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Captive husbandry of stoats *Mustela erminea*

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Abstract Captive stoats are essential for testing technological developments for pest control in New Zealand. We have reviewed husbandry practices and experiences of keeping stoats in captivity for a range of purposes. Stoats can be kept individually outside and subjected to normal regimes of light and temperature if sufficient bedding and shelter is provided. They appear to survive and breed best when fed on freshly killed rodents. Live prey is desirable though will rarely be permissible due to regulatory constraints. Breeding in captivity has been problematic in most cases, and although in a few instances wild-caught females carrying embryos in delay have given birth, this is a rare event. Procedures taken to minimise stress in captivity may reduce the loss rate of blastocysts due to resorption and facilitate rapid expansion of captive colonies.

Keywords animal husbandry; captive breeding; diseases; feeding; housing; Mustelidae; zoo biology

INTRODUCTION

Introduced stoats *Mustela erminea* are a major pest in New Zealand, where they are targets for large-scale culling aimed at enhancing the status of native birds (King 1984; McDonald & Murphy 2000). So far, lethal methods of stoat control, mainly trapping and poisoning, are predominant and current research aims to enhance the success of these methods by improving the efficacy of traps, baits, and lures (Department of Conservation 2000). Recently, diseases, fertility control agents, and immunocontraceptive methods have been considered as potentially long-term solutions for New Zealand's stoat problem (Hinds et al. 2000; Norbury 2000; McDonald & Larivière 2001a,b). Captive colonies of stoats will be invaluable for developing conventional and novel control technology. Captive animals can be used to test lures, baits, and traps in order to improve conventional methods. They can assist with investigations of the control of reproduction and can provide subjects for toxicological and epidemiological trials.

In the past, stoats have been considered difficult to tame and no records of breeding in captivity were thought to exist (Deanesly 1935). We have not been able to locate any sources describing the methods adopted for raising stoats in fur farms, though occasional records of short-lived attempts at farming stoats involving fewer than 10 stoats at single farms have been recorded in Canada (Dominion Bureau of Statistics 1931). To our knowledge there are no commercial fur farms in North America that currently keep stoats (T. Platt, Fur Commission USA pers. comm.). Captive stoats have received attention in a diverse range of science projects in New Zealand (e.g., Murphy et al. 1992; Spurr 1999, 2000) and elsewhere (e.g., Gulamhusein & Tam 1974; Gulamhusein & Thawley 1974; Nams 1981; Ternovsky 1983; Robitaille & Baron 1987; Robitaille 1989; Raymond et al. 1990; Vaudry et al. 1990; Bern 1993). Scientific facilities in New Zealand that held stoats in 2001 were maintained by

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Landcare Research (n = 40–50, E. Spurr pers. comm.), Waikato University (n = 5–11, C. King pers. comm.), and by Massey University (n = 11, L. Robbins pers. comm.). Stoats have also been held and bred in captivity as pets (M. Gamache pers. comm.; J. Roberts pers. comm.) and for display in zoos (Andreewskaja & Brandesowa 1977; Doncarlos et al. 1986; D. Gow pers. comm.). Because they spend much time asleep or out of sight, stoats are frequently considered unsuitable for captive display (Crandall 1964). The International Species Information Service (ISIS) at www.worldzoo.org provides a list of the few zoos that keep stoats in captivity. None of the zoos participating in the ISIS have reported births in recent years and to our knowledge, the Minnesota Zoological Garden, New Forest Nature Quest, Hampshire and Wild Wood Park, Herne Bay, Kent are the only zoos that have recently bred stoats in captivity.

In this paper, we summarise the details of captive stoat facilities maintained for a diverse range of purposes. Accounts of keeping stoats in Bern (Müller 1970), at Minnesota Zoo (Doncarlos et al. 1986), and at the Siberian Branch of the Soviet Academy of Sciences in Novosibirsk (Ternovsky 1983) were particularly useful. Polkanov (2000) has also recently provided a review of Soviet literature relevant to this topic. We supplement this information by accounts of keeping related species, particularly weasels *Mustela nivalis*, where relevant.

