

DEER MOUSE, *PEROMYSCUS MANICULATUS*, AND ASSOCIATED RODENT FLEAS (SIPHONAPTERA) IN THE ARCTIC-ALPINE LIFE ZONE OF ROCKY MOUNTAIN NATIONAL PARK, COLORADO

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ABSTRACT.— *Peromyscus maniculatus* and related small rodents have been examined for ectoparasites in the tundra region of the Rocky Mountain National Park 1974–1979. One hundred and ninety-four *P. maniculatus* were examined from two tundra sites. Flea infestation rates were 1.9 fleas per mouse examined and 4.1 fleas per infested mouse. Species taken in significant numbers were *Monopsyllus thambus* (51 percent), *Peromyscopsylla hesperomys* (34 percent), *Malaraeus euphorbi* (9 percent), and *Catallagia calisher* (4 percent). *Peromyscus maniculatus* host/flea relationships in the tundra are compared with those in other life zones in the park.

Personnel of the Vector-Borne Diseases Division have studied ectoparasite/host relationships in the Rocky Mountain National Park (RMNP) for a number of years. Of principal interest have been vectors and reservoirs of *Yersinia pestis* and Colorado tick fever virus. All life zones in the Park have been investigated. Because of a dearth of published information concerning fleas and other ectoparasites of rodents in the arctic-alpine life zone of the Rocky Mountains, data obtained during the period 1974–1979 in the zone are presented here. Emphasis has been placed on the deer mouse, *Peromyscus maniculatus*, as it is by far the most abundant rodent in the zone. *Peromyscus maniculatus* fleas in the tundra are compared with those in other life zones.

STUDY AREA

The RMNP is located in Larimer and Boulder counties in north central Colorado. It covers 1046 km² of mountainous terrain, with elevations ranging from 2400 to over 4300 m.

Regional ecosystems of north central Colorado, with approximate elevations as defined by Marr (1961), include the grassland-lower montane ecotone region (1707–1829 m),

lower montane forest climax region (1829–2347 m), lower montane-upper montane ecotone region (2347–2438 m), upper montane forest climax region (2438–2743 m), upper montane-subalpine ecotone region (2743–2835 m), subalpine forest climax region (2835–3353 m), subalpine-alpine ecotone region (3353–3475 m), and alpine tundra climax region (3475 m-mountain tops).

Collections in the tundra were concentrated at sites 1 and 2, located as shown in Figure 1. Site 1 is 2.5 km west of Rainbow Curve on Trail Ridge Road at an elevation of around 3475 m. Site 2 is on Fall River Road, some 1.5 km below the Alpine Visitors Center at an elevation of approximately 3523 m. Sites 1 and 2 are in areas with limited human activity. Trapping was confined to an area of 5 or 6 ha in both locations. In the tundra (Fig. 2) short grasses, sedges, and forbes predominate in the exposed meadows. Somewhat taller grasses and dwarf shrubs are found in low-lying areas partially protected from the violent winds that sweep the tundra.

METHODS

Mammals were captured in the tundra, primarily in Sherman live traps (7.62 × 7.62

