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Authors
Witmer, Gary
Burke, Patrick

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The Ability of a Geo-Textile Barrier Material to Exclude Rodents

Gary Witmer and **Patrick Burke**
USDA APHIS Wildlife Services, National Wildlife Research Center, Fort Collins, Colorado

ABSTRACT: Many rodent species, including both commensal and native species, cause numerous types and extensive amounts of damage worldwide. Much of their adverse effects on human populations involve food consumption and contamination as well as disease transmission. Their digging and gnawing abilities, however, are well developed and other types of damage result. These include the undermining of hydraulic structures, ditches, levees, building foundations, roads, and runways. They also damage pipes, cables, and building insulation, occasionally resulting in power outages and fires. Effective and efficient barriers would help reduce these latter types of rodent damage. We examined two types of geo-textile (containing metal fibers and called "Xcluder") materials for their ability to prevent house mouse and Norway rat entry through regularly-used openings. We also examined the materials ability to protect highly palatable food sources from these rodents. Although these were preliminary trials, the materials showed considerable promise in some applications. We discuss potential applications and ways to maximize the effectiveness of geo-textile barriers, along with additional research needs.

KEY WORDS: barriers, commensal rodents, exclusion, geo-textile, invasive species, *Mus musculus*, *Rattus norvegicus*, rodent control, Xcluder

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Originally from Asia and parts of the Middle East, Norway rats (*Rattus norvegicus*) and house mice (*Mus musculus*) have followed humans around the world and are now found worldwide (Long 2003). In many situations they live in a close commensal relationship with humans, but on many tropical islands and on portions of some continents, they are free-ranging and do not need the food and shelter provided incidentally by humans. Invasive rats and mice pose a threat to the native flora and fauna of islands (Burbidge and Morris 2002, Witmer et al. 2006, 2007) and can cause significant damage to agricultural commodities and property (Long 2003, Timm 1994a,b). Most seabirds that nest on islands have not evolved to deal with predation and are very vulnerable to introduced rodents (Moors and Atkinson 1984). House mice are very prolific, and populations have irrupted periodically to cause "plagues" in places such as Australia and Hawaii (Long 2003). The Study Director had conducted a site visit to Pennsylvania where house mice were posing a serious threat to the poultry industry, both by consuming and contaminating chicken feed and by the transmission of the bacterial disease, Salmonella. Despite the use of a variety of rodenticides by the poultry growers, problems with mice persist. Norway rats cause the same types of problems at many dairies and livestock feedlots where food and cover are abundant. The abilities of rodents to climb, jump, gnaw, and squeeze through small openings poses a formidable challenge.

More effective tools are needed to reduce rodent populations and the damage they cause (Witmer et al. 1995, Witmer and Jojola 2006). Effective barriers would help reduce or eliminate rodent problems in and around buildings and reduce the likelihood of transmission of rodent-borne diseases such as hantavirus (Hopkins et al. 2002). If the barriers were affordable and durable, they could also be used in other applications, for example to reduce burrowing on large grassy areas such as in agricultural settings and at airports (Witmer and Fantinato 2003), or reduce damage to insulation in buildings (Hygnstrom 1995). Unfortunately, the abilities of rats and mice, including their very sharp, ever-growing incisors, make it very difficult to prevent their access to vulnerable resources (Baker et al. 1994). Nonetheless, Bourne (1998) noted that the development of new and affordable building materials can greatly help prevent incursion by rodents.

We tested the ability of two types of metallic barrier materials to deter rodent access. We tested one barrier material (geo-textile containing metal fibers) in pen trials to evaluate its ability to prevent access through holes by wild Norway rats and wild house mice. We tested the ability of another type of geo-textile barrier material to deter the rodents from gaining access to covered food boxes. The animals were motivated to gain access to the other side of the barrier by the use of preferred food items.

