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CONTRACEPTION IN STRIPED SKUNKS WITH NORPLANT® IMPLANTS

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Uncontrolled or poorly controlled increases in wildlife populations are a problem in many areas of the world. In certain species, such as the striped skunk (*Mephitis mephitis*), population reduction has been used successfully to control the spread of communicable diseases, including sylvatic rabies. Pybus (1988) used traditional lethal control methods (shooting, trapping, strychnine poisoning) to reduce skunk populations and the incidence of rabies in Forty Mile County, Alberta.

Leg-hold trapping is an increasingly unpopular approach to population control. At least 50 countries worldwide and 2 states have banned any use of these devices, and 8 other states have legislated partial bans (Nilsson

1980). Programs of poisoning of skunks also have shortcomings. First, no published evidence exists to confirm that rabid skunks eat poisoned baits. Second, the population reduction by poisoning is temporary, and each new breeding season results in new increases in the population. Third, poison kills nontarget species. Hegdal et al. (1986) and Marsh et al. (1987) have demonstrated that poisons such as sodium fluoroacetate (1080) kill nontarget species, and neither leg-hold trapping nor poisoning is an acceptable strategy in urban areas. Finally, one of the strongest arguments for a contraceptive approach is that there is currently no registered predacide for above-ground use against skunks (E. Schaffer, Denver Wildlife Research Center, pers. commun.).

The striped skunk (*Mephitis mephitis*) is the most common of 4 species of skunks in the U.S. and is indigenous to the entire country (Honacki et al. 1982). It is the striped skunk that is most often implicated in overpopulation problems and the spread of rabies (Pybus 1988).

The concept of slowing or stopping population increases in wild or feral species by means of fertility control is not new (Kirkpatrick and Turner 1985), but its application to skunks has been limited and is largely untested. The only published reference to attempted skunk contraception reported oral administration of diethylstilbestrol (DES), which was unsuccessful (Storm and Sanderson 1969). The objective of the present study was to test the antifertility effectiveness of a small, commercially available steroid contraceptive implant in striped skunks, as a possible skunk control strategy for urban areas.

MATERIALS AND METHODS

A small pilot study was first conducted to assess the likelihood of successful contraception in skunks with Norplant®, prior to carrying out a significantly higher cost study with captive animals. In this pilot study, 24 wild female striped skunks were live-trapped and implanted with Norplant® contraceptive implants. A paucity of females in the study area precluded the use of sham-implanted control females. The skunks were caught in Wickencamp No. 32 welded-wire traps, within the city of Billings or in Yellowstone County, Montana, during November 1988. Traps were baited with chicken eggs and a mixture of beaver castor and cod-liver oil. Each skunk was anesthetized with 1.0–2.0 cc ketamine HCL (Vetalar, Parke Davis, Morris Plains, N.J.) (Jessup 1982), given intramuscularly in a front shoulder by means of a 2.0-m pole syringe. A 4.0-cm^2 area of the lateral region of the neck was shaved and cleansed with betadyne (Acudyne Prep Swab, Acme United Corp., Bridgeport, Conn.). A single Norplant® rod (Leiras Pharmaceutical, Turku, Finland) was inserted subdermally with a 10-gauge trocar, and the puncture wound was dusted with sulfathiozole (Sigma Biochemical, St. Louis, Mo.). Each Norplant® rod consisted of a 2.5 × 30 mm (O.D.) Silastic tube containing 36 mg of levonorgestrel, a synthetic progestin. A color-coded 0.15-cm diameter monel eartag (National Band and Tag Co., Newport, Ky.) was placed in 1 ear and the skunk's white stripe and head patches were dyed with a commercial sheep dye (Ausimark, Coopers Animal Health, Kansas City, Kans.). Six of the skunks were fitted with radio collars (Advanced Telemetry Systems, Isanti, Minn.). We were required by city and county animal control officials to translocate all but 4 of the treated animals to nonurban areas for release. Male skunks which were trapped were released at the site of capture.

