

# The biology of the stoat (*Mustela erminea*) in the National Parks of New Zealand

## VII. Fleas

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**Abstract** Among 680 fleas found on 1501 stoats there were 662 *Nosopsyllus fasciatus* (Bosc, 1800), 8 *Leptopsylla segnis* (Schönherr, 1811), 1 *Ceratophyllus gallinae* (Schrank, 1803), 1 *Parapsyllus n. nestoris* (Smit, 1965), and 8 unidentified. Five of the *L. segnis* were found on stoats from Craigieburn Forest Park, where mice carry mostly *L. segnis*; in Fiordland stoats, mice, and rats carry only *N. fasciatus*. The single *P. n. nestoris* also came from Craigieburn, where keas (*Nestor notabilis*) are common. Stoats caught in leg-hold traps had more fleas than those caught in humane Fenn traps, because the former lived longer after capture. Stoats found alive in either kind of trap had more fleas than stoats found dead. The incidence of fleas on stoats found alive was higher in beech forest than in podocarp or mixed forests but not significantly different between sexes and seasons.

**Keywords** *Mustela erminea*; New Zealand National Parks; trapping; Siphonaptera; *Nosopsyllus fasciatus*; *Leptopsylla segnis*; *Ceratophyllus gallinae*; *Parapsyllus nestoris*; host-parasite relationships.

### INTRODUCTION

During autopsy of a large number of stoats collected from 14 study areas in New Zealand, fleas were observed in the fur and occasionally also in the gut. As the fleas of New Zealand stoats have not been surveyed before, the opportunity was taken to record their identity and distribution.

The morphology, distribution, and hosts of the fleas of New Zealand were described by Smit (1979), who recorded *Nosopsyllus fasciatus* as occurring accidentally on the stoat.

The flea fauna of New Zealand is quite different from that of the rest of the world. Of a total of 34 taxa, 12 are found on mammals (i.e., 35% of the list, as against about 94% of the world list of flea species); of these, 11 are introduced and 1 is endemic. On the other hand, 22 taxa are found on birds (65%, as against 6% of the world list); only 1 is introduced. Stoats are liable to pick up almost any of the introduced mammal fleas, but fewer of the bird fleas, many of which are associated with seabirds (Smit 1979).

### MATERIAL AND METHODS

A total of 1501 stoats were searched for fleas. Before autopsy, each carcass was held over a pale background and thoroughly brushed against the lie of the fur; the plastic bag in which it had been wrapped was also carefully checked. Fleas were stored in 75% ethanol pending identification. Variations in field collection procedures influenced the results, but were mostly outside our control, as explained by King & Moody (1982a) and in Fig. 1. The most important of these variations were the type of trap used to kill the stoats; the frequency of inspection of traps; and whether the trapper always wrapped the dead stoat in a bag on the spot. Where humane traps, infrequently checked, were used by trappers who did not carry bags with them, many fleas were lost.

### RESULTS

#### Species of flea found

The overwhelming majority of the fleas identified (99% of 672) were rat fleas, *Nosopsyllus fasciatus* (Table 1). For only 1 collection area was this not so: only 22 of 28 fleas found on stoats from Craigieburn Forest Park were *N. fasciatus*, and 5 were *Leptopsylla segnis*. At Craigieburn quarterly rodent census lines were being operated simultaneously with the stoat trapping. A total of 97 carcasses of mice were examined, on which were found 43 *L. segnis* and 1 *N. fasciatus* (Table 2). No rats were caught at Craigieburn, in either rodent or stoat traps. In Fiordland, where rodent traps were also operated quarterly, only *N. fasciatus* was found on both rats and mice. Stoats from Fiordland carried only *N. fasciatus*.

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**Table 1** Species and relative incidence of fleas found on 181 stoats from New Zealand.

	Number of fleas		?sex	
	Male	Female		
<i>Nosopsyllus fasciatus</i> (Bosc, 1800)	209	453		662
<i>Leptopsylla segnis</i> (Schönherr, 1811)	1	7		8
<i>Ceratophyllus g. gallinae</i> (Schrank, 1803)	1			1
<i>Parapsyllus nestoris</i> (Smit, 1965)		1		1
Unidentified (fragments, or escaped)			8	8
	211	461	8	680

Single specimens of 2 other species of flea were found, both normally occurring on birds. On 1 stoat from the Eglington Valley, Fiordland, collected on 21 January 1973, a male *Ceratophyllus gallinae* was found, and on 1 stoat from Craigieburn, collected on 16 February 1975, there was a female *Parapsyllus n. nestoris*. *P. n. nestoris* is specific to the kea (*Nestor notabilis* Gould, 1856), an endemic alpine parrot common in the area. However, the known range of distribution of *P. nestoris* is not much extended by this find; many of Smit's records are from Arthur's Pass, which is only about 25 km north of Craigieburn.