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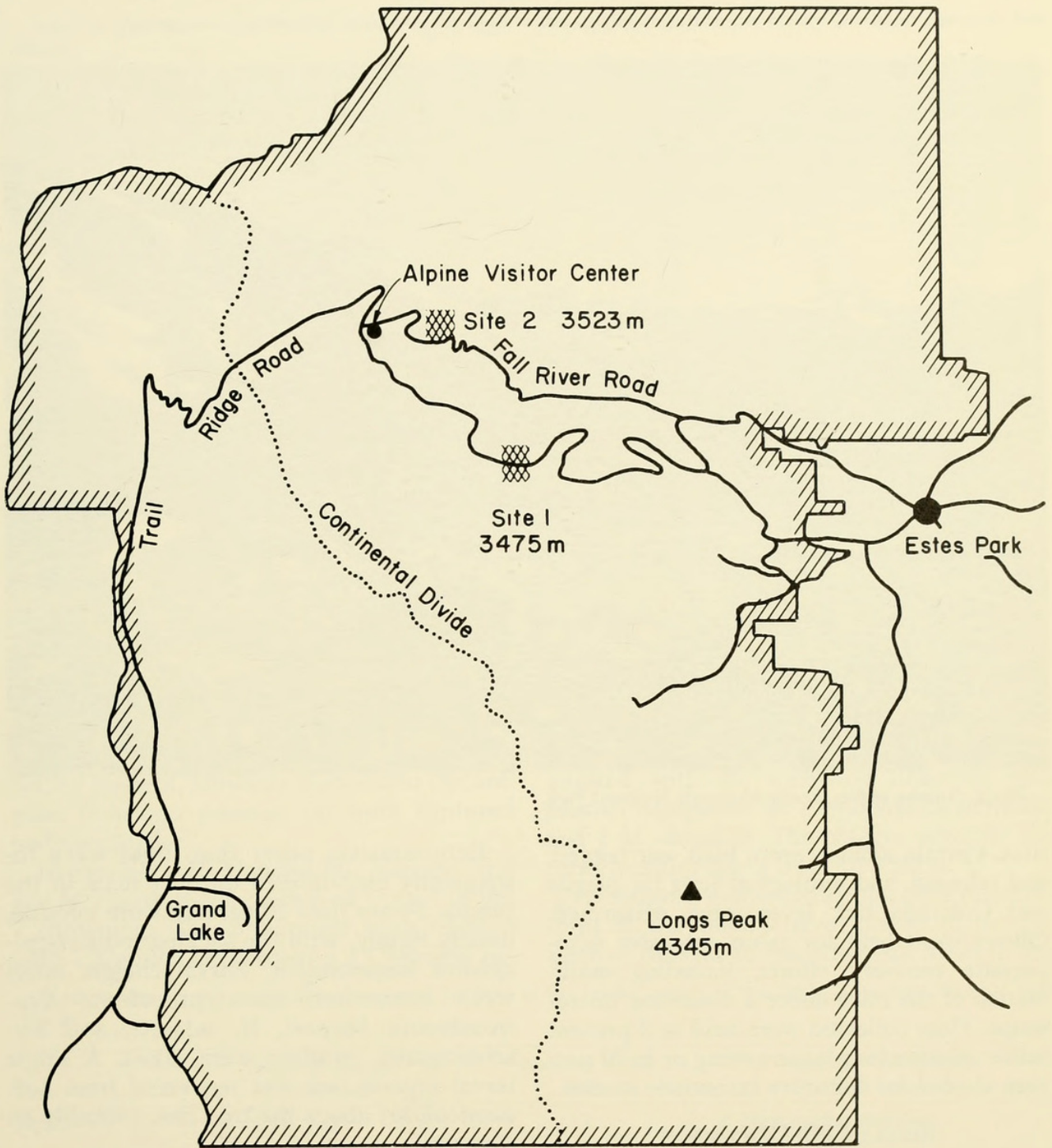


Fig. 1. Flea collection sites in the Rocky Mountain National Park, Larimer County, Colorado.

$\times 22.86$ cm), with National live traps ($12.7 \times 12.7 \times 40.64$ cm) also used on occasion. No attempts were made to collect larger mammals. Traps baited with rolled oats were set in parallel lines of 20 stations at approximately 20 m intervals. Traps were placed adjacent to rocky outcroppings, when available, to provide trapped rodents some protection from the elements. The number of lines varied, but there were usually 4 or 5, 25 m apart. Traps were set in the morning and inspected the following day.

Trapping in the tundra was limited to the summer months. Trail Ridge and Fall River roads were only open to vehicular traffic June–September, with some closures at irregular intervals during this period due to hazardous driving conditions.

As the Sherman traps were picked up, those containing rodents were placed in plastic bags to prevent loss of fleas during transport to a field laboratory. Each mammal was lightly anesthetized with ether and brushed in a white enamel pan to remove ectopara-



Fig. 2. Tundra region, Rocky Mountain National Park.

sites. Certain animals were bled, ear tagged, and released, and serological tests for plague and Colorado tick fever were performed. Others were held for more extensive ectoparasite recovery efforts, including examination of the mice under a dissecting microscope. Fleas collected were held in 2 percent saline solution for plague testing or in 70 percent alcohol for definitive taxonomic studies.

RESULTS AND DISCUSSION

Trapping over a six-year period (1974–79) has provided considerable information on deer mouse host/flea relationships in the Colorado tundra region. As shown in Table 1, 156 *P. maniculatus* were captured in this period during the summer months at Site 1. An average of 8 *P. maniculatus* were taken per 100 trap nights. About 47 percent were infested with fleas, with a mean number of 2.1 fleas per animal examined and 4.4 per infested animal. Site 2 was trapped less frequently than Site 1. As shown in Table 2, the flea burden was 1.1 fleas per mouse and 2.9 fleas per infested mouse.

Ectoparasites other than fleas were infrequently encountered on deer mice in the tundra. Fewer than 10 percent were infested, usually lightly, with the sucking louse, *Hoplopleura hesperomydis*. Larval chigger mites were somewhat more prevalent. *Neotrombicula harperi*, *N. microti*, and *Euschoengastia guntheri* were taken. A single larval argasid tick was recovered from a *P. maniculatus* above the tree line, probably an *Argas* sp.

The second most prevalent rodent taken in the tundra was the heather vole, *Phenacomys intermedius*. Twenty-three were examined, and 65 percent were infested with three species of fleas at the rate of 2.4 fleas per animal and 3.6 per infested animal. Species included *Peromyscopsylla selenis* (67 percent), *Megabothris abantis* (19 percent), and *Monopsyllus thambus* (15 percent). Two species of chigger mites, *N. harperi* and *E. guntheri*, were recovered from heather voles. One vole was heavily infested and several lightly infested with the dermanyssid mite *Hirstionyssus isabellinus*.