HOUSING

In Bern, stoats were kept in cages made of 10 mm mesh of 1 mm gauge wire with fibre cement (Woodcrete) bottoms and sheet metal or glass lids. The cages were 125 cm cubes, 120 × 80 × 70 cm or preferably 150 × 100 × 60 cm. The bottoms of the cages were covered with a variety of natural material including sticks, moss, leaves, and hollow logs which were replaced only every 1–2 months to avoid irritating the animals (Müller 1970). Stoats at Minnesota Zoo were housed individually in holding boxes 25 × 20 × 45 cm in size but were exhibited in a 200 × 200 × 100 cm glass-fronted container for 1 h at a time (Doncarlos et al. 1986). Part of the New Forest Nature Quest stoat collection was housed indoors, in cages with wooden sides and "chicken wire" mesh tops, c. 150 × 200 × 50 cm. Other stoats were kept outdoors on the ground in metallic circular pens of c. 600 cm diameter by 150 cm high. Outdoor pens contained a pile of logs and rocks in which stoats also apparently made their own nests. Stoats occasionally escaped from these outdoor pens through mole and rodent tunnels (D. Gow pers. comm.). In Sweden, stoats have been kept successfully in cages of 120 × 50 × 60 cm for up to 10 days before and after their use in behavioural experiments. The experimental arenas measured c. 30 m^2 and contained simulated habitat with tree stumps, piles of rock, and brush (Erlinge 1977).

At Landcare Research, Lincoln c. 100 stoats have been housed individually in cages of 200 × 100 × 100 cm or 150 × 60 × 90 cm, made of 12 mm steel weld mesh. Logs and vegetation were provided for climbing on and the cages were located outdoors on a wooden floor, sheltered under a veranda. New facilities at Landcare house stoats individually in larger outdoor pens of 200 × 400 × 220 cm. These pens adjoin one another and open onto a shared enclosed lane to reduce the risk of escapes. Murphy et al. (1992) kept five stoats at Te Anau Wildlife Park in separate outdoor enclosures of 120 × 240 × 90 cm with weld-mesh walls and roof and a plywood floor. Enclosures were equipped with a variety of logs, rocks, and vegetation for environmental enrichment, and half of the enclosure roof was covered with corrugated iron to provide some shelter. Massey University and Waikato University have maintained small numbers of stoats in observation pens of 90 × 230 × 210 cm with a concrete floor, plywood lower walls, and mesh upper walls, or smaller home cages of 100 × 200 × 35 cm with wooden frames and weld-mesh sides (Robbins, in review; C. King pers. comm.).

At Exeter University, captive weasels were held in a cage of 120 × 60 cm (East & Lockie 1964). In New Zealand, eight weasels were successfully kept and bred outdoors in cages of 120 × 50 × 50 cm with wooden nest boxes of 25 × 15 × 15 cm (Hartman 1964). At Aberdeen University, weasels were housed individually in wire cages 60 × 30 × 20 cm with a glass-topped removable nest box 15 × 15 × 15 cm with non-absorbent cottonwool for bedding. The floor of the cage was covered with sawdust that was regularly replaced (Moors 1974). At Helsinki University, weasels were kept in a cage of 120 × 60 × 60 cm, with a Plexiglas roof and wire mesh for sides (J. Sundell pers. comm.). A single pet weasel was permanently kept in a clear plastic rat's cage of 55 × 40 × 20 cm (Scott 1982).

In Bern, stoat cages were furnished with a nest box with a 5 cm diameter entrance hole (Müller 1970). The box was made of thick softwood of 35 × 25 × 25 cm on the outside with an inner box of

20 cm^3 and fibreboard insulation between the two layers. Natural moss was provided for nesting material. Cages developed later were equipped with a nest box on the outside of the cage, the door of which could be opened and closed without opening the cage (Müller 1970). At Minnesota Zoo, holding boxes were provided with a detachable nest box of $18 \times 12 \times 14$ cm. The nest box had a Plexiglas roof for observation of stoats and their litters and was equipped with a sliding entrance cover (Doncarlos et al. 1986). In the New Forest, both cages and outdoor pens were supplied with a nest box of c. 15 $\times 15 \times 15$ cm and ample wood shavings and hay for bedding (D. Gow pers. comm.). At Landcare, stoat cages were equipped with a nest box of $40 \times 33 \times$ 19 cm with a 6.5 cm diameter hole, to reflect the larger size of stoats in New Zealand, a Perspex top covered with a metal roof and filled with shredded paper (E. Spurr pers. comm.). In Te Anau, a nest box filled with straw and Dacron was provided (Murphy et al. 1992).

