2010

Potential Attractants for Detecting and Removing Invading Gambian Giant Pouched Rats (*Cricetomys gambianus*)

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Research Article

Received: 24 July 2009 Revised: 9 October 2009 Accepted: 9 October 2009 Published online in Wiley Interscience: 10 December 2009

(www.interscience.wiley.com) DOI 10.1002/ps.1892

Potential attractants for detecting and removing invading Gambian giant pouched rats (*Cricetomys gambianus*)

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Abstract

BACKGROUND: Native to Africa, Gambian giant pouched rats (Gambian rats; *Cricetomys gambianus* Waterh.) are a threatening invasive species on a Florida island, Grassy Key. Gambian giant pouched rats shifted from a domestic pet to invading species after suspected release from a pet breeder. Because of the large size of Gambian rats (weighing up to 2.8 kg), they pose a serious threat to native species (particularly nesting species) and agricultural crops, especially if Gambian rats invade mainland Florida. Also, Gambian rats pose a threat from disease, as they were implicated in a monkeypox outbreak in the midwestern United States in 2003. The United States Department of Agriculture's Wildlife Services has initiated eradication and detection efforts in the Florida Keys, but trapping the sparse population of Gambian rats has proven difficult.

RESULTS: Fifteen attractants that could be used in traps for capturing or detecting single or paired Gambian rats were tested. It was found that conspecific scents (i.e. feces and urine) from other Gambian rats were the best treatment for attracting single and paired Gambian rats. Single Gambian rats explored more attractant types than paired Gambian rats.

CONCLUSIONS: Effective attractants for use with Gambian rats have been identified, and multiple attractant types should be used to capture or detect the sparse population. It is recommended that mainly urine and feces from Gambian rats be used, but peanut butter, anise, ginger and fatty acid scent could also be useful for attracting the currently small population of Gambian rats on Grassy Key.
Published 2009 by John Wiley & Sons, Ltd.

Keywords: attractants; Gambian giant pouched rat; *Cricetomys gambianus*; invasive species; trapping

1 INTRODUCTION

Introduced rodents pose a serious threat to the native flora and fauna of islands.[1–3] Rodents can be very prolific on islands where there are few or no predators, and their omnivorous foraging has led to the endangerment or extinction of numerous island species.[1,4] Most seabirds that nest on islands have not evolved to deal with predation and are very vulnerable to introduced rodents and other species introductions. There has been a concerted worldwide effort to eradicate introduced rodents from islands, with numerous successes.[1,5] These efforts have relied heavily on the use of various rodenticides.[5,6]

In some cases, rodenticides cannot be used, or only in limited ways, and other approaches (e.g. traps) are employed.[7] Additionally, the presence of invasive rodents must be monitored to assess the success of eradication efforts and to provide an early alert system for newly invading species.[8,9] Methods for monitoring include: traps, chew blocks, track stations or remote cameras. These methods require effective attractants, especially when rodent densities are very low. Effective attractants may also help get rodents to widely placed bait stations used for detection or lethal removal, and could help to detect and prevent reinvasions.[9]

Gambian giant pouched rats (Gambian rats; *Cricetomys gambianus* Waterh.) became established on Grassy Key in the Florida Keys in 1999, following an escape or release by a pet breeder,[10] and they remain a free-ranging and breeding population today.[11] These rodents are native to a large area of central and southern Africa,[12] and, because of their large size (∼2.8 kg), they are commonly considered as a high-protein food source.[13] This species could cause substantial agriculture damage if it were to reach the mainland USA and become established.[11,14] A dead Gambian rat was found about 33 km from Grassy Key, en route to mainland Florida on US Highway 1 (Parker Hall, USDA Wildlife Services, private communication). This Gambian rat likely originated from the free-ranging population on Grassy Key, suggesting that these rats can travel long distances or can hitch rides on vehicles and potentially invade new islands and mainland Florida.