TABLE 1. *Peromyscus maniculatus* examined for fleas in the tundra region of the Rocky Mountain National Park (Site 1).

Date	Percent traps with <i>P. manic.</i>	Number <i>P. manic.</i>	Number with fleas	Total fleas	Mean number fleas/animal	Mean number fleas/infested animal
7-16-74	9	11	6	19	1.73	3.17
7-24-74	8	6	3	31	5.17	10.33
8-14-74	10	10	4	11	1.1	2.75
8-15-74	8	6	3	16	2.67	5.33
9-26-74	15	18	4	6	.33	1.5
8-22-75	14	17	11	19	1.12	1.73
8-18-76	6	7	3	7	1.0	2.33
6-29-77	7	2	2	10	5.0	5.0
8-17-77	5	10	4	22	2.2	5.5
9-02-77	5	4	3	6	1.5	2.0
9-09-77	10	4	1	4	1.0	4.0
6-27-78	5	6	4	26	4.33	6.5
7-07-78	3	3	1	2	.67	2.0
7-25-78	5	4	2	12	3.0	6.0
8-03-78	3	4	4	6	1.5	1.5
9-07-78	16	17	7	22	1.29	3.14
7-10-79	7	7	3	16	2.29	5.33
7-18-79	6	6	3	54	9.0	18.0
8-24-79	12	14	6	36	2.57	6.0
	8.11	156	74	325	2.08	4.39

Lesser numbers of the least chipmunk, *Eutamias minimus* (7); golden-mantled ground squirrel, *Spermophilus lateralis* (3); yellow-bellied marmot, *Marmota flaviventris* (2); and pika, *Ochotona princeps* (3) were captured and examined.

Eleven fleas, 10 *Monopsyllus eumolpi*, and one *M. thambus* were removed from 4 of the 7 chipmunks. The 2 marmots were infested with 7 *Thrassis stanfordi* and 2 *Oropsylla ru-*

pestris. Three *Oropsylla idahoensis* were recovered from 2 of the 3 golden-mantled ground squirrels. The 3 pikas examined were infested with the following fleas: 46 *Amphalius necopinus*, 46 *Ctenophyllus terribilis*, and 1 *M. thambus*. The chigger mite, *N. mi-croti*, was also taken from all 3 pikas.

Peromyscus maniculatus host/flea relationships in the tundra have proven to be distinctive relative to the other life zones in the

TABLE 2. *Peromyscus maniculatus* examined for fleas in the tundra region of the Rocky Mountain National Park (Site 2).

Date	Number of mice trapped	Number with fleas	Number and species of fleas
7-17-74	3	1	2 <i>Monopsyllus thambus</i>
7-24-74	4	2	3 <i>M. thambus</i> 1 <i>Malaraeus euphorbi</i>
8-17-77	10	4	9 <i>M. thambus</i> 7 <i>M. euphorbi</i> 4 <i>Peromyscopsylla hesperomys</i> 1 <i>Megabothris abantis</i> 1 <i>Catallagia calisheri</i>
9-02-77	4	3	5 <i>P. hesperomys</i> 2 <i>M. thambus</i> 1 <i>C. calisheri</i>
9-09-77	15	4	3 <i>M. thambus</i> 2 <i>P. hesperomys</i> 1 <i>M. euphorbi</i>
9-24-77	2	1	1 <i>Peromyscopsylla selenis</i>
TOTALS	38	15	43

RMNP. As shown in Table 3, 21 species were recovered in 1974 and 20 in 1975 in all life zones. This is well over twice the number of species found to be parasitizing deer mice in the tundra. The 2 × ratio remains virtually unchanged when the recoveries are limited to normal or true parasites of deer mice, excluding species that have strayed from environmental associates.

Monopsyllus wagneri was the principal flea below the treeline (68 percent); over 60 percent of the deer mice were infested in 1974–1975. The only other prevalent species were *Malaraeus telchinum* (10 percent of total fleas) and *Opisodasys keeni* (8 percent of total fleas). Each of the other 11 species normally parasitic on deer mice made up 1–5 percent of the total fleas. As shown in Table 4, mean infestation rates for the 2,090 *P. maniculatus* examined in all life zones in the RMNP in 1974–76 were 1.2 fleas per mouse and 2.5 fleas per infested mouse.

Higher flea infestation rates per deer mouse were obtained in the tundra than in

the other life zones. This may be a reflection of more intensive examination of the mice in the tundra. Also, tundra mice were usually held for several examinations, and in the other life zones normal procedure was to inspect them once, tag and release them. A total of 194 deer mice were examined from the two tundra sites, and 368 fleas were recovered from 89 of them. This is a rate of 1.9 fleas per mouse examined and 4.1 fleas per infested mouse.

In the tundra