METHODS

Hole Barrier Trial

Free-ranging house mice and Norway rats, live-trapped near Fort Collins, CO, were maintained in individual plastic shoebox cages (mice) within a room of the Animal Research Building (ARB) or metal rack cages (rats) in an outdoor rodent building (ORB) at NWRC as per SOP AC/CO 005.00 (mice) and SOP AC/CO 011.01 (rats). The mice and rats were provided with commercial laboratory rat chow and water *ad libitum*. Each cage had a den box, a piece of cardboard or chew stick for gnawing, and cotton (mice) or burlap (rats) for bedding material. The mice and rats were quarantined for 2 weeks before the trial began. The mice and rats were weighed and sexed before the start of the trial.

A pre-conditioning trial had been conducted to identify several highly preferred foods to use as lures in the trial. Lure foods tested included small slices of orange, apple, melon, banana, green bean, potato, cucumber, cheese, hot dog, and chocolate/peanut candy bar. We also tested pelleted dog food and small balls of oatmeal mixed with peanut butter; the latter is a standard bait used in both live and snap traps in rodent field studies. Foods were added 3 at a time and monitored for several days before a new group of 3 foods was tested. The lure foods most preferred by Norway rats were peanut butter-oatmeal balls and apple and cheese slices. The lure foods most preferred by house mice were peanut butter-oatmeal balls and hot dog and cheese slices. Consequently, we used these as lure foods in the barrier study.

Ten caged mice and 10 caged rats were randomly assigned to the barrier treatment group with each group having 5 males and 5 females. An additional 10 mice and 10 rats were assigned as controls. All rodents continued to receive rodent chow and water throughout the trial. Prior to addition of the individual treatment rodent to a trial cage, a barrier wall was placed in each cage. The walls were constructed of wood and held in place by screws (rat cages) or wood dowels (mice cages). Each of the 10 rat cage walls had a circular hole of 2½-inch diameter drilled through it; the mouse cages had 1¼-inch holes. The wall was positioned about 1/3 of the way from one end of the cage. The larger area of the cage contained the den box, rodent chow and the water bottle.

Treatment animals were fed the preferred foods for 3 days before the trial was started. The lure foods were placed each day on the smaller side of the cage wall so that the rodent would have to go through the hole in the wall to access the preferred foods. Almost always, the preferred foods were completely eaten overnight. The amount of rodent chow placed on the larger side of the cage was also reduced to 4 pellets per day per rat and 2 pellets per day per mouse so that the rodents would be a little more hungry and more inclined to try to gain access to the preferred foods on the smaller side of the cage, once the barriers were inserted. The rodent pellets were replenished as necessary.

On the afternoon of the start of the barrier trial, a wad of the geo-textile barrier material (marketed as "Xcluder Rodent & Pest Control" materials; Global Materials Technologies, Inc., Palantine, IL) was inserted tightly into the wall hole of each treatment cage while the rodent was in its den box. Half of the wads were inserted from the left side and half from the right side of the walls (i.e., 5 from the front-side and 5 from the backside). This was because in a real world setting, one would not know from which side the rodent might approach the inserted barrier. Fresh lure food was added to the now blocked side of the cage. It was replenished every other day so that the food odors would remain a strong enticement for the rodent to get to the preferred foods on the other side of the barrier.

Each barrier was examined each day and recorded as: 1) no visible damage, 2) slight damage but not breached, 3) moderate damage but not breached, and 4) breached. The trial continued for 7 days for the rats and 7 days for the house mice. If the hole barrier was breached on any day, the trial ended immediately for that animal.

At the end of the trial for each animal, the hole barrier was removed after fresh preferred food had been added to the smaller side of the cage. This was to assure that the animals would readily go through the now unblocked hole and consume the lure foods.

At the end of the study, all rodents were euthanized with carbon dioxide and examined to see if there were any injuries or abrasions from their trying to remove the barrier material. All rodents were then incinerated.

Food Box Barrier Trial

Ten 10 caged mice and 10 caged rats were randomly assigned to the barrier treatment group with each group having 5 males and 5 females. An additional 10 mice and 10 rats were assigned as controls. All rodents continued to receive rodent chow and water throughout the trial. Prior to addition of the individual treatment rodent to the trial cage, a food box was placed in each cage. We used metal (rats) or plastic (mice) food boxes to contain the preferred foods. For mice, the food box was a plastic circuit box (supplied by hardware stores) with a rectangular opening on one side of about 2 by 3.5 inches. For rats, the circuit box was metal with a square opening of about 4 by 4 inches. Food boxes were placed on the floor of mouse cages, but were attached to the inside front of the rat cages using a bolt and nut to secure them. Treatment animals were fed the preferred foods for 3 days before the trial was started. The lure foods were placed each day in the open food box.

