4.4 PHOTOPERIOD TREATMENTS TO STIMULATE OUT-OF-SEASON MATING

In 2002, the 12 stoats (six male, six female) in the 6-month artificial photoperiod trial showed no obvious differences from the control animals that were exposed to normal day length in either behaviour or reproductive function.

In contrast, in 2003, seasonal reproduction was significantly advanced in both male and female animals that experienced the advanced summer photoperiod treatment (Table 5, Fig. 9). Five of the six females exposed to this treatment came into season between 26 August and 8 October, as indicated by swelling of the vulva and the high ratio (> 7.0) of keratinised to non-keratinised cells in vaginal washings. This was significantly earlier than the onset of oestrus in control animals (Table 5) and in previous captive breeding trials (JT, unpubl. data). None of the control females in this study were detected to be in oestrus before November (Table 5). Four of the light-treated females were partnered with light-treated males in early October. Three of these females were believed to have mated, as they were no longer in oestrus in late October. Two of these females were subsequently killed and had seven and three blastocysts present *in utero*.

Light treatment mimicking early exposure to long summer photoperiods also advanced testicular development in the male stoats (Fig. 9). Between April and July, testis size increased more rapidly in advanced photoperiod males than in natural light males. In August, testis length of the light-treated males was significantly greater than in the control animals ($F = 3.1$, df = 3, 40, $P = 0.037$). In September, prior to attempting matings, semen samples were collected by manual manipulation from all six treated males and five of the six control males. Spermatozoa were present in all samples, indicating that the males were fertile. The collection of stoat semen samples may be useful in future studies to assess seasonal changes in male fertility.

TABLE 5. REPRODUCTIVE ACTIVITY OF FEMALE STOATS (*Mustela erminea*) IN THE ADVANCED SUMMER PHOTOPERIOD TRIAL (n = 6) v. THE NATURAL PHOTOPERIOD CONTROL (n = 6) IN 2003.

Results of statistical tests are shown in parentheses.

	ADVANCED	NATURAL
Date of onset of oestrus (mean ± SEM)	2 October ± 12.1 days	4 December ± 10.2 days
	(ANOVA: $F = 19.0$, df = 1, 9, $P = 0.002$)	
Number of females detected in oestrus (August–October)	5	0
	(Fisher exact test (two tailed): $P = 0.015$)	
Number of females detected in oestrus (August–January)	5	6
	(Fisher exact test (two tailed): $P > 0.05$)	

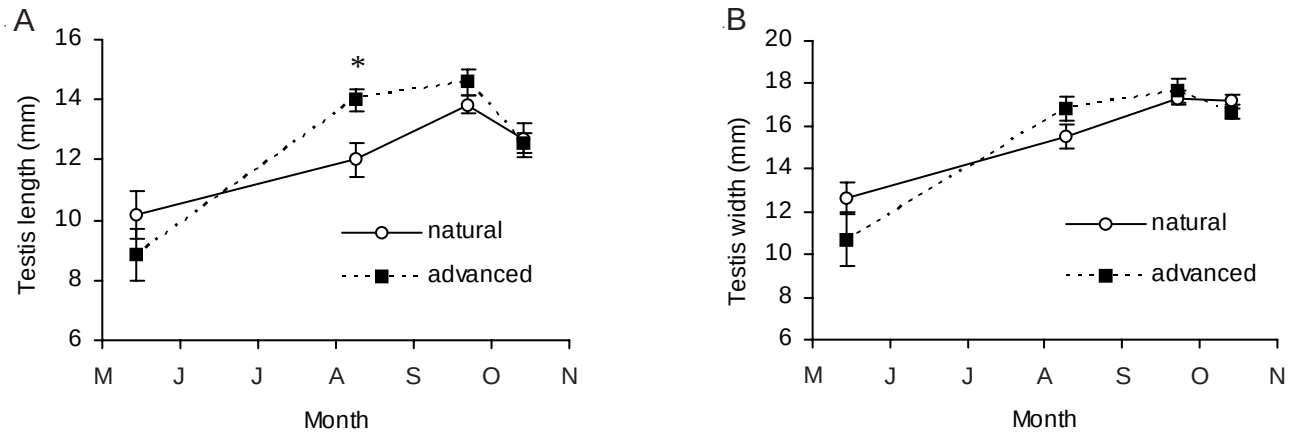

Figure 9. The effect of photoperiod treatment on the length (A) and width (B) of testes of male stoats (*Mustela erminea*) that were exposed to advanced long days or to natural day length. Data are means ± SEM. Asterisk indicates significant differences between treated and control means (Tukey's test, $P < 0.05$).

4.5 CAPTIVE BREEDING

For the first time in New Zealand, two baby stoats or 'kits' were born in captivity in November 2001 (Fig. 10). During the previous October/November, four of the six females in captivity were found to be in oestrus, as indicated by vulval swelling and discharge. We believe that successful mating, based on the regression of the previously swollen vulva, was achieved in at least three of those four females. All six females remained in the facility under a minimal stress regime, and pregnancy was monitored until the birth of offspring. One litter of two kits was born and one other female, whose mammary glands had developed, probably also had a litter or carried to near term; however, we did not see any evidence of the kits.

During the 2001–2002 breeding season, at least 10 of the 12 females in the pens came into oestrus and were believed to have mated. This included the female kit that was born in captivity in November 2001. She was found to be sexually mature and in oestrus at 6 weeks of age, and was allowed to mate. Two litters of three kits were born from the ten female stoats in the captive breeding trial during this year. The female kit that was born and mated in captivity in 2001 did not produce kits that year.