Because of their long, thin shape, thermoregulation in stoats is managed behaviourally, and captive stoats must be provided with ample nesting material if kept in cold temperatures. When provided with insulated boxes and adequate bedding, the stoats kept in Bern, in Siberia and at Landcare fared well when housed outside with no artificial heating or lighting (Müller 1970; Ternovsky 1983; E. Spurr pers. comm.). The Minnesota Zoo kept their stoat colony indoors at 21°C, with illumination provided from fluorescent and incandescent light modified weekly to mimic natural photoperiod (Doncarlos et al. 1986). At the Wellcome Institute and in the New Forest, stoats were kept in an unheated, well-lit room under normal daylight conditions (Gulamhusein & Tam 1974; D. Gow pers. comm.). At the latter location, artificial lighting was used when feeding the animals in the morning and evening in winter and this may have upset the animals' photoperiod (D. Gow pers. comm.). At Waikato University, stoat cages were placed in an unheated shed with no artificial lighting (C. King pers. comm.). At Exeter, captive weasels were initially kept indoors, then they were transferred via a cold greenhouse, to the outdoors (East & Lockie 1964). Similarly, at Aberdeen, weasels were kept in a shed with no artificial lighting or heating (Moors 1974) and in Helsinki, weasels were kept in greenhouses under normal photoperiod (J. Sundell pers. comm.).

Individual housing of adult stoats is preferable, as combinations of unrelated individuals, particularly those of the same sex, can result in fighting. Mixed sex pairs have, however, been kept together successfully, occasionally outside of the mating season (C. O'Connor & L. Robbins pers. comm.). Accidental encounters between stoats outside of the breeding season have resulted in fatalities (J. Duckworth pers. comm.) and experience at Wairori Sanctuary suggested that stoat enclosures should not even adjoin one another due to fatal encounters between neighbours outside of the breeding season (S. Fuller pers. comm.). Siblings may be housed together, but they should be separated when they reach adult size (Doncarlos et al. 1986).

FEEDING

In Bern, stoats were fed mainly on ox heart, which was considered better than muscle, liver or offal because it kept longer. They were also fed freshly killed mice from a colony kept for the purpose. However, the stoats' requirements exceeded the breeding capacity of the mouse colony and so this was supplemented with rats, guinea pigs, and hamsters from a commercial laboratory supplier. Smaller rodents were fed to the stoats live but larger rodents were killed and cut in two. These stoats were not fond of newborn rodents, hatchling birds, or foetuses. On average they ate about 50–70 g of food per day, although food was provided in excess so that starvation was not a risk (Müller 1970).

Prior to 1983, captive stoats at the Minnesota Zoo were fed canned cat food twice daily in amounts approximating 25% of body weight (Doncarlos et al. 1986). However, none of the three captive females bred successfully on this diet. In 1984, one female was fed freshly killed laboratory mice and she reproduced, whereas the other two females that were still fed on canned cat food did not. In 1985, all three females were fed freshly killed mice and all three bred successfully. Since then all stoats at the Minnesota Zoo have been fed freshly killed mice *ad libitum* (Doncarlos et al. 1986). At Leningrad Zoo, a female stoat and her litter of 12 young were fed mainly on live white mice, supplemented with eggs, cream, curds, and a little meat with vitamin and mineral supplements (Andreewskaja & Brandesowa 1977).

