Use of a Dorsal Radio-Transmitter Implant in American Badgers, *Taxidea taxus*

GILBERT PROULX and NEIL MACKENZIE

Alpha Wildlife Research & Management Ltd., 229 Lilac Terrace, Sherwood Park, Alberta T8H 1W3 Canada

Proulx, Gilbert, and Neil MacKenzie. 2012. Use of a dorsal radio-transmitter implant in American Badgers, *Taxidea taxus.* Canadian Field-Naturalist 126(3): 221–225.

We investigated the use of a dorsally implanted radio-transmitter in four American Badgers (*Taxidea taxus*) in southwestern Saskatchewan. The dorsal radio-transmitter did not appear to affect the health or behaviour of the animals. When the antenna was stretched out subcutaneously along the animal's back, the signal could be received from about 1 km away when the animal was above ground and from 750 m away when it was in the den. The dorsal implantation of radio-transmitters is a promising technique for the study of the movements of American Badgers.

Key Words: American Badger, *Taxidea taxus*, dorsal radio-transmitter implant, radio-telemetry, Saskatchewan.

Externally mounted radio-transmitters have commonly been used in the study of American Badgers (*Taxidea taxus*) but, because these animals have loose skin, a wide neck circumference relative to their head, and a burrowing lifestyle, the radio-transmitters have a tendency to get entangled and American Badgers shed the collars or harnesses (Messick and Hornocker 1981; Collins 2003). Abdominal (intraperitoneal) radio-transmitter implants may be used (Goodrich and Buskirk 1998; Apps et al. 2002), but health risks (e.g., omental adhesions, infections) have been reported in European Badgers (*Meles meles*) (Ågren et al. 2000), American Badgers (Quinn et al. 2010), and other mustelids (Eagle et al. 1984; Copeland 1996; Zschille et al. 2008).

Study Area and Methods

We investigated the use of a dorsal radio-transmitter implant in American Badgers (*Taxidea taxus*) near Hazenmore (49°41'N, 107°08'W), in southwestern Saskatchewan. Our study area was located within the Brown soil zone characterized by warm temperatures, lack of moisture, and lack of organic matter. It encompassed mixed grasslands of Crested Wheatgrass (*Agropyron cristatum*), brome (*Bromus* spp.), Slender Wheatgrass (*Elymus trachycaulus*), alfalfa (*Medicago* spp.), and annual crops such as Wheat (*Triticum aestivum*) and Barley (*Hordeum vulgare*).

We used a snare pole to capture two orphaned male American Badgers approximately 10 weeks old (their mother had been road-killed) in June 2008 on a dirt road. Their maternal den was located in a nearby ditch bordering a pasture with various grasses. The den was approximately 1.5 km from the pasture where the young American Badgers with radio-transmitter implants would be released. We also captured with a snare pole one adult male in May 2010 on a dirt road adjacent to a Wheat field and a pasture dominated by Crested Wheatgrass where the American Badger hunted for Richardson's Ground Squirrels (*Urocitellus richardsonii*). We released the adult male with radio-transmitter implant at the capture site, at the edge of the Wheat field. We captured an adult female in a 36 × 36 × 92 cm wire mesh trap (model HD X-large, Duke Traps, West Point, Mississippi) in September 2008. The trap was set in a rock pile at the edge of a pasture with Crested Wheatgrass, brome, and buckbrush (*Ceanothus* spp.) where she hunted for Richardson's Ground Squirrels. We released the female American Badger with radio-transmitter implant beside the rock pile.

We transported the adult female in the wire mesh trap, and transferred the orphaned and the adult male American Badgers in a carrying cage, and anaesthetized them in a veterinary clinic with isoflurane. After an area 15 × 15 cm between the shoulder blades had been shaved and washed with antiseptic, the skin was peeled back from an incision 7 cm long (Figure 1).

With the young American Badgers and the adult female, we undermined the skin in an area sufficiently large to allow the introduction of a 25-g radio-transmitter with mortality mode, coiled whip antenna, and three-year battery life (model AI-2M, Holohil Systems Ltd., Carp, Ontario) (Figure 1). The 4.5 × 1.5 cm housing of the transmitter was a hermetically sealed brass cylinder. With the adult male, we lifted and freed the skin along the back to stretch out the 29-cm-long whip antenna subcutaneously to improve the distance of signal transmission. The incision was sutured, glued, and cleaned with hydrogen peroxide. The animals were injected with a non-steroidal anti-inflammatory drug and a dose of the antibiotic Tribissen 24% (Merck Animal Health, Kirkland, Quebec).