During the 2002–2003 breeding season, at least nine adult females (including the captive-born female from 2001) in the pens came into oestrus and were mated. In addition, the two female kits that were born in 2002 were also mated at approximately 8 weeks old. One of the adult females was killed in April, owing to failure to thrive, and necropsy revealed that she had eight blastocysts *in utero*. During the third breeding season, two litters (of five and eight kits) were born. The successful litters were both from captive-born females: one was mated as an adult (born 2001) and the other was one of the 2002 kits.

In this third year, we provided a variety of foods, particularly high-protein foods, to all female stoats from mid-winter. The foods that they ate, and which we will continue to provide, included eggs, mice, rat heads and good quality dog roll. Other foods, which were provided but were not well accepted by the stoats, included fresh and pureed fruit, cat biscuits, and fresh and canned cat food. There seemed to be no obvious effect of nutrition (i.e. amount or types of food eaten) on breeding success.

Figure 10. The first stoat (*Mustela erminea*) kits born in captivity in New Zealand, November 2001. *Photo: Susie Scobie, Landcare Research.*

5. Conclusions

- Blastocysts survived in wild-caught female stoats that were brought into captivity; however, they did not successfully implant.
- Stoats were only willing to feed within the first hour of food being offered after 6 weeks in captivity. Their fear response to humans reduced after 8 weeks in captivity.
- Immunological responses improved between 4 and 12 weeks post-capture.
- Accurate techniques to monitor for both female oestrus activity and male testicular function in captive stoats have been developed using physical changes. In addition, changes in the cytology of vaginal washes can be used to identify oestrus.
- The exposure of stoats to a simulated summer day length in winter significantly advanced seasonal reproduction in both male and female stoats, and resulted in out-of-season mating.
- For the first time in New Zealand, stoats have been recorded as mating and giving birth in captivity. Both captive-born juvenile and wild-caught adult females were successfully mated. A total of 21 stoat kits have now been born at Landcare Research and nine of the captive-born females are part of the stoat captive breeding colony.

6. Recommendations

6.1 MANAGEMENT

- We recommend that stoats should be allowed to acclimatise to captivity for at least 8 weeks before being included in any physiological research.
- The successful captive breeding of stoats requires careful husbandry. Males should be introduced to mating enclosures only when females show signs of oestrus. Animals should be monitored for aggressive interactions (particularly when juveniles are present). Juvenile females may be mated at 6–8 weeks of age. Breeding success appears to be improved by using captive-born females and by providing varied and high-quality nutrition in a natural and minimal-stress environment.
- Captive-bred animals can provide high-quality animals for future stoat control research.

6.2 RESEARCH

- Improved stoat husbandry and handling techniques that have been developed during this research project plus our better understanding of stoat reproductive biology, behaviour and immunology should be utilised in stoat research projects that aim to develop improved stoat control technologies in New Zealand.
- Protocols for the robust testing of fertility control agents, including chemosterilants and immunocontraceptives, should be implemented.
- The husbandry of stoats, with due attention to stoat welfare, should be optimised so that pregnant stoats captured from the wild give birth. Methods need to be established to trigger reactivation of blastocysts in diapause, so that pregnant stoats (either captured from the wild or bred in captivity) give birth out-of-season.

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Appendix 1

HAEMATOLOGICAL PARAMETERS FOR RECENTLY CAPTURED AND ACCLIMATISED STOATS

Stoats were either recently captured (within 3 days) or acclimatised for more than 12 weeks. For each group of stoats (*Mustela erminea*; $n = 12$), male ($n = 5$) and female ($n = 7$) values were pooled. ANOVA results are presented; asterisks indicate significant differences ($P < 0.05$).

PARAMETER	RECENTLY CAPTURED		ACCLIMATISED		*F*	df	*P*
	MEAN	RANGE	MEAN	RANGE			
Haemoglobin (g/L) *	140.8	99–159	166.9	139–190	12.3	1, 21	0.002
Red blood cells ($\times 10^{12}$/L) *	9.87	6.6–11.8	12.28	10.1–14.9	17.0	1, 20	0.001
Hematocrit (L/L) *	0.42	0.31–0.47	0.47	0.39–0.54	5.4	1, 21	0.031
Mean corpuscular volume (fl) *	43.0	39–47	39.1	34–43	11.9	1, 20	0.002
Mean corpuscular haemoglobin (pg)	14.3	13.2–15.2	13.8	12.1–14.9	2.2	1, 21	0.15
Mean corpuscular haemoglobin concentration (g/L) *	332	315–344	353	340–365	29.6	1, 21	0.001
White blood cells ($\times 10^9$/L)	1.60	0.3–2.9	2.15	0.3–6.2	0.9	1, 22	0.35
Segmented neutrophils ($\times 10^9$/L)	1.23	0.15–2.67	1.10	0.15–2.42	0.14	1, 22	0.71
Lymphocytes ($\times 10^9$/L)	0.215	0.004–0.990	0.778	0.04–3.35	4.1	1, 22	0.056
Monocytes ($\times 10^9$/L)	0.122	0.05–0.16	0.127	0.02–0.33	0.23	1, 22	0.88
Segmented neutrophils (%) *	73.2	43–91	52.1	31–68	11.9	1, 22	0.002
Lymphocytes (%) *	14.4	3.0–34.0	30.9	14–54	11.8	1, 22	0.002