In Sweden, Canada, and at Exeter University, captive stoats used in behavioural experiments were fed on live mice (East & Lockie 1964; Erlinge 1977; Erlinge et al. 1982; J. F. Robitaille pers. comm.). At the Wellcome Institute, London, stoats were fed on raw minced beef or horsemeat alternated with dead

mice, plus an egg-milk mixture every other day (Gulamhusein & Tam 1974). Similarly, stoats at Landcare Research were fed daily with raw meat, either minced beef, horsemeat, or chicken. Male stoats were provided with c. 70 g per day, while females were provided 50 g (E. Spurr pers. comm.). Captive stoats and weasels at the New Forest Nature Quest and the Wild Wood Park were fed mainly on day-old chicks (D. Gow pers. comm.). Pet stoats have been fed a variety of foods including fresh meat from muskrats *Ondatra zibethicus*, woodchucks *Marmota monax*, snowshoe hare *Lepus americanus* and rabbits *Oryctolagus cuniculus* as well as commercial cat food. Surprisingly, captive stoats that were offered simultaneously dry cat food and fresh meat from muskrats or woodchucks preferred the dry cat food (M. Gamache pers. comm.). Thirteen stoats caught in Canada were kept in captivity for trials of the effects of Aleutian Disease Virus on the Mustelidae (Kenyon et al. 1978). They were fed on a prepared diet of fish (30%), poultry (32%), cottage cheeses (15%), soya bean meal (15%), bread crumbs (5%), and corn sugar (1%) or on a complete ration (G′NF-100 supplied by National Northwood Co., a division of Cudahy Co., New Holstein, Wisconsin).

In Helsinki, captive weasels were fed dead chicks as well as laboratory mice and rats. Each weasel consumed on average one 30 g vole per day. In early attempts at establishing the colony, several weasels died in the first few days of captivity. However, no weasels died when they were fed live voles for the first few days of captivity, apparently because killing voles appeared to relax stressed weasels (J. Sundell pers. comm.). In New Zealand, captive weasels were fed twice daily until 3 months of age and once daily after that. They were given ox heart with occasional fresh milk, egg yolks and ox liver, with vitamin supplements and cod liver oil (Hartman 1964). At Aberdeen University, captive weasels were provided with food and water *ad libitum*. Their main diet was dead day-old chicks supplemented with dead mice or portions of rabbit (Moors 1974). A single pet weasel was fed a single weaner rat every day (Scott 1982).

Caching behaviour is well developed in mustelids (Yeager 1943; Oksanen 1983; Oksanen et al. 1985). In captivity, stoats regularly cache food in the nest box, resulting in rapid disappearance (not necessarily rapid consumption) of large amounts of food (Doncarlos et al. 1986; J. F. Robitaille pers. comm.). Fresh meat cached in the nest box rapidly deteriorates, and so regular cleaning of the nest box is necessary to maintain sanitary conditions. On the other hand, cleaning is invasive and probably distressing for the animals, hence a compromise between hygiene and providing a familiar environment must be achieved. Development of a dry, unspoilable feed (similar to dry cat food), or offering a paste-type food or mince (L. Robbins pers. comm.) may prevent stoats from caching surplus food and allow managers to monitor food intake more accurately.

Stoats rapidly learn to use commercial water "sippers" designed for gerbils and hamsters (M. Gamache pers. comm.), though these should be of robust construction to withstand use by highly active stoats. At the Minnesota Zoo and at the Wellcome Institute, sippers provided water *ad libitum* to each captive stoat (Gulamhusein & Tam 1974; Doncarlos et al. 1986). In Helsinki, weasels were provided with an open water dish, but because they frequently urinated in the water dish, a sipper was also provided. Captive stoats and weasels often bathe in open water vessels, especially during hot weather and this doubtless contributed to the enrichment of their captive environment (C. King, C. O'Connor & J. Sundell pers. comm.). One pet weasel was provided with a 500 cm^3 sipper and water *ad libitum* (Scott 1982). Bissonnette & Bailey (1940) provided each captive stoat with two sippers, one for cow's milk and one for water.

Hand-reared baby stoats should be weaned as soon as possible rather than fed on milk. If feeding with milk is unavoidable, powdered milk formula and water is apparently preferable to cows' milk (Müller 1970).