Invading species of rats have repeatedly disrupted and decimated populations of native nesting birds throughout the world.[1,15] Also, Gambian rats have been known to cause substantial losses to food crops in Africa.[16] Furthermore, Gambian rats are known to carry monkeypox and various other diseases transmissible to humans and livestock.[10,16] There was an outbreak of monkeypox in the midwestern USA in 2003 that was linked to

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infected Gambian rats that had been brought into the country for the exotic pet industry,[17] bringing the first monkeypox outbreak in the western hemisphere.[18] Fortunately, the Centers for Disease Control and Prevention found a free-ranging subsample of the Gambian rat population on Grassy Key to be seronegative for monkeypox.[10] For these reasons, preliminary work with the Grassy Key invasive rodent population, including monitoring, preliminary rodenticide testing and an eradication strategy, was designed and implemented.[3] The eradication effort is ongoing, with difficulties in achieving success.[11] Hence, additional effective attractants are needed to aid in detection and eradication of the introduced Gambian rats.

The present study investigated a variety of natural and synthetic materials as attractants, using wild-caught Gambian rats from Grassy Key in the Florida Keys. The hypothesis that wild-caught Gambian rats would visit some attractant stations more often than others was tested.

2 METHODS

Twenty wild Gambian rats were captured on Grassy Key Island during 2007. The wild-caught rats were brought to the NWRC in Fort Collins, Colorado, in their capture cages and then placed in individual cages (i.e. rabbit rack cages) in an animal room of the Invasive Species Research Building (ISRB) for a two-week quarantine period and normal maintenance thereafter. The Gambian rats were dusted with an insecticide (Delta-Dust; Bayer Environmental Science, Montvale, NJ) and dewormed (liquid topical dewormer Revolution/selamectin; Pfizer, New York, NY) before leaving Florida. Upon arrival, each rat was weighed, sexed, given an AVID pit tag (American Veterinary Identification Devices, Norco, CA), checked for general health and dusted again with insecticide to kill any remaining ectoparasites. A den tube, water bottle, rodent chow pellets (Lab Diet 5008; PMI Nutrition International LLC, Brentwood, MO), fruit, nuts and chew sticks were provided to each cage. Three of the wild-caught females had litters after arrival at NWRC. They were allowed to raise their young, which were subsequently used in trials after maturation (i.e. $>$4 months of age).

Six single (five females and one male) and six pairs (one male and one female) of Gambian rats were independently tested in indoor attractant trials in a controlled environment. Trials were conducted in a simulated natural environment (SNE) of the ISRB to test the attractiveness of 15 potential attractants. The treatments tested included: almond extract (McCormick & Co., Inc., Hunt Valley, MD), anise extract (Sigma-Aldrich Corp., St Louis, MO), bacon grease (Hormel Foods Corp., Hormel Place, Austin, MN), cantaloupe extract in oil (Peak Candle Supplies, Denver, CO), cheddar cheese (Kraft Foods Global, Inc., Northfield, IL), semi-sweet chocolate (Kraft Foods North America, Inc., Rye Brook, New York, NY), 1% solution of carbon disulfide (CS_2; Sigma-Aldrich Corp., St Louis, MO), fatty acid scent [FAS; a mixture of nine fatty acids, but predominantly hexanoic acid (30.0%) and butyric acid (26.7%); Pocatello Supply Deport, Pocatello, ID), feces and urine from conspecifics, cod liver fish oil (Twin Laboratories, Inc., American Fork, UT), geraniol (Sigma-Aldrich Corp., St Louis, MO), ginger oil (Rainbow Meadow, Inc., Jackson, MI), lemon extract (McCormick & Co., Inc., Hunt Valley, MD), peanut butter (JM Smucker Co., Orrville, OH), peppermint extract (Frontier Natural Brands, Inc., Boulder, CO) and water (control). Urine and feces from Gambian rats used in individual trials were always collected from unrelated Gambian rats. For trials with single Gambian rats, feces and urine from the opposite sex were used, whereas for trials with pairs of Gambian rats a mixture of male and female feces and urine was used.

Single or pairs of Gambian rats were rotated into the SNE for trials, and allowed 3 days to acclimate and develop a consistent activity routine. A T-shaped PVC tube was placed horizontally on top of a 15 cm tall wooden pallet. Pallets were located on the floor, at the centers of each of the four side walls of the SNE room. Four of these devices were placed in the SNE to contain the treatment substances. The entire PVC tube was 10 cm in diameter and had a pass-through segment of 20 cm length and a centrally located dead-end chamber of 12 cm length that contained the treatment substance behind a wire mesh. Behind the wire mesh was deposited about 1 mL of a treatment substance on Whatman No. 1 filter paper (Whatman, Maidstone, Kent, UK) inside an aluminum pan (70 mm diameter by 5 mm deep; VWR, International, West Chester, PA). The Gambian rats could not directly contact any of the treatment substances. On day 1 of an attractant trial, three different potential attractants were tested along with a control (distilled water). The potential attractants and the control were randomly assigned to one of the four tubes.