On the afternoon of the start of the barrier trial, a piece of the geo-textile barrier material, cut to just cover the opening of the food box, was placed over the food box opening. It was held in place entirely around the perimeter of the food box opening by securing a flat sleeve over the opening with 2 screws. Fresh lure food was added to the food boxes before they were sealed.

Each sealed food box was examined each day and recorded as: 1) no visible damage, 2) damaged but not breached, 3) moderate damage but not breached, and 4) breached. If a food box was breached, we examined it to see if the lure food had been removed. If the food box barrier was breached on any day, the trial ended immediately for that animal. At the end of the trial for each animal, the food box barrier was removed and fresh preferred food was added to the cage. This was to assure that the animals would readily consume the lure food now that it was easily available. The trial was scheduled to continue for 7 days for rats and 7 days for mice unless most food boxes were breached at which time the trial would end for that species.

At the end of the study, all rodents were euthanized with carbon dioxide and examined to see if there were any injuries or abrasions from their trying to remove the barrier material. All rodents were then incinerated.

RESULTS AND DISCUSSION

Hole Barrier Trial

None of the 10 blocked holes were breached by Norway rats during the 7-day trial. Only one rat tugged at the barrier material and removed some of the geo-textile material. Interestingly, it appeared that the rat used the material for bedding in its den box. After the hole barriers were removed, all 10 rats passed through the open wall holes and consumed the lure food during the first night. No signs of injury were noted on any of the treatment rats. All 10 control rats survived the study period, consumed preferred foods daily, and exhibited no injuries.

None of the 10 blocked holes were breached by house mice during the 5-day trial. There was only very slight shredding of the geo-textile material by 3 mice. After the hole barriers were removed, all 10 mice passed through the open wall holes and consumed the lure food during the first night. No signs of injury were noted on any of the treatment mice. All 10 control mice survived the study period, consumed preferred foods daily, and exhibited no injuries.

Food Box Barrier Trial

Six of the 10 blocked holes were breached by Norway rats during the 4-day trial. Three were breached during the first night, 1 more on the second night, and 2 more on the third night. In all cases, lure food was removed from the breached food boxes, even though the hole the rat made in the barrier material was quite small (usually about 1 inch). Four of 10 protected food boxes had not been breached when the trial was ended after 4 days, and these had received very little damage. We did not continue the trial to 7 days, because 60% of the food boxes had already been breached. After the food boxes were removed and fresh lure food added to each cage, the preferred foods were consumed during the first night. No signs of injury were noted on any of the treatment rats. All 10 control rats survived the study period, consumed preferred foods daily, and exhibited no injuries.

The house mice were much slower in breaching food boxes, so this portion of the trial continued for 7 days. One food box was breached after 2 days and a second food box was breached after 6 days. In all cases, lure food was removed from the breached food boxes, even though the hole the mouse made in the barrier material was quite small (usually about ¾-inch). Eight of 10 food boxes had not been breached when the trial was ended after 7 days, and these had received very little damage. After the food boxes were removed and preferred foods placed in the cages, all 10 mice consumed the lure food during the first night. No signs of injury were noted on any of the treatment mice. All 10 control mice survived the study period, consumed preferred foods daily, and exhibited no injuries.

CONCLUSIONS

The commensal rats and mice have amazing adaptability, are well equipped to gnaw and claw through materials, and can make use of a wide array for foods and resources. They also have a high reproductive capability and can achieve high densities. As a result, rodents cause significant damage to human and natural resources in all parts of the world. Effective barriers can prevent or reduce their access to resources, providing economic relieve to humans and protection to natural resources. The barriers constructed of geo-textile materials used in the blocked hole study were highly effective in preventing access to valued food resources by both wild Norway rats and wild house mice. The barrier material is easily installed, allowing homeowners, food producers, and personnel of other industries to readily make use of them. We recommend that future trials be conducted in real-world settings and over longer periods of time. Those trials should not only evaluate effectiveness, but also the durability (e.g., weathering effects) of the barriers over time.