BREEDING

Virtually all females caught alive are already carrying fertilised blastocysts in delay (King 1981), although experience in New Zealand has found that these wild-caught females do not go on to produce young in captivity (C. O'Connor & L. Robbins pers. comm.). Such failure to implant blastocysts or subsequent loss of embryos seems likely to be related to stress, whether behavioural or nutritional, arising from captivity. Instances of obviously young stoats giving birth up to 10 months after capture with mating taking place before capture have been recorded by a small number of observers (cited in Müller 1970; D. Gow & J. Roberts pers. comm.). Andreewskaja & Brandesowa (1977) briefly described the care at Leningrad Zoo of a single wild-caught young female and the litter that was born to

her while in captivity. East & Lockie (1965) describe the birth and development of a litter to a female stoat after 27 days in captivity, hence this individual was, unusually, caught early in the period of active pregnancy. Unfortunately, few details are provided about the conditions in which either of these females were kept prior to giving birth. These few instances suggest that if conditions are correct, the birth of litters to female stoats captured during the period of delayed implantation ought to be useful for establishing captive colonies of stoats. Indeed, since the reproductive cycle in the wild is synchronised by daylength, captive females carrying blastocysts in delay could at least in theory be induced to give birth earlier than expected by manipulating the lighting regime (Ternovsky 1983).

At the Minnesota Zoo, all 33 stoats born in captivity between 1983 and 1986 survived to maturity. In Siberia, 46 litters of 335 young (168 males, 167 females) were born to 40 captive female stoats between 1968–82 (Ternovsky 1983). In Bern, Müller (1970) documented the live births of 52 young in nine litters from eight females, all of which survived at least 40 days, before some were killed for histological studies. These records suggest that, so long as the mother does not resorb the litter, survival of captive-born stoats does not appear especially problematic.

In Bern, adult males were kept separate from pregnant females during the period of pregnancy, birth, and early stages of rearing the young. In one case, 47 days after the birth of her litter, a female stoat aggressively chased away a male that had been let into her cage. At 60 days the same female allowed herself to be mated by the same male. Three days after this the same male mated with the 9-week-old females, although the mating was interrupted by the mother (Müller 1970). In a further case, a male was introduced to the cage containing three 64-day-old females. The first female was mated almost immediately in typical copulation behaviour (Heidt et al. 1968). The male grasped the female by the neck with his teeth, gripped her body with front and hind paws and dragged her around the cage. The copulation lasted 3.5 min and was followed immediately by the male copulating with a second female. This second copulation lasted 19 min. After this, the third female arched her back like a cat and presented her genital area to the male. Her advance was ignored by the male who then returned to his cage. Successful matings also took place between adult males and young females of 36–39 days (Müller 1970).

In Siberia, 29 of the breeding females were mated by adult males between 17–75 days after birth and gave birth to normal offspring the following year (Ternovsky 1983). The youngest 17-day-old female was still blind and helpless when mated successfully by an adult male. Females that mated as neonates were no less fertile than those mated as adults. Furthermore, the female offspring resulting from matings between neonates and adults were no less fertile when they bred themselves. Mother stoats were found to chase male suitors away only in the first 5–10 days after birth but hostility diminished rapidly thereafter.

In Minnesota Zoo, four adult males were introduced one at a time to a cage containing five, 6-week old stoats (2 males, 3 females) and their mother. Typical copulation between the adult male and all the young females followed. Neonatal females did not show oestrus behaviour, except in the presence of a male. When a male was introduced, neonatal females (36–48 days of age) vocalised with high-pitched trills or chuckles, and crawled after the male and even interfered with matings with their mother or siblings. Males that were unsuccessful in copulating with adult females had greater success in copulating with neonatal females. A single neonatal female mated at 42 days of age later gave birth to 10 young after a delay of 307 days. Most matings between adult males and young females took place 36–48 days after birth (Doncarlos et al. 1986).

Usually, adult males do not interact with the juvenile males. In one case in Minnesota Zoo an adult male attempted to copulate with a neonatal male, but was fought off by the kit (Doncarlos et al. 1986). In one case in Siberia, the adult male mated with all four females in a litter and killed all four males (Ternovsky 1983). Mating between adults follows a similar pattern to that described above. Males were always introduced to the cage of females, ideally by removing a partition between adjoining cages. Copulation was very vigorous, lasted between 2–13 minutes and was repeated four or five times over a period of about an hour (Müller 1970).