The SNE lighting was programmed to rotate between day and night in 12 h intervals, and the room was maintained at 21 °C and 35% relative humidity. The SNE was also equipped with two central den boxes containing ground corn cobs as bedding material, four nearby rubber tubs containing soil and rodent chow pellets and a nearby water container. Chunks of apples, bananas and oranges were scattered around the SNE each day. Food was replaced daily. Two metal rack ‘climbing structures’ were placed near two opposite corners of the SNE. Cinder blocks and small tree limbs were placed near the two other corners of the room. Four live potted plants were placed near each corner of the room; these were replaced as needed. Several rawhide chew sticks were scattered about the room and replaced as needed.

The potential attractants were placed in the tubes in late afternoon, shortly before the night cycle began. Each treatment trial was conducted for 24 h, and then the treatments and tubes were removed from the room. Four clean, empty tubes were placed in position but left empty for 24 h. This allowed a period for dissipation of any lingering odors before the next sets of potential attractants were applied and the routine repeated. All potential attractants were tested over a 15 day period for each single or pair of Gambian rats. Between trials with each new single rat or pair of rats, the SNE was thoroughly cleaned. The room was left vacant for several days before new rat(s) were introduced for acclimation.

An infrared camera was attached to each side wall of the room so that one pointed at each pallet. These allowed a DVD recording of the Gambian rat activity at each pallet and attractant tube throughout the duration of the trials. When the trials were completed, all DVD recordings were viewed and the number of animal visits to each treatment station was recorded for each treatment type. Tests were made for equality of variances ($P \leq 0.05$) for treatment visits among single and paired Gambian rats using Levene’s test for homogeneity of variance (Proc GLM; SAS Institute, Cary, NC). Because a sizable variability was noticed in the variances of visits between treatment types (Table 1), counts of visits were log transformed to examine any differences in the mean number of visits per treatment type with an ANOVA (Proc GLM). Visits were compared separately for single and paired Gambian rats. To find the most attractive treatment type(s), a set of contrast statements was constructed

Table 1. Mean number of visits to potential attractants (original scale) for single and male and female pairs of Gambian giant pouched rats over 24 h indoor trials during 2007–2008

	Single (n = six individuals)			Paired (n = six pairs)		
Treatment	Mean	SE	Variance	Mean	SE	Variance
Feces/urine	16.0	±9.49	540.0	70.8	±18.35	2019.4
FAS extract	11.0	±6.72	270.8	9.8	±4.50	121.4
Peanut butter	9.0	±2.25	30.4	10.8	±3.28	64.6
Ginger	7.8	±3.05	55.8	8.8	±1.92	22.2
Anise extract	5.8	±2.10	26.6	13.0	±7.64	350.0
Cheese	4.7	±0.80	3.9	9.7	±2.82	47.9
Bacon grease	4.3	±1.09	7.1	12.0	±2.63	41.6
Peppermint Extract	4.3	±1.58	15.1	11.8	±3.96	94.2
Chocolate	3.5	±0.99	5.9	12.5	±7.52	339.1
Fish oil	3.5	±0.96	5.5	8.5	±1.65	16.3
Lemon extract	2.3	±0.76	3.5	10.8	±3.31	65.8
10% sol. CS_2	2.2	±1.33	10.6	2.8	±0.65	2.6
Geraniol	2.2	±0.95	5.4	7.7	±2.42	35.1
Water (control)	1.7	±0.47	1.3	4.8	±1.43	12.2
Almond extract	1.7	±0.42	1.1	5.3	±1.12	7.5
Cantaloupe	1.7	±0.21	0.3	4.0	±1.65	16.4

to examine for differences in the visits to individual treatments versus the mean number of visits to all other treatments (Proc GLM).

3 RESULTS

Overall, the variances among visits to all treatment types were not equal for single ($F_{15,80}$ = 11.11, $P < 0.0001$) or pairs of male and female ($F_{15,80}$ = 3.74, $P < 0.0001$) Gambian rats respectively (Table 1). Therefore, the number of visits was log transformed, resulting in equal variances (i.e. single rats = $F_{15,80}$ = 0.99, $P = 0.478$; paired male and female rats = $F_{15,80}$ = 0.18, $P = 1.000$).

