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Application of Burrow Cameras in Wildlife Damage Research

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Abstract: Many fossorial species of wildlife cause damage in a variety of land-use settings. Research of these species is challenging because of the complications associated with working underground. Traditional methods of conducting research on fossorial rodents in their natural environments are expensive, labor intensive, and invasive on the landscape. More innovative and effective methods of doing research underground are needed. We evaluated a burrow-probe camera for viewing inside the burrows of California ground squirrels (*Spermophilus beecheyi*) as part of an anticoagulant baiting study. It was useful for locating carcasses as well as for collecting information on live squirrels and non-target species. We also used burrow cameras to aid in on-going studies of black-tailed prairie dogs (*Cynomys ludovicianus*) and evaluated their utility in the burrows and dens of other mammals along the front range of Colorado. We will discuss our evaluations of burrow cameras and applications for their use in wildlife damage research.

Key Words: rodent burrow, camera, rodent, rodenticide, wildlife damage management, California ground squirrel, *Spermophilus beecheyi*

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INTRODUCTION

Many species of wildlife that damage natural and agricultural resources spend time underground; this poses unique challenges to researchers studying these species and evaluating methods of managing them. Research to evaluate the impacts of rodenticides often requires evaluating bait efficacy and retrieving poisoned rodent carcasses for chemical analyses. It is also important to determine if poisoned rodents die close enough to burrow entrances to be available to various species of scavengers. The majority of poisoned rodents die in their burrow systems, and radio-telemetry techniques are commonly used to position the researcher directly above the underground transmitter (Witmer and Pipas 1999). Researchers then excavate, by hand or with the aid of a backhoe, the transmitter and carcass (Hegdal and Colvin 1986). Although this method has been the traditional approach, the equipment (i.e., radiotransmitters, excavating machinery) is very costly, labor intensive, and destructive to the landscape. Researchers evaluating toxicants need more innovative and effective methods to locate and retrieve poisoned hypogeal rodents. Further, researchers studying the biology and ecology of animals that spend time underground need non-invasive methods of viewing the contents and structure of underground burrows and dens, to learn more about their inhabitants.

To address these needs, we collected quantitative, qualitative, and descriptive data using a burrow-probe camera system designed for viewing the interiors of burrows. Our report presents 2 evaluations of the burrow-probe camera system. The first evaluation was conducted adjunct to a research effort being funded by the California Department of Food and Agriculture (CDFA) and coordinated by Dr. T. P. Salmon, University of California, Davis, California. The goal of the CDFA study was to evaluate the efficacy of anticoagulant baits for controlling California ground squirrels (*Spermophilus beecheyi*). The objective of our portion of the study was to quantitatively and qualitatively evaluate the burrow camera for locating the carcasses of affected squirrels. The objective of our second evaluation was to describe the utility of the burrow camera in the burrows of prairie dogs and burrows and dens of other species. The purpose being to more fully assess its functionality, versatility, and limitations.

METHODS

Evaluation 1 was conducted on a private ranch in south-central California that had a high-density population of California ground squirrels. Evaluation 2 was conducted along the front range of the Rocky Mountains, near Fort Collins, Colorado.

The burrow-probe camera we used was the Peep-A-Roo Video Probe (Sandpiper Technologies, Inc., Manteca, California). The camera consisted of a 3.7-mm focal-length lens with 537 horizontal and 505 vertical lines of resolution (Christensen 2000). Six infrared light emitting diodes (LEDs) provided a minimum of 4 lux illumination. The camera and LEDs were encased in a hard-plastic head. The head was connected to a 3 m-long bi-wound stainless steel flex-tube jacketed in rubber. The camera operator wore video-display glasses to view real-time images transmitted by the camera. We recorded desired video footage with a compact video camera. A 12-volt gel-cell battery, mounted on an adjustable waist belt, powered the system.

For Evaluation 1, we viewed active burrows and retrieved carcasses for 5 consecutive days, beginning 2 days after the area was baited. We attempted to view each burrow to a maximum of 2 m. As a means of measuring the efficiency of our methods, we documented the time required to probe each burrow, from time of insertion of the camera head into the burrow until we reached the maximum attainable depth. We recorded the presence or absence of carcasses for each burrow and the depth below ground at which they were found. We retrieved all carcasses located within 1 m of a burrow entrance and made reasonable efforts to retrieve carcasses up to 2 m deep. A hook rod was used to extract carcasses, with occasional supplemental excavation required with a shovel and a digging bar. Each carcass we retrieved was frozen for later chemical analysis.

While probing, we occasionally encountered live animals (squirrels and other species). We recorded the same information for live animals as for dead ones. In addition, we recorded descriptive behavioral notes (e.g., apparent health, reaction to the probe).

For Evaluation 2, we evaluated descriptively the utility of the burrow camera for viewing the burrows of black-tailed prairie dogs (*Cynomys ludovicianus*), voles (*Microtus* spp.), and coyotes (*Canis latrans*). We probed active and inactive burrows.

RESULTS AND DISCUSSION

For Evaluation 1, we probed 654 California ground squirrel burrows. Squirrel burrows had a diameter of about 9 cm. Average depth probed to was 1.4 m (SE = 0.02, $n = 654$) and we were able to probe to $\geq$1 m 84% of the time. Mean time to probe a burrow was 46.1 sec (SE = 1.41, $n = 654$) and the mean time to probe 50 active burrows was 2 hrs 24 min (SE = 17, $n = 11$).