East & Lockie (1964) describe the conditions for breeding weasels. Male and female weasels were kept in adjoining cages, and were introduced to one another initially under close observation and subsequently by having two 2.5 cm holes joining the cages through which only the female could pass. When the female was pregnant the male was removed from the adjoining cage (East & Lockie 1964). On mink farms, breeding rates are reduced by the presence of sterile males. Unsuccessful male

breeders have been reported as a problem for captive stoats (Doncarlos et al. 1986) and sperm tests developed for farmed mink could help detect and identify whether sterility was the cause of the lack of breeding success (Sundqvist & Gustafsson 1983).

DISEASES

A range of infectious diseases can affect small mustelids (Williams & Thorne 1996) but they have not received as much attention as the diseases of larger carnivores (Murray et al. 1999). Consequently, the pathology and epidemiology of the numerous diseases that may affect stoats are poorly known. The economic incentive for rearing ferrets and mink *M. vison* has led to a good deal of information on the diseases that afflict them, and fortunately these species are useful models for stoat disease because of good evidence that congeners are similarly vulnerable to many diseases. Diseases of stoats have been reviewed recently elsewhere (McDonald & Larivière 2001a).

For a programme of captive breeding stoats, precautions can be taken to prevent stock loss due to disease. However, researchers investigating the biological control of stoats may wish to take advantage of unexpected disease outbreaks in a newly established captive colony which may suggest further potential biocontrol agents. Under intensive production management systems, any animals are likely to contract diseases, especially if subjected to dense groupings, rigorous breeding schedules, and restricted space. Thus, preventive vaccination and sanitary conditions are required for maintaining healthy captive animals. The following recommendations were developed for captive mink (Tomson 1987) but could be adapted for captive stoats:

1. Vaccinations at 10 weeks of age against distemper, viral enteritis, haemorrhagic pneumonia, and botulism, caused by contamination of food supplies. Note that vaccination of animals with vaccines developed for even closely related species can actually induce the disease for which protection was envisaged. This is particularly true of parvoviruses and morbilliviruses, including distemper, Aleutian disease, and viral enteritis (McDonald & Larivière 2001a). Feder (1990) reports the vaccination of 10 stoats and weasels with Galaxy DA2PL vaccine for canine distemper with no ill effects for either species. She did not, however, test whether the vaccine was effective against challenge with distemper virus.
2. Incoming animals should be tested for potentially common conditions, such as Aleutian disease, before they are introduced to the captive colony.
3. Storage and preparation of feed must prevent bacterial spoilage or contamination.
4. Proper cage and utensil sanitation is desirable, though the requirements of familiarity with the stoats' environment in reducing behavioural stress suggests that a compromise must be sought between hygiene and undue interference with captive animals. It is notable that the unit with significant success in breeding stoats in Bern, cleaned cages only once every 1–2 months.
5. Precautions must be taken to exclude wild animals and pets from the vicinity of cages.

OTHER MUSTELIDS IN CAPTIVITY

The IUCN Small Carnivore Specialist Group considered that promoting captive breeding of mustelids was a priority (Schreiber et al. 1989). At the time, they recommended that a Captive Breeding Specialist Group be formed. However, we do not know whether such a group was ever active. European mink *Mustela lutreola* and black-footed ferrets *M. nigripes* have been successfully raised in captivity, but to our knowledge tropical weasels *M. africana*, Indonesian mountain weasels *M. lutreolina*, Colombian weasels *M. felipei*, and back-striped weasels *M. strigidorsa* have never been kept in captivity (Schreiber et al. 1989). Amstislavsky & Ternovskaya (2000) have reviewed the breeding biology of several mustelid species, notably including *M. altaica*, at the Siberian Academy of Sciences, Novosibirsk. Other mustelids, primarily those in which there has been a commercial interest, have frequently been kept in captivity and guidelines for their husbandry are well described. Detailed manuals are available for mustelids in general (Partridge 1995) and in particular for raising American mink (Adams 1935; Laberee 1941; Kellogg et al. 1948; Leonard 1966). Guidelines are also available for American martens (Yerbury 1947; Ritchie 1953), ferrets (Carpenter & Hillman 1978; Fox 1998), long-tailed and common weasels (Wright 1948; Sanderson 1949; Short 1961; Heidt et al. 1968) and black-footed ferrets (Aldous 1940; Progulske 1969; Thorne et al. 1985). Fishers do not reproduce well in captivity (Powell 1993) but some information on farming is nonetheless available (Hodgson 1937; Laberee 1941). Guidelines for the care and handling of North American river otters