3.1 Potential attractants for single Gambian rats

Using the log-transformed data, it was found that the mean amount of visits was not equal among all treatment types ($F_{15,73}$ = 2.67, P = 0.003) for single Gambian rats. The feces and urine treatment and the peanut butter treatment were visited significantly more than all other treatment types ($F_{1,73}$ = 8.84, $P = 0.004$ and $F_{1,73}$ = 6.76, $P = 0.011$ respectively) (Fig. 1). Figure 1 also shows that single Gambian rats frequently visited other treatment types (although this was not statistically significant), especially anise ($F_{1,73}$ = 2.44, P = 0.123), ginger ($F_{1,73}$ = 2.04, P = 0.157) and FAS ($F_{1,73}$ = 1.88, P = 0.175). The control (water) was visited less often than any of the other treatment types ($F_{1,73}$ = 7.81, $P = 0.007$).

3.2 Potential attractants for pairs of male and female Gambian rats

Using the log-transformed data, it was found that the mean amount of visits was not equal among all treatment types ($F_{15,80}$ = 3.51, $P = 0.0001$) for pairs of male and female Gambian rats. The feces and urine treatment was visited significantly more than all other treatment types ($F_{1,80}$ = 34.65, $P = 0.004$) (Fig. 2). The control (water) was visited less frequently ($F_{1,80}$ = 3.38, P = 0.070) and at similar levels to some of the lesser visited attractants such as carbon disulfide and cantaloupe. The pairs of Gambian rats did not seem to visit multiple treatment types as much as the single rats did.

4 DISCUSSION

Finding an effective attractant for Gambian rats is important for reducing the threat posed by the invading rats currently on Grassy Key. The present findings suggest that, of the various potential attractants tested, a blend of feces and urine from Gambian rats

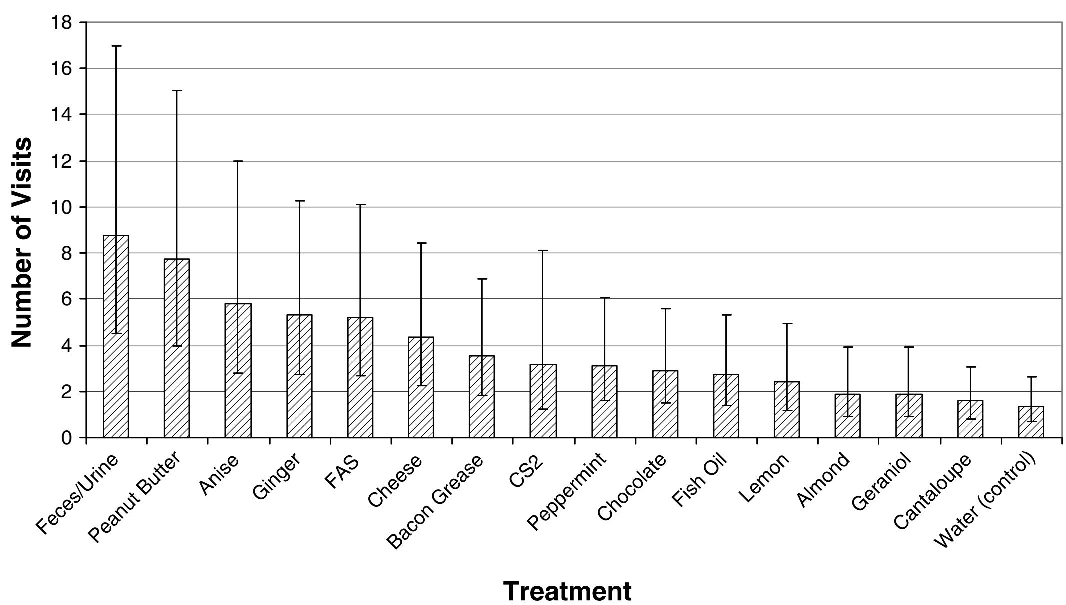

Figure 1. Mean number of visits (back-transformed from log scale) to treatment types with 95% CI for 24 h indoor trials with single Gambian giant pouched rats during 2007–2008.

