TRANSPONDERS AS PERMANENT IDENTIFICATION MARKERS FOR DOMESTIC FERRETS, BLACK-FOOTED FERRETS, AND OTHER WILDLIFE

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Abstract: A 0.05-g transponder implanted subcutaneously was tested to see if it provided a reliable identification method. In laboratory tests 20 domestic ferrets (*Mustela putorius furo*) received transponders and were monitored for a minimum of 6 months. None showed signs of inflammation, and necropsies conducted at the end of the study showed no scar tissue or transponder migration. Seven of 23 transponders failed during the test because of leakage through the plastic case, and a glass case is now being manufactured that does not have the leakage problem. During mark-recapture studies in September and October 1985, transponders were implanted in 20 black-footed ferrets (*M. nigripes*), 11 of which were subsequently recaptured and 9 of which were brought into captivity; none showed signs of inflammation. Transponders provide a reliable new method for identifying hard-to-mark wildlife with a unique, permanent number that can be read with the animal in-hand or by remote equipment.

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Finding permanent, individually-identifiable markers for small mammals has generally been difficult. Biologists have used metal fingerling ear tags, ear tattoos, and toeclipping to individually mark animals. These methods have often proven unsatisfactory; some individuals lose the ear tags within a few days or weeks and the majority of ear tattoos are not permanent or, if permanent, are not recognizable as a unique number or letter (Fagerstone et al., Pages 10.1–10.10 *in* Proc. Black-footed Ferret Workshop, Univ. Wyoming, 1985). Toeclipping may cause infection or loss of limb function. A more reliable method of identifying individuals is needed for long-term population studies. This study evaluated the effectiveness of subcutaneously implanted transponders as permanent marking devices for domestic ferrets in the laboratory and for wild black-footed ferrets. The transponder is a polypropylene-encased microchip that is preprogrammed during its manufacture with a unique 10-digit identifying code.

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METHODS

Laboratory Tests

Before use of transponders in black-footed ferrets, we tested transponders in 20 domestic ferrets (11 females and 9 males) that were 6 months old at the beginning of the study. Animals were held in groups of 2–6, separated by sex, in stock tanks in a metal building equipped with a thermostatically controlled evaporative air conditioner, forced-air space heater, and exhaust fan. Temperatures within the building were allowed to vary between 13 and 29 C to correspond with ambient diurnal and seasonal changes. Lighting was provided by overhead incandescent bulbs controlled by a clock, and the light-dark cycle was changed every 2 weeks to correspond to natural sunlight. Food and water were available ad libitum. Wood chips were placed in the bottom of each stock tank for bedding and tanks were cleaned daily.