Lontra canadensis are also available (Serfass et al. 1996).

In North America and elsewhere, fur-bearing carnivores have been raised extensively in captivity for fur farming. Intensive farming of mink for fur began in 1925 (Tomson 1987) and the American mink remains the most important species for fur-farming (Venge 1959; Thompson 1968). For this reason there is an extensive literature on the behaviour (MacLennan & Bailey 1969), metabolism and physiology (Wamberg 1994), lactation (Clausen et al. 1996; Hansen et al. 1996), reproduction (Hansson 1947; Enders 1952; Duby & Travis 1972; Sundqvist & Gustafsson 1983; Sundqvist et al. 1988; Lagerkvist et al. 1992), selective breeding (Lagerkvist et al. 1994), stress levels (Gilbert & Bailey 1967, 1969), veterinary care (Tomson 1987), economics (Lagerkvist 1997) and welfare (Nimon & Broom 1999) of captive mink. There is also a number of papers on techniques for increasing rates of reproduction in Siberian polecats (Mead & Neirinckx 1990) and farmed mink (e.g., Lagerkvist 1992, 1997; Lagerkvist et al. 1992, 1994; Lagerkvist & Tauson 1993) which may be useful for rapidly establishing a colony of captive stoats.

DISCUSSION

Colonies of captive stoats will assist several aspects of the development of new technology for controlling stoats. Stoats do not lend themselves to display or to commercial exploitation, hence there have been relatively few attempts at captive breeding. However, a small number of detailed studies permit recommendations for the husbandry and breeding of stoats in captivity.

Captive stoats should be housed individually in cages of c. 150 × 100 × 60 cm made out of wood, or more easily sanitised plastic, fibre glass or similar material, fine wire mesh, and glass or Perspex. An insulated, removable nest box with a door that may be closed from outside the cage and an inspection window should be provided, and is essential for handling and moving animals as well as cleaning cages when required. Adequate bedding material, such as wood shavings, moss or hair is essential, and features for environmental enrichment such as a water dish, hollow logs, and pipes are beneficial. Stoats can be kept outside and no artificial lighting or heating should be provided, unless active management of photoperiod is required to manipulate reproductive cycles. Stoats should be fed *ad libitum* on live, or, where feeding live animals is not acceptable from a regulatory perspective, freshly-killed small rodents. Day-old chicks or ox heart are an alternative, though should be considered in light of a few cases of reduced breeding performance. Provision of live rodents where acceptable is particularly desirable in the early stages of captivity. Finally, successful captive breeding facilities should be separated into smaller groups to prevent complete loss of a colony should a contagious disease infect animals.

If loss of blastocysts can be prevented, and experience suggests that this is a major challenge, young females caught in the wild during embryonic diapause will be invaluable for establishing colonies, since they ought to give birth the next spring. For breeding in captivity, males should be introduced to females' home cages in which resident females will have a territorial superiority. In the case of females with young this should probably be c. 25–45 days after giving birth, although female stoats do appear able to mate or defend themselves as appropriate before this time. Polkanov (2000), drawing on the experiences of Ternovsky and others, provides a tabular key to deriving the age of young stoats from developmental indicators. To ensure successful mating, males can be left with females for a few days, but male kits should be removed from the cage during mating attempts to reduce the small risk of infanticide. Clearly, best practice in maintaining stoats in captivity will continue to be improved and those publishing in this field should be aware of the importance of formally and fully documenting their practices for future reference.

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