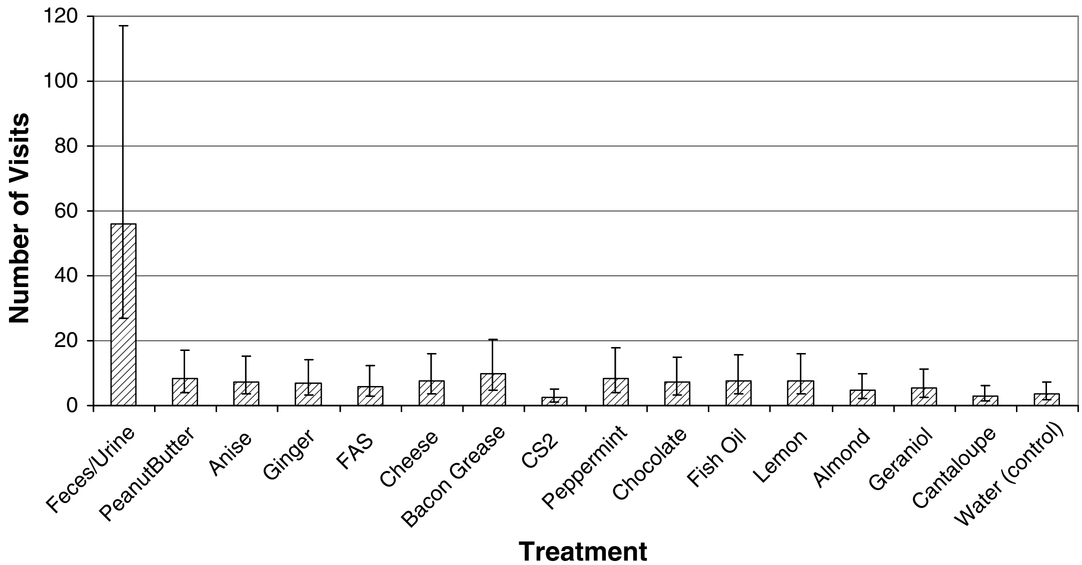

Figure 2. Mean number of visits (back-transformed from log scale) to treatment types with 95% CI for 24 h indoor trials with male and female pairs of Gambian giant pouched rats during 2007–2008.

will likely be the best attractant type for Gambian rats. Other studies have shown that rodents were more likely to be captured in traps that had previously captured rats, even if the traps were baited with attractants.[19] This suggests that rats might actively seek conspecifics or potential mates, more so than other biological requirements. Therefore, using feces and urine as an attractant for capturing the sparsely populated Gambian rats on Grassy Key, and for detecting newly invading Gambian rats on other islands or mainland Florida, should provide the best probability for attracting Gambian rats.

Evidence was also found that single Gambian rats more freely investigated multiple treatment types by comparison with Gambian rats in male and female pairs. Single Gambian rats were attracted to peanut butter, which is already being used successfully to capture the invading Gambian rats on Grassy Key (John Woolard, USDA Wildlife Services, private communication). This ongoing eradication program has greatly reduced the number of free-ranging Gambian rats on Grassy Key; therefore, the sparse population likely contains individuals that are isolated away from conspecifics. Thus, using multiple types of attractant to capture or detect these Gambian rats could be useful. Based on the results of the present study, it is suggested that primarily using Gambian rat feces and urine, but also placing one or more of peanut butter, anise extract, ginger or FAS extract, should provide the best opportunities for capturing or detecting Gambian rats. Further testing should help to identify additional and potentially better attractants for Gambian rats. Examining the efficacy of liquid concentrated banana extract as a potential attractant may be especially worthwhile in view of its current use as a reward substance for trained Gambian rats.[20]

ACKNOWLEDGEMENTS

This study was conducted under the approved NWRC Project ‘Development and assessment of methods and strategies to monitor and manage invasive mammalian vertebrate species with emphasis on rodents’. The study protocol, QA-1427, was approved by the NWRC Institutional Animal Care and Use Committee on 22 February 2007. The authors thank USDA Wildlife Services – Florida operational staff for funding and logistical support during the Gambian rat work in Florida and the attractant study conducted in Fort Collins. They also thank the State of Florida and the US Fish and Wildlife Service for support in the Gambian rat eradication effort in Florida.

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