We viewed 31 dead, 9 dying, and 5 apparently healthy squirrels in the burrows. Signs exhibited by dying squirrels included labored respiration, drowsiness, and general lethargy (affected individuals could be touched with the camera head without exhibiting a reaction). The mean number of squirrels (alive and dead) viewed per burrow was 0.07 (SE = 0.01). The average depth at which we found dead squirrels was 1.0 m (SE = 0.08, $n = 31$). Twenty-three (74%) of the dead squirrels were retrieved, 18 with the hook and 5 by hand. Some excavation with a shovel and digging bar was required to reach 7 of the carcasses. Other species seen while probing included western diamondback rattlesnake (*Crotalus atrox*, $n = 3$), gopher snake (*Pituophis* spp., $n = 1$), burrowing owl chicks (1 clutch of unknown size), and side-blotched lizards (*Uta stansburiana*, $n = 3$).

The burrow camera worked well to locate carcasses of poisoned California ground squirrels that were shallow enough to be available to aboveground scavengers. Studies on rodenticide assessment could be optimized by combining burrow cameras with traditional telemetry methods. There were 3 merits of using the burrow camera for locating carcasses. First, we were able to collect information on rodent presence or absence in burrows and depth belowground (up to 3 m). Second, we could obtain information on the behaviors of poisoned rodents in their burrows, although we were probably less likely to observe healthy squirrels because the probe may have frightened them deeper into their burrows. Third, we viewed and retrieved the carcasses of other species encountered in burrows; this type of information could provide valuable data on mortality of non-target species and on secondary hazards of rodenticide baiting programs.

For Evaluation 2, the diameter of vole burrows (4 cm) approached the minimum size for the camera to fit and maneuver in. We could not insert the camera deeper than about 0.1 m into vole burrows. The diameter of black-tailed prairie dog burrows was approximately 11 cm and the system worked well in these burrows. Mean probing depth of prairie dog burrows was 2.08 m (SE = 0.17, $n = 35$), with a mean search time of 3 min 42 sec (SE = 15.5). No prairie dogs were seen and since Evaluation 2 took place during the winter, we assumed prairie dogs were deeper in their burrow systems than we could reach with the burrow camera. We detected two live mountain cottontail rabbits (*Sylvilagus nuttallii*) in separate prairie dog burrows, one at 0.96 m and the other at 1.31 m. Neither rabbit reacted when nudged by the camera head. Coyote den openings were approximately 30 cm in diameter and easy to probe deeply. However, it was difficult to manipulate the camera head in to see den contents very well.

The diameter, geometry, and configuration of each burrow dictated probing depth. The burrow camera worked best in burrows the diameter of those belonging to ground squirrels and prairie dogs. Up to approximately the dimensions of a prairie dog burrow, the camera was able to present a full cross-sectional image of the burrow with slight lateral manipulation of the camera head. In burrows of larger size, the camera presented a partial cross-sectional view, the extent depending on the diameter of the burrow. These limitations could be addressed to a point by manipulating the camera head laterally within the confines of the burrow and advancing the camera more slowly. The amount of debris (loose soil, soil clods, rocks, and vegetation) on the burrow floors was also a key determinant of the utility of the burrow camera. In cases where the burrow floor had loose soil, the camera head would hang up; oftentimes, by slowly withdrawing the camera, the operator was able to view the burrow again. In general, the deeper we probed burrows, the greater were the limitations of the system. It was difficult to maneuver the camera around sharp turns and up steep grades. When a burrow system forked, we could sometimes direct the camera into a selected branch, but more often, the camera followed the main, or lower, branch. The burrow camera could be improved if the operator had more control of the camera head and if it were possible to penetrate deeper into burrows.

Time required to probe a given burrow was in large part due to the physical characteristics of the burrow. The probing experience of the operator was also an important determinant of probing times. Once familiar with the procedure of manipulating the flex tube and camera head to circumvent negotiable obstructions, the operator could reduce probing time substantially and increase the depth probed to.

A feature of the burrow camera system is that a compact video camera could be used to collect video footage. Video could then be watched at a later date under better viewing conditions. On 2 instances while viewing recorded video we noted dead squirrels, both in the presence of rattlesnakes, that we did not notice in the field while viewing the burrows in real-time. We also found video footage to be very valuable when determining the species of invertebrates, amphibians, and reptiles we were unfamiliar with.

Burrow cameras have applications to other aspects of wildlife damage research as well as other branches of biological and ecological research. For example, they could be used to complement aboveground carcass searches and activity indices. They could also be used to describe the structure and form of the burrows and dens of mammals that until now have been examined primarily through excavation. The burrow camera permits the exploration of burrows and dens without destroying or otherwise physically altering them. Because the behavior of organisms we viewed in the burrows (including insects) did not appear to be impacted greatly by the presence of the camera, perhaps because the light source was infrared, the system may prove valuable for studying fossorial behavior and species interactions. More work is needed to fully realize the utility of burrow cameras across the range of species that inhabit underground burrows and dens. Burrow cameras also have potential to be used to examine other natural and animal-made dwellings, like hollow trees and beaver lodges.

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