Transponders were obtained from Identifi-

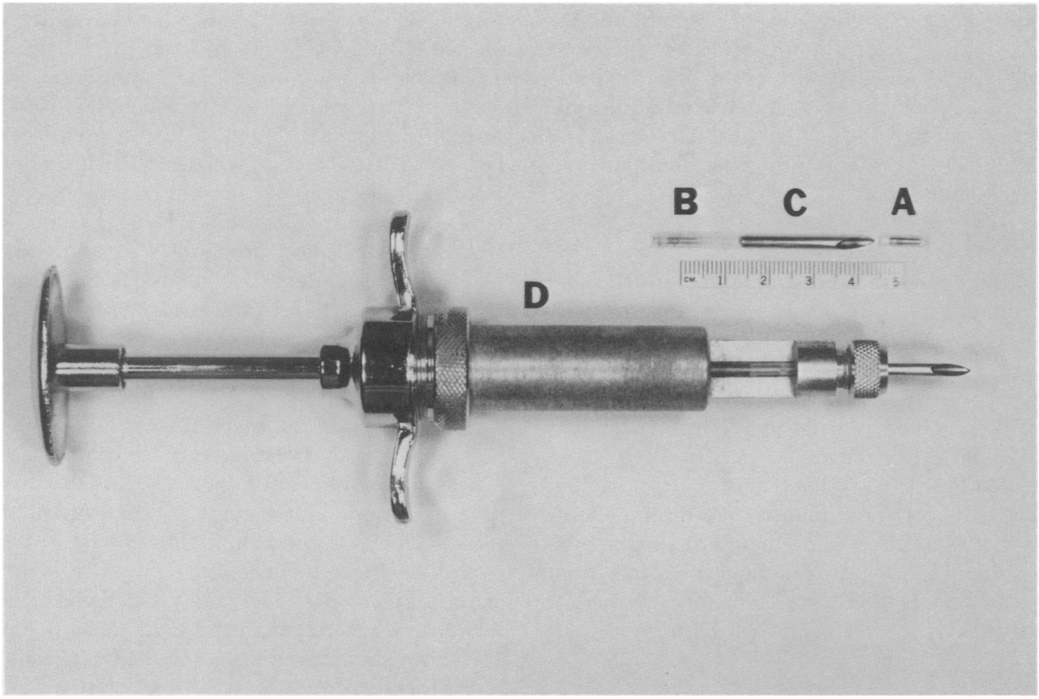

Fig. 1. An implantable transponder (A) was used to provide individual identification of ferrets. The transponder was packaged with sterile solution in a sleeve (B) and implanted using a 12-gauge needle (C) attached to a metal syringe implanter (D).

cation Devices, Inc. (Westminster, Colo.). The rod-shaped transponder measured 2 mm in diameter by 10 mm in length and weighed 0.05 g (Fig. 1). The transponder had no power source of its own and lay dormant until activated by an electromagnetic signal to transmit its identifying code number. The transponder code was read by a Handwand/Reader (Model HS 0011, ID Devices, Inc.). The Handwand generated a low-frequency electromagnetic signal that energized the transponder to activate code transmission. Once transmitted, the signal was received by the Handwand and sent to the attached Reader, which decoded and displayed the signal as a series of letters and digits.

Transponders were implanted with a Model VI 0009 implanter (ID Devices, Inc.), a metal syringe with a removable 12-gauge needle through which the transponder passes (Fig. 1). The syringe, needles, and transponders were sterilized with Nolvasan Solution® (Fort Dodge Lab., Fort Dodge, Iowa) before use. Transponders were implanted beneath the skin on the cranium, medial to the ear. This location was chosen for 3 reasons: (1) the animals could not bite at the transponders; (2) the skin of the neck and head was loose, allowing easy insertion of the transponder in the fascia between skin and muscle; and (3) blood vessels and nerves were not prevalent. Animals were anesthetized by intramuscular injection of 18 mg/kg of ketamine hydrochloride in a hind leg before implanting the transponder. The implant injection site was cleaned with a 1:750 tincture of benzalkonium chloride to minimize infection. No sutures were required.

We implanted the 1st transponders on 25 March 1985 and the last on 23 May 1985. Domestic ferrets were checked visually every day. Each week, we visually and tactually inspected the transponder site for outward signs of infection and read and recorded the transponder number. During the weekly inspection, we weighed each ferret using a top-loading electronic balance, anally measured body temperatures, and recorded the reproductive status. During the 1st months of the study, ferrets were in breeding condition and fighting among the males was common. Therefore, we recorded the location and severity of wounds, and in several cases, isolated ferrets for a few days. Because female domestic ferrets lose weight and be-

come anemic if they are not bred, 100 units of chorionic gonadotropin were administered to all females on 6 June to stop estrus. Animals were held and examined for a minimum of 6 months. They were killed and necropsies were conducted by a consulting veterinarian on 10 December 1985.

Field Test

Transponders were implanted in 17 black-footed ferrets captured near Meeteetse, Wyoming, from 10 to 13 September 1985 and in 3 additional ferrets from 4 to 6 October 1985. Ferrets were anesthetized with a 200:1 solution of ketamine hydrochloride and diazepam (Thorne et al., Pages 9.1–9.8 *in* Proc. Black-footed Ferret Workshop, Univ. Wyoming, 1985) at 14 mg/kg. Transponders were implanted in the same location using the methods developed on domestic ferrets. For field use the 110-volt wand and reader were connected through an inverter to a portable 12-volt battery.

RESULTS

Laboratory Tests

Twenty-three transponders were implanted in 20 domestic ferrets (1 animal received 2 transponders, and 2 transponders that failed 8 and 14 days after implantation were excised and replaced). Of these, 7 failed or gave intermittent readings. One transponder failed on 31 October and 1 on 21 November (220 and 238 days after implantation). Two transponders gave intermittent readings during July and August for 22 and 43 days, then were easily read for the duration of the study. One transponder became intermittent on 3 September and remained so until 5 November (225 days after implantation), at which time it failed.

Two females died but neither death was associated with the transponder. One died 18 days after the transponder was implanted and necropsy revealed hepatitis. The 2nd died of a lymphocytic leukemia 136 days after the transponder was implanted. In both cases necropsy showed no significant cellular response to the transponder, which lay under the skin in the fascia. Transponders in the remaining 18 ferrets were in place for 201–260 days ($\bar{x} = 225.5$ days). At necropsy, the transponders were encapsulated in fibrous connective tissue and no migration was noted. From June through mid-August, male ferrets showed considerable scarring from bite wounds. Most scarring occurred on the shoulders, neck, and top of the head. Transponders were unaffected by the bites.