The barriers constructed of geo-textile materials used in the food box study were not effective in preventing access to valued food resources by wild Norway rats. The material was relatively effective in preventing access to valued food resources by wild house mice. We recommend that addition trials be conducted with mice with a somewhat heavier material. Once a 100% effective material is identified, trials should be conducted in a real world setting. Those trials should not only evaluate effectiveness, but also the durability of the barriers over time. It appears that rats are more difficult to exclude from highly valued food resources and testing of other types of barrier materials will be needed.

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LITERATURE CITED

BAKER, R. O., G. R. BODMAN, and R. M. TIMM. 1994. Rodent-proof construction and exclusion methods. Pp. B137-B150 *in*: S. E. Hygnstrom, R. M. Timm, and G. E. Larson (Eds.), Prevention and Control of Wildlife Damage. Cooperative Extension Service, University of Nebraska, Lincoln, NE.

BOURNE, J. 1998. Norway rat exclusion in Alberta. Proc. Vertebr. Pest Conf. 18:242-246.

BURBIDGE, A., and K. MORRIS. 2002. Introduced mammal eradications for nature conservation on Western Australian islands: a review. Pp. 64-70 *in*: C. Veitch and M. Clout (Eds.), Turning the Tide: The Eradication of Invasive Species. SSC Invasive Species Specialist Group, IUCN, Gland, Switzerland.

HOPKINS, A. S., J. WHITETAIL-EAGLE, A. L. CORNELI, B. PERSON, P. J. ETTESTAD, M. DIMENNA, J. NORSTOG, J. CRESWELL, A. S. KHAN, J. G. OLSON, K. F. CAVALLARO, R. T. BRYAN, J. E. CHEEK, B. BEGAY, G. A. HODDENBACH, T. G. KSIAZEK, and J. N. MILLS. 2002. Experimental evaluation of rodent exclusion methods to reduce hantavirus transmission to residents in a Native American community in New Mexico. Vector Borne and Zoonot. Dis. 2:61-68.

HYGNSTROM, S. 1995. House mouse damage to insulation. Int. Biodeter. Biodegrad. 36:143-150.

LONG, J. 2003. Introduced Mammals of the World. CSIRO Publishing, Collingwood, Victoria, Australia.

MOORS, P. J., and I. A. E. ATKINSON. 1984. Predation on seabirds by introduced animals, and factors affecting its severity. ICBP Technical Publication No. 2:667-690.

TIMM, R. M. 1994a. Norway rats. Pp. B105-B120 *in*: S. E. Hygnstrom, R. M. Timm, and G. E. Larson (Eds.), Prevention and Control of Wildlife Damage. Cooperative Extension Service, University of Nebraska, Lincoln, NE.

TIMM, R. M. 1994b. House mice. Pp. B31-B46 *in*: S. E. Hygnstrom, R. M. Timm, and G. E. Larson (Eds.), Prevention and Control of Wildlife Damage. Cooperative Extension Service, University of Nebraska, Lincoln, NE.

WITMER, G., F. BOYD, and Z. HILLIS-STARR. 2007. The successful eradication of introduced roof rats from Buck Island using diphacinone, followed by an irruption of house mice. Wildl. Res. 34:108-115.

WITMER, G., P. BURKE, and S. JOJOLA. 2006. The biology of introduced Norway rats on Kiska Island, Alaska, and an evaluation of an eradication approach. Northwest Sci. 80:191-198.

WITMER, G., M. W. FALL, and L. A. FIEDLER. 1995. Rodent control, research, and technology transfer. Pp. 693-697 *in*: J. Bissonette and P. Krausman (Eds.), Integrating People and Wildlife for a Sustainable Future. Proc. First Int. Wildl. Manage. Congress. The Wildlife Society, Bethesda, MD.

WITMER, G., and J. FANTINATO. 2003. Management of rodents at airports. Proc. Wildl. Damage Manage. Conf. 10:350-358.

WITMER, G., and S. JOJOLA. 2006. What's up with house mice? – A review. Proc. Vertebr. Pest Conf. 22:124-130.