**Table 2** Species and numbers of fleas found on stoats and rodents caught in the same collection areas.

	Craigieburn Forest Park			Fiordland National Park†			Hollyford Valley		
	Mice	Rats	Stoats	Mice	Rats	Stoats	Mice	Rats	Stoats
<i>N. fasciatus</i>	1	—	22	10	—	124	16	2	39
<i>L. segnis</i>	43	—	5	—	—	—	—	—	—
Unidentified	1	—	1	2	—	3	—	—	—
No. of hosts with fleas	18	—	12	10	—	45	4	1	11
No. of hosts searched	97	—	164	250	6	217	230	14	151

†Stoats collected 1972–1976. A further series of 241 stoats collected for another study in Fiordland from 1976 to 1978 (King, unpubl. data) yielded 117 more fleas, all *N. fasciatus* (44 males, 73 females)

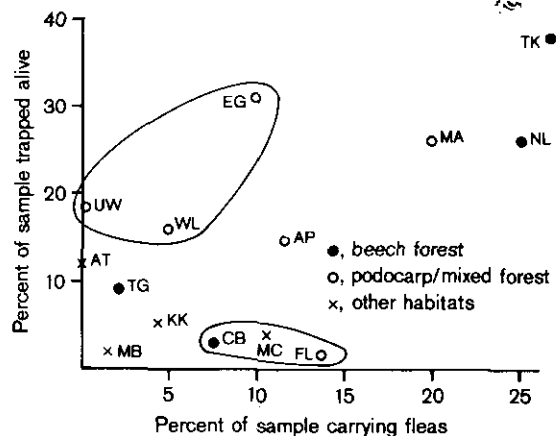
**Table 3** Influence of trap type and condition of trapped stoat on incidence of fleas.

	Numbers of stoats on which: fleas found no fleas found		
	fleas found	no fleas found	
Fenn trap	103	821	924
Gin trap	55	256	311
	158	1077	1235
	$\chi^2 = 8.91$		$0.01 > P > 0.001$
Alive when found	34	109	143
Dead when found	125	959	1084
	159	1068	1227
	$\chi^2 = 16.8$		$P < 0.001$

**Table 4** Frequency distribution of fleas on stoats recovered alive and dead.

No. of fleas	Stoat alive	Stoat dead	No. of fleas	Stoat alive	Stoat dead
0	109	959	8	2	3
1	13	77	9	0	2
2	6	15	10	0	0
3	5	7	11	0	2
4	1	6	12	0	2
5	3	3	13+	2	7
6	1	1		143	1084
7	1	0			

In a Mann-Whitney U-test,  $U = 67\ 312$  ( $z = 4.36$ )  $P < 0.01$



**Fig. 1** Relationship between the proportion of a sample of stoats that was trapped alive and the proportion found to be carrying fleas (abbreviations explained in King & Moody (1982a)). At UW, WL, and EG stoats were often caught alive in gin traps, and sent in by opossum trappers, who were not always equipped with plastic bags. At CB, MC, and FL most stoats were killed immediately in Fenn traps, but were usually collected within a day and bagged at once. Hence,  $r_s = 0.40$ ,  $N = 14$ , NS. The highest proportion of flea-infested stoats came from TK and NL, where the 3 factors most favouring collection of fleas—gin traps, daily inspection, immediate bagging—coincided.

**Table 5** Incidence of fleas on stoats trapped alive or shot, by season, sex, and habitat.

	SPRING		Females		SUMMER		Females		AUTUMN		Females		WINTER		Females	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Beech forest	35	20	66	3	11	9	40	5	44	16	80	5	25	12	100	3
Podocarp or mixed forest	17	6	—	2	—	5	25	4	—	10	—	3	7	15	—	6
Other habitats	25	4	33	3	—	5	—	3	14	7	50	2	—	3	—	2
	<b>30</b>	<b>30</b>	<b>38</b>	<b>8</b>	<b>5</b>	<b>19</b>	<b>25</b>	<b>12</b>	<b>24</b>	<b>33</b>	<b>50</b>	<b>10</b>	<b>13</b>	<b>30</b>	<b>27</b>	<b>11</b>