During May 1989, treated and untreated female skunks were recaptured by live trapping, as previously described, anesthetized and examined for evidence of fetuses, by abdominal palpation, or for lactation, by nipple size. Treated skunks that were recaptured were palpated in the neck region to verify the presence of the Norplant® implants.

Following the completion of the first study, 20 captive, sexually mature female striped skunks maintained at a commercial facility (Ruby Fur Farm, New Sharon, Ia.) were each given a single Norplant® implant, as previously described, in October 1989. Two additional females were implanted with 2.5 × 30 mm empty Silastic rods. Permission to sham-implant more skunks could not be obtained from the facility's owner. The captive females were housed in 0.76- × 1.06- × 0.91-m wire cages, in pairs, and fed a mixture of ground chicken, chicken skin, and beef. Each cage was attached to an adjacent wooden nest box. Each female was removed from its cage, anesthetized with ketamine, and the implants placed in the neck region as previously described with wild skunks. During February 1990, a sexually mature male of proven fertility was introduced into each cage and permitted to remain through March 1990. All implanted, sham-implanted, and untreated females were housed, fed, and bred with identical procedures, which were standard for this commercial breeding facility. On 24 June 1990, the treated skunks were observed for the presence of litters and general physical condition, and the number of litters was compared to litters for the 2 sham-implanted skunks and 208 untreated captive females. Differences in litter numbers between treated and all untreated skunks were tested for significance by means of binomial probability distribution (Freedman et al. 1978).

RESULTS

Four of 24 wild skunks receiving Norplant® implants and 6 untreated female skunks were captured in May 1989. Two of the treated skunks had radio collars and had been among those translocated after treatment. Two did not have radio collars and had not been translocated. The incidence of pregnancy, lactation, or both between treated and untreated skunks differed ($P < 0.05$). None of the treated skunks were pregnant or lactating, while all untreated female skunks captured were pregnant.

Among the skunks studied in captivity, 2 captive skunks died following Norplant® treatment, 1 during the winter of 1990 and before the breeding season, and a second in the spring of 1990, after the breeding season. The latter female was not pregnant at the time of death. A precise figure for winter and spring mortality among all untreated skunks in the fur farm was unavailable (records were not kept) but has been estimated at 10% annually (L. C. Ruby, pers. commun.). The cause of death of the 2 treated skunks is unknown. None of the surviving 18 treated captive females produced a litter. One of the 2 females implanted with empty Silastic tubing failed to produce a litter; the other produced a litter of 5 kits. Of 208 untreated captive females, 149 (71.6%) produced litters. The difference in the number of litters between treated and all untreated females was significant ($P < 0.001$).

DISCUSSION

Norplant® implants and levonorgestrel have been shown to be effective fertility inhibitors in a variety of species, including laboratory rats (*Rattus norvegicus*) and rabbits (*Oryctolagus cuniculus*) (Phillips et al. 1987) and humans (Brache et al. 1990). In humans subdermal placement of 6 rods imparts contraceptive protection for up to 5 years, with each implant releasing approximately 30–50 μg of levonorgestrel per day (Robertson 1983). In animal models (Pasquale et al. 1987) levonorgestrel exerts its contraceptive effects in the hypothalamus and pituitary, where it blocks the pulsatile release of luteinizing hormone (LH), thereby blocking ovulation. The striped skunk is a reflex ovulator (Wade-Smith and Richmond 1975, 1978*a*), releasing its ova in response to copulatory stimuli. These stimuli ultimately lead to a surge of LH and ovulation, a process which may be blocked by levonorgestrel in the skunk. Progestins, natural and synthetic, also block ovulation in cats (*Felis silvestris*) (Remfry 1978) and rabbits (Phillips et al. 1987), 2 other species characterized by reflex ovulation.