We monitored the American Badgers with a portable receiver (model TRX-2000S, Wildlife Materials Inc., Carbondale, Illinois) and a four-element Yagi antenna. We monitored the location of the young American Badgers daily, in the morning and at dusk, from 9 to 12 July 2008 at a distance of 300–500 m, which allowed us to observe the animals with binoculars. We

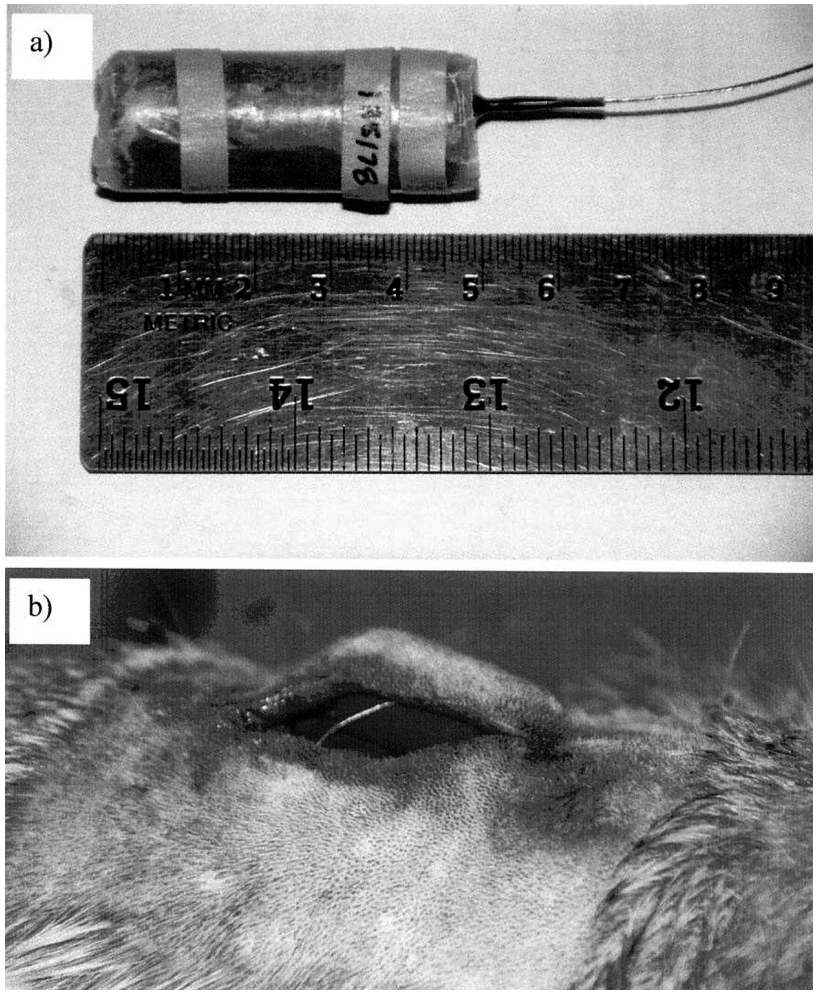

FIGURE 1. Radio-transmitter (a) implanted between the shoulder blades of an American Badger (*Taxus taxidea*) (b). Photo: G. Proulx

monitored the adult female's movements during 16 nights from September 29 to November 28 2008 (she was not active afterwards, when temperatures dropped to −20°C) and during irregular night visits from 2 May to 5 July 2009. Although she was present in her usual hunting grounds in 2010, we could not monitor her movements due to poor access caused by flooding. We monitored the adult male at night from 17 to 23 May and from 11 to 23 June 2010. We did not recapture the adult badgers to retrieve the radio-transmitters at the end of the study in July 2010.

In order to determine how far a radio signal could be received, we tried to locate the adult American Badgers at least 1 km away from the hunting grounds, where we observed them with a 400 000 candle power search light (Golight Inc., Culbertson, Nebraska). When we did not find the animals, we drove slowly towards the hunting grounds until we received a radio signal. Sometimes, the animals were first detected with the search light, and we then confirmed their identity with the radio signal. When no radio signals were received, we drove near the edge of the hunting grounds or we walked through them to pinpoint the burrows where the animals were.

We considered that the American Badgers in their burrow system were close to the surface when we could hear them hissing or when the radio signal was very strong near the burrow entrance. We considered that the animals were deep below the surface when the radio signal was weak even when the antenna was placed near the burrow entrance. In a few instances, when the signal was weak, we used a push cable (snake type)

FIGURE 2. Young male American Badger (*Taxus taxidea*) at time of release, 9 July 2008. Photo: G. Proulx

video camera (model SWJ-3188D, Shenzhen FXT Technology Development Co., Shenzhen, China) to estimate how far below the surface the American Badgers were.

Results

Young male American Badgers

We captured the young American Badgers on 23 June 2008. The same day, one transmitter was implanted in one (1.7 kg) of the American Badgers. We kept both animals in a 4 × 4 m enclosure, and we observed their behavior with a remote video-camera until 6 July. During this observation period, the young male with the dorsally implanted radio-transmitter showed no sign of infection or discomfort. He never tried to scratch or rub the implant site, and his daily activities, movements, and feeding habits were identical to those of his sibling without an implant. Both animals were playful, fought over food, and dug holes within the enclosure.

Each young male American Badger ate approximately 300 g, i.e., 1.5 Richardson's Ground Squirrel carcasses, per day. In one instance, the young male with the implant gave chase to a Richardson's Ground Squirrel that had made its way inside the enclosure. He killed the Richardson's Ground Squirrel after capturing it by the upper thorax, as reported by Michener and Iwaniuk (2001), and proceeded to eat it.

Since the behaviour of the young male with the radio-transmitter implant appeared to be unaffected by the implant during the post-surgical recovery period, the second young male (3.1 kg) was equipped with a radio-transmitter implant on 6 July 2008 and was kept in the enclosure to recover for three days after the surgery. At the time of release on 9 July 2008, both young American Badgers had doubled in size, the radio-transmitters were still at their implantation sites (i.e., they had not moved sideways), and both animals were of similar size.

We released the two young male American Badgers in a pasture approximately 300 m from an apparently abandoned American Badger burrow system. We chose this pasture because it was not subjected to Richardson's Ground Squirrel poisoning, which was common throughout southwestern Saskatchewan (Proulx and MacKenzie 2012). We also believed that no other American Badgers inhabited the pasture. However, on 29 September 2008, we captured an adult female 500 m from the apparently abandoned burrow. We surgically implanted a radio-transmitter in this female and found that she used a den less than 100 m from the abandoned burrow.

The young male American Badgers adopted the abandoned burrow system. They investigated their surroundings and fed on Richardson's Ground Squirrels. They were active all day, and at night they stayed in their burrow. We saw them for the last time on 12 July 2008, in the evening, prior to a thunderstorm with strong winds and heavy rain that saturated the grounds. We were not able to access the study area until 14 July, and we were not successful in finding the American Badgers. The following week, we searched for them daily, and thereafter on a weekly basis. On 25 September 2008, we found the remnants of a skin approximately 300 m from the young American Badgers' burrow. The skin was punctured in the thoracic region, and the site of the implant was obvious. However, the radio-transmitter was missing. We searched the pasture

and surrounding crops for signs of the other young American Badger but found no signs and received no radio-telemetry signal. On 30 September, we found a large regurgitation pellet with American Badger hairs approximately 500 m from the young American Badgers' burrow.

Adult American Badgers

We surgically implanted a radio-transmitter in the adult female American Badger on 29 September 2008 and released her approximately 6 hours after the surgery. We surgically implanted a radio-transmitter in the adult male on 17 May 2010 and released him a few hours later. They entered a nearby burrow system upon release, but we observed them digging out Richardson's Ground Squirrel burrow systems the same night. Thereafter, we located them in their usual hunting grounds.

Radio signal

Usually, the signal from the transmitters with the coiled antennas was received from ≤250 m away when the American Badgers were active above ground and from ≤85 m away when they were 1 m deep in their den. In one case, when the adult female was near the surface in a burrow system in a summer fallow, the signal was received from approximately 750 m away. Usually, the deeper the location of an animal in a burrow system, the weaker the signal. Also, when American Badgers were >2 m below the surface, the signal was received only when the antenna was nearby the occupied burrow.

The signal of the adult male's transmitter (with the antenna stretched out subcutaneously along the back) was received approximately 1 km away when he was above ground and from 750 m away when he was in the den (≤1.5 m underground). When the American Badger was >1.5 m underground, if the tunnel went straight down, we had to aim the antenna directly over the den entrance in order to receive a signal.

Discussion

Biggins et al. (2006) reported using intraperitoneal and subcutaneous implants in American Badgers in 1984. They found that dorsally implanted subcutaneous units with implanted whip antennas 15.2 cm in length radiated more powerful signals than intraperitoneal units in the same animals, but abscesses that developed around the subcutaneous transmitters resulted in their premature loss. Echols et al. (2004) documented an overall implant surgery failure of 64% and a mean retention time of 101 days in American Black Bear (*Ursus americanus*) cubs with transmitters implanted between the base of the neck and the space between the shoulder blades. Although they could not explain all the circumstances under which implants came out of the cubs, it appears that body rejection and maternal and sibling intervention were important factors.

In the current study, on the basis of a very small sample size, we conclude that dorsal subcutaneous implants do not have an apparent effect on the health or behaviour of American Badgers. However, this study warrants further investigation with larger samples over long time periods to assess the transmitter housing, its wear or damage, and the long-term side effects on study animals that carry these implants throughout their lifespan (Thompson et al. 2012).

Subcutaneous and intraperitoneal implants have a relatively poor reception range compared with radio-collars (e.g., Green et al. 1985; Koehler et al. 2001) because the antennas are shorter (Korschgen et al. 1996) and the signal is absorbed by the body tissue (Kenward 1987; Biggins et al. 2006). The reduced signal is further attenuated by the animal's position in the burrow and terrain features nearby (Philo et al. 1981).

In this study, stretching the antenna subcutaneously along the animal's back allowed us to receive radio signals from a distance of 1 km when the animal was on the surface and from a distance of 750 m when it was underground. These distances are similar to or greater than those reported by other researchers for implants. The radio signal of subcutaneous transmitters implanted in the neck of Grizzly Bears (*Ursus arctos*) could be adequately received from an aircraft at a distance of 1.5 km, and the signal of subcutaneous abdominal transmitters implanted in Grizzly Bears could be received from 0.4–0.8 km away (Philo et al. 1981). Green et al. (1985) received signals transmitted from an abdominal implant 75–100 m away from Kit Foxes (*Vulpes macrotis*) in dens (1–2 m underground) and ≥200 m from Kit Foxes outside dens. In grasslands, Hunter (1998) received signals ≤850 m from a Lion (*Panthera leo*) with an abdominal transmitter implant.

While implants may not be suitable for locating far-ranging animals (Hunter 1998; Koehler et al. 2001), we found that the dorsally implanted radio-transmitters used in this study would be suitable for investigating questions related to American Badger habitat use (particularly at a fine scale), hunting grounds, and den utilization.

Acknowledgements

Advancing Canadian Agriculture & Agri-Food in Saskatchewan (as a Collective Outcome Project with Advancing Canadian Agriculture and Agri-Food in Alberta), Saskatchewan Agriculture Development Fund, and Saskatchewan Association of Rural Municipalities provided funding for this work. We thank Dr. Bonnie Brandt from the Animal Hospital of Assiniboia for implanting the transmitters and Keith MacKenzie for technical support. We are grateful to Pauline Feldstein, Thomas Jung, and Carolyn Callaghan for their comments on an earlier version of this manuscript.

Literature Cited

Ågren, E. O., L. Nordenberg, and **T. Mörner.** 2000. Surgical implantation of radio-telemetry transmitters in European badgers (*Meles meles*). Journal of Zoo and Wildlife Medicine 31: 52–55.

Apps, C. D., N. J. Newhouse, and **T. A. Kinley.** 2002. Habitat associations of American badgers in southeastern British Columbia. Canadian Journal of Zoology 80: 1228–1239.

Biggins, D. E., J. L. Godbey, B. J. Miller, and **L. R. Hanebury.** 2006. Radio telemetry for black-footed ferret research and monitoring. Pages 175–190 *in* Recovery of the Black-footed Ferret: Progress and Continuing Challenges — Proceedings of the Symposium on the Status of the Black-footed Ferret and its Habitat, Fort Collins, Colorado, January 28-29, 2004. *Edited by* J. E. Rolle, B. J. Miller, J. L. Godbey, and D. E. Biggins. U.S. Geological Survey, Fort Collins, Colorado. Scientific Investigations Report 2005-5293.

Collins, D. P. 2003. Badger ecology on the Chapparal Wildlife Management Area, Texas. M.Sc. thesis, Stephen F. Austin State University, Nacogdoches, Texas.

Copeland, J. P. 1996. Biology of the wolverine in central Idaho. M.Sc. thesis, University of Idaho, Moscow, Idaho.

Eagle, E. C., J. Choromanski-Norris, and **V. B. Kuechle.** 1984. Implanting radio transmitters in mink and Franklin's ground squirrels. Wildlife Society Bulletin 12: 180–184.

Echols, K. N., M. R. Vaughan, and **H. D. Moll.** 2004. Evaluation of subcutaneous implants for monitoring American black bear cub survival. Ursus 15: 172–180.

Goodrich, J. M., and **S. W. Buskirk.** 1998. Spacing and ecology of North American badgers (*Taxidea taxus*) in a prairie-dog (*Cyonomys leucurus*) complex. Journal of Mammalogy 79: 171–179.

Green, J. S., R. T. Golightly, S. L. Lindsey, and **B. R. Leamaster.** 1985. Use of radio transmitter implants in wild canids. Great Basin Naturalist 45: 567–570.

Hunter, L. T. B. 1998. The behavioural ecology of reintroduced lions and cheetahs in the Phinda Resource Reserve, Kwazulu-Natal, South Africa. Ph.D. thesis, University of Pretoria, Pretoria, South Africa.

Kenward, R. 1987. Wildlife Radio Tagging: Equipment, Field Techniques and Data Analysis. Academic Press, London, U.K.

Koehler, G. M., P. Briggs Hall, M. H. Norton, and **J. J. Pierce.** 2001. Implant- versus collar-transmitter use on black bears. Wildlife Society Bulletin 29: 600–605.

Korschgen, C. E., K. P. Kenow, A. Gendron-Fitzpatrick, W. L. Green, and **J. Dein.** 1996. Implanting intra-abdominal radiotransmitters with external whip antennas in ducks. Journal of Wildlife Management 60: 132–137.

Messick, J. P., and **M. G. Hornocker.** 1981. Ecology of the badger in southwestern Idaho. Wildlife Monograph 76: 1–53.

Michener, G. R., and **A. N. Iwaniuk.** 2001. Killing technique of North American badgers preying on Richardson's ground squirrels. Canadian Journal of Zoology 79: 2109–2113.

Philo, L. M., E. H. Follmann, and **H. V. Reynolds.** 1981. Field surgical techniques for implanting temperature-sensitive radio transmitters in grizzly bears. Journal of Wildlife Management 45: 772–775.

Proulx, G., and **N. MacKenzie.** 2012. Relative abundance of American badger (*Taxidea taxus*) and red fox (*Vulpes vulpes*) in two landscapes with high and low rodenticide poisoning levels. Integrative Zoology 7: 41–47.

Quinn, J. H., **P. M. Gaffney, M. Murray, D. A. Jessup,** and **C. K. Johnson.** 2010. Complication associated with abdominal surgical implantation of a radio transmitter in an American badger (*Taxidea taxus*). Journal of Zoo and Wildlife Medicine 41: 174–177.

Thompson, C. M., R. A. Green, J. Sauder, K. L. Purcell, R. A. Sweitzer, and **J. M. Arnemo.** 2012. The use of radiotelemetry in research on *Martes* species: techniques and technologies. Pages 284–319 *in* Biology and Conservation of Martens, Sables, and Fishers: A New Synthesis. *Edited by* K. Aubry, B. Zielinski, M. Raphael, G. Proulx, and S. Buskirk. Cornell University Press, Ithaca, New York.

Zschille, J., N. Stier, and **M. Roth.** 2008. Radio tagging American mink (*Mustela vison*)—experience with collar and intraperitoneal-implanted transmitters. European Journal of Wildlife Research 54: 263–268.

Received 8 November 2011
Accepted 3 October 2012