Difference between sexes:  $P = 0.18$  (2-tailed signs test)  
forest types:  $P = 0.008$  (2-tailed signs test, excl. 'other habitats')  
seasons:  $P = >0.1$  (Kruskal-Wallis 1-way analysis of variance;  $H = 0.225$ ,  $df = 23$ )

### Incidence

Fleas were found on 181 of the 1501 stoats searched, but the distribution of infested stoats was not random. Most of the stoats collected for this study were caught in Fenn traps, a humane type designed to kill quickly (King & Edgar 1977), and they generally carried fewer fleas than did stoats caught in gin traps, a traditional leg-hold type still frequently used by opossum trappers (Table 3). This is because fleas tend to leave a carcass as it cools. Of the stoats found still alive in a trap of either kind, twice as many had fleas as did stoats which were recovered dead (Tables 3 and 4). Hence, the proportion of the stoats in a given trapped sample which had fleas was markedly influenced by the proportion found alive (Fig. 1). There was considerable variation between study areas in the ratio of stoats caught in Fenn and gin traps (details in King & Moody (1982a)). Analysis of geographic variation in the incidence of infested stoats is clearly impossible from these data.

By considering only those stoats known to have been trapped alive or shot, some indication of the variation in incidence of fleas with sex, season, and habitat can be given (Table 5). In general, more females (34%) than males (20%) carried fleas, though not consistently in every season and habitat ( $P = 0.18$ ), and there is no difference in incidence between seasons. Stoats of both sexes from beech forest carried fleas significantly more often than those from mixed and podocarp forests ( $P = 0.008$ ), partly because many of the collection areas with high proportions of live gin-trapped stoats are classified as beech forest (Fig. 1). In the Eglinton and Hollyford valleys, 2 lines of experimental Fenn traps were laid out and operated between 1974 and 1976 in the same way, and were always inspected daily. In the Eglinton (beech) trap line incidence was 10.3% ( $n = 73$ ); in the Hollyford (podocarp and mixed forest) line it was 5.3% ( $n = 94$ ); but  $\chi^2 = 0.86$  ( $P > 0.05$ ).

### DISCUSSION

The poor species diversity of fleas on stoats in New Zealand forests is notable, and in marked contrast with the results of collecting fleas from weasels in Britain (King 1976, Mardon & Moors 1977). It is related to the paucity of fleas on the mammals and birds available as prey for stoats in New Zealand. The main foods of these stoats, described by King & Moody (1982b), were birds (probably mostly common native and introduced forest passerines), rabbits and hares, opossums, rats, mice, and an occasional hedgehog. Of the mammals, only rats and mice have their own fleas in the areas surveyed.

King (1976) suggested that weasels and stoats usually pick up their fleas from nests (of prey or non-prey species) which they have hunted through or slept in, rather than directly from the bodies of prey animals being eaten. A warm nest is important to a stoat, because as Brown & Lasiewski (1972) have shown, small mustelids generally are unable to curl up into a ball, the most efficient shape for reducing heat loss during sleep. In New Zealand, stoats would be likely to pick up fleas only in rats' nests, so it was not surprising to find *N. fasciatus* the commonest flea on stoats.

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### REFERENCES

- Brown, J. H.; Lasiewski, R. C. 1972: Metabolism of weasels: the cost of being long and thin. *Ecology* 53: 939–943.

- King, C. M. 1976: The fleas of a population of weasels in Wytham Woods, Oxford. *Journal of zoology (London)* 180: 525-535.
- King, C. M. Edgar, R. L. 1977: Techniques for trapping and tracking stoats (*Mustela erminea*): a review and a new system. *New Zealand journal of zoology* 4: 193-212.
- King, C. M.; Moody, J. E. 1982a: The biology of the stoat (*Mustela erminea*) in the National Parks of New Zealand. I. General introduction. *New Zealand journal of zoology* 9: 49-55.
- 1982b: The biology of the stoat (*Mustela erminea*) in the National Parks of New Zealand. II. Food habits. *New Zealand journal of zoology* 9: 57-80.
- Mardon, D. K.; Moors, P. J. 1977: Records of fleas collected from weasels (*Mustela nivalis* L.) in northeast Scotland (Siphonaptera: Hystrichopsyllidae and Ceratophyllidae). *Entomologist's gazette* 28: 277-280.
- Smit, F. G. A. M. 1979: The fleas of New Zealand. *Journal of the Royal Society of New Zealand* 9: 143-232.