past five years, several sustained release, long-life lures for controlling and monitoring rats. The lures contain blends of chemical compounds that we identified as attractive to rats. Our early prototype lures were effective at kill-trapping wild, free-ranging ship rats without the need for replenishment for six months. We have since engineered other lures to suit different applications (e.g., kill-trapping and monitoring) and users (e.g., pest control and conservation) and are also testing our lures as bait consumption motivators. We are currently transforming our prototypes into products for international markets.

KEY WORDS: bait consumption, lures, rodent control, monitoring, *Rattus*, semiochemical, trap

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INTRODUCTION

All vertebrate pest control and detection devices require baits and lures to be effective (Apfelbach et al. 2005, Kok et al. 2013). Emerging advanced smart multi-kill and monitoring devices require long-life lures because they operate remotely for extended periods without maintenance. The development of vertebrate pest lures and baits (including those containing toxins) has not kept pace with the innovation seen for invertebrate baits and lures (Kimball et al. 2000, Schlexer 2008, Jackson et al. 2018a). Today, vertebrate pest control still depends on the use of crude, perishable food-based products like peanut butter and cereals, and commercially available pastes and gels, to attract animals to monitoring and control devices (Eason et al. 2016, Jackson et al. 2018b). But these are perishable rendering them ineffective in a matter of days. This means the likelihood of detecting, kill-trapping, or delivering a lethal toxic dose to an animal rapidly diminishes soon after device deployment. In turn, this decreases control operation efficacy and increases labour costs, as lures or baits need to be frequently replenished at considerable cost (Parshad 2002, Linklater et al. 2013, Murphy et al. 2013). In practice, however, devices commonly operate sub-optimally for substantial periods of time, especially in less accessible locations where traps cannot be more frequently visited. The logistic and financial constraints perishable lures impose substantially impact management outcomes and pest control programme success.

More effective vertebrate pest control strategies would become possible if semiochemicals (i.e., volatile organic signalling compounds), like those used as lure and bait additives for invertebrate monitoring and control for decades (Witzgall et al. 2010), could be developed for vertebrate pests. This is because the semiochemicals attractive to animals can be encapsulated into non-perishable products that emit a sustained odour for extended time periods. They would ensure control and monitoring devices are always optimally attractive and facilitate the advance to automated smart technologies (Marsh 1988, Mauchline et al. 2018). In this paper, we describe our ongoing development of semiochemical lures and their transformation into sustained release, long-life products for rats (*Rattus* spp.). We provide summarised results and discuss the implications of our product development to global vertebrate pest control.

METHODS

We developed three prototype encapsulation and controlled release technologies and tested them for their efficacy on rats. The encapsulation devices and the means of controlling the release of our semiochemicals are commercially sensitive so not discussed here. Lures were tested in the laboratory (to calculated lure longevity) and in-field trials (to test for efficacy and longevity on wild, free-ranging animals). Laboratory trial lures were analysed over an extended time-period using gas chromatography-mass spectrometry. Lures were kept at room temperature and continually emitted odour. Field trials lures were placed in DOC-boxes (Department of Conservation, New Zealand) containing DOC 150 traps in a low-density environment. Traps were checked bi-weekly for six months. Lures were not replaced during the trial period.

RESULTS

Fifteen ship rats were caught during the field trial period. Semiochemical long-life lure ‘A’ statistically outperformed the within-trial peanut butter standard ($P < 0.01$; binomial distribution test) and statistically outperformed the wider community network of 300 traps over the same time period (95 rats across a network of 300 traps over the same period, $P < 0.01$; binomial distribution test). After 200 days, three kills were recorded in trap boxes containing our sustained release, long-life lures. In the laboratory, GC-MS time-lapse trials indicate that the current long-life lure prototypes have an in-field life-expectancy of approximately seven months.

DISCUSSION

Our semiochemical long-life lures outperformed the peanut butter standard in extended-life kill trials of wild, free-ranging rats. The lures were effective at kill-trapping wild, free-ranging rats without replenishment for 6 months and laboratory data supports that life-expectancy. Our semiochemical products, when developed and comercially available, will likely improve the effectiveness of rat monitoring and control, by overcoming the current limitations of food-based lures (Turkowski et al. 1979, Shivik et al. 2014). They will increase the probability of rats entering trap boxes by helping overcome the neophobic responses of animals to them. This is important as control and eradication operations often fail due to trap shyness associated with neophobic individuals (Seymour et al. 2005). Ultimately, our products will help achieve major operational cost savings, especially by large reductions in labour, and enable a substantial expansion in the scale and frequency of pest control, especially in inaccessible locations. All these economic and operational savings, and the dramatic expansion in efficacy, are amplified because semiochemical product will enable near-future automated pest detection and control devices to reach their maximum operational potential.

We are currently working to transform our prototype semiochemical products into sustained release, long-life lure and bait consumption motivator products for national and international markets. We are trialling several technologies as different environments and context (e.g., indoors, out-of-doors, urban, and rural) will necessitate different application technologies. We are now engineering other products with different lifespans (1, 2, and 3 months), and comprising different blends to suit different applications and uses. We are also trialling our semiochemicals as bait additives to increase bait consumption.

CONCLUSIONS

Our semiochemical-based lures will be applicable to all current and emerging biosensor, monitoring, trapping and baiting technologies and will help emerging remotely operated, smart, multi-kill, automated monitoring and recognition, and toxin delivery devices realise their potential. Lastly, our animal response-guided discovery method (Jackson et al. 2018a,b) is an advance that could be adapted more widely for semiochemical lure discovery in other pest species.

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