The results of the pilot study with wild skunks could possibly be attributed to capture and translocation procedures rather than the pharmacological effects of the contraceptive steroid, although neither of the 2 treated females which were not translocated produced litters. It is also unlikely that handling and anesthesia of skunks 5 months prior to the breeding season had any inhibitory effect on reproduction. Ketamine is used routinely on a variety of animals and no long-term effects on reproduction have been reported in any species; daily handling of captive skunks during the breeding season, to prepare vaginal smears, had no effect on reproductive success (Wade-Smith and Richmond 1978*b*). Additionally, the positive results obtained with the captive population and the highly significant differences in fertility between treated and untreated captive skunks suggest a pharmacological contraceptive effect rather than capture-induced stress effects.

The use of Norplant® as a chemical fertility inhibitor in skunks, particularly in urban areas, has several advantages over lethal controls. First, these data indicate a highly significant effect of treatment. Second, both the capture procedures and the placement of implants are relatively simple operations, requiring no sophisticated anesthesia procedures nor any surgical procedures beyond the subdermal insertion of the trocar. A minimum of training is required to prepare animal control personnel to carry out the procedures. Presently, in urban areas, where poisoning is not permitted, live trapping must be carried out by animal control personnel in order to destroy or move skunks. Thus the costs of live trapping are already incurred by animal control agencies. Costs for the implant, based on estimates by the original pharmaceutical manufacturer (Lieras Pharmaceutical, Turku, Finland) are approximately $2.60 per implant, and anesthesia costs are approximately $1.00 per animal. The time to anesthetize and implant a skunk is approximately 10 minutes. Third, on the basis of laboratory animal (Phillips et al. 1987) and human studies (Salah et al. 1987, Brache et al. 1990) and physical examinations of treated skunks, there appear to be no significant short-term effects on health other than the loss of fertility. The 10% mortality rate for the 20 treated skunks was not different from the mortality rate for all untreated captive skunks in this particular fur farm. Fourth, the nonlethal nature of fertility control will be more acceptable to some segments of the general public than lethal control.

There are 2 additional theoretical advantages of Norplant® contraception. The effective contraceptive life of a single Norplant® implant in small mammals has not yet been determined, but if the contraceptive effects of Norplant® in skunks are found to last for the 5-year period demonstrated in humans, or even 2–3 years, each treated skunk will be removed from the breeding population for much or all of its reproductive life. Second, the preservation of a core population of skunks, albeit infertile, may slow the immigration of new skunks into treatment areas. Lethal controls and permanent removal of skunks in Billings have created habitat vacuums into which new animals migrate (D. Pauli, Billings Animal Control, pers. commun.).

The use of any synthetic contraceptive steroid in wildlife brings up the issue of passage of these hormones through the food chain and possible deleterious effects on other species. In the case of urban skunks, death is primarily caused by humans. The only significant predator is the great horned owl (*Bubo virginianus*; Bent 1961: 307, Chapman and Feldhamer 1982: 680), which is not commonly found in densely populated urban areas. The release rate of levonorgestrel (approximately 30 μg/day) is extremely low. Based on an average weight of 1.3 to 2.2 kg it is unlikely that a given predator would consume a sufficient number of skunks or a dose of levonorgestrel sufficiently large to cause infertility to itself. The levonorgestrel will pass to the predator only from circulating or stored concentrations in the flesh of the prey, and not from the implant itself, which cannot be digested. The prolonged contraceptive effects of Norplant® are imparted only as an intramuscular implant. In the unlikely event that a predator did consume a whole implant and cause the release of levonorgestrel in the gastrointestinal tract, the effects of oral levonorgestrel would be short-lived.

Population reduction of skunks has been demonstrated to be an effective method of reducing the incidence of rabies (Rosatte et al. 1986), and fertility control may be a sound approach to reducing populations, particularly with urban populations. Future studies must be directed at demonstrating population control of skunks by means of contraception, determining the proportion of the population which must be treated to achieve varying degrees of control, understanding the relationships of population contraception to the incidence of rabies, studying the effective contraceptive life of the implant in skunks, determining the retreatment interval required to maintain populations at the desired level, studying the health of animals treated with implants, and meeting federal registration requirements.

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