After implantation of transponders, body weight changes of domestic ferrets were well below the 30–40% body weight fluctuations that frequently occur under normal conditions (Ryland et al., Comp. Continuing Educ. Practicing Vet. 5:25, 1983) and probably were unrelated to the transponders. No body temperature change associated with insertion or presence of transponders was detected.

Field Test

Eleven of the 20 black-footed ferrets implanted with transponders were recaptured and 9 were taken into captivity. An outbreak of canine distemper killed many of the implanted ferrets and shortened the field test. However, recaptured ferrets showed no signs of infection at the implant site. The transponder code was readable when tested in the field in 10 of the 11 ferrets recaptured between 3 and 25 days after implantation. It was not readable in 1 juvenile male which, when recaptured 23 days after implantation, was blind in the right eye and had been wounded on the head and neck. The thick scabs may have prevented a reading from the transponder or the transponder may have failed. Six of the ferrets taken into captivity died of canine distemper 31–105 days after the transponder was implanted. Necropsy results showed the transponders to be lightly encapsulated in fibrous connective tissue, and no evidence of inflammation was present.

DISCUSSION AND IMPLICATIONS

Transponders have a number of advantages over typical marking systems, the primary advantage being their permanence. None was removed by ferrets despite frequent fighting between males. Because transponders have no power source of their own and lie dormant until activated by the low frequency electromagnetic signal, their projected life span should be indefinite. Each individual transponder code is unique, and >34 billion combinations are available.

The major drawback of the transponder for use in wildlife studies is that the Handwand/Reader has to be ≤7.5 cm from the implant site to get a reading. This normally requires retrapping and handling an animal. For burrowing

animals or cavity nesters a reader tube is available that can be inserted into the burrow or cavity and that will read the transponder number each time the animal enters or leaves. The data may be automatically recorded by a computer wired to the reader. A newer version of the Handwand/Reader is powered by an internal battery that makes it convenient for field use.

The failure rate of the transponders tested in this study was 30%. Tests by Identification Devices, Inc. engineers indicated that the polypropylene casing allowed minute amounts of moisture to enter and short-circuit contacts. Identification Devices, Inc. has recently developed a glass casing that does not allow leakage and should eliminate most failures. We are currently testing these in the laboratory in 14 black-tailed prairie dogs (*Cynomys ludovicianus*), and they have been in place for 20 weeks with no failures.

Domestic ferrets have thick skin for a small animal. It was difficult to penetrate their skin with the needles originally provided with the implanter unit or with 12-gauge needles purchased from other sources. Therefore, it was necessary to sharpen needles prior to each use. Identification Devices, Inc. is currently working on the development of a disposable syringe and needle.

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DYNAMICS OF AN EXPLOITED CANADA LYNX POPULATION IN ONTARIO

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Abstract: Population structure, mortality, productivity, and condition of lynx (*Felis lynx*) from zones of distinctly different harvest density and forest type in northeastern Ontario were contrasted. These population parameters were remarkably consistent and showed little variation across the 107,000-km^2 study area. Productivity was high; 33% of kits and nearly all yearling and adult females bred, and mean litter size was 4.18. The mean rate of trapping mortality over several years was 46 ± 26% for males, 28 ± 17% for females, and 38% overall. Trapping accounted for nearly all mortality experienced by the population. The population increased in face of this rate of harvest. Trapping mortality appeared uniform across the study area. The data suggest that population density of lynx is lower in boreal coniferous forest than in boreal mixed-wood forest.

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The Canada lynx is a commercially important furbearer that is harvested across most of its range. However, the biological basis of lynx population management is deficient. Lynx are practically impossible to census and management strategies are often based solely on trends of the harvest. The mean value of lynx pelts has increased to >$500.00 (Can.) and there is concern that such high prices may result in overexploitation.

The impact of commercial trapping on lynx populations is not fully understood. In Ontario furbearer harvests are regulated via quotas on legally delineated traplines. Determination of allowable harvests of some species, including lynx, is left essentially to the judgement of local wildlife officers. There are areas of the province in which the harvest of lynx is consistently higher than others yet reasons for this are unclear. Spatial variation of the harvest could be due to some intrinsic quality of the populations, such as productivity, or simply to the discretion of local managers. We contrasted the structure, mortality, condition, and productivity of lynx populations from zones of distinctly different harvest density (harvest/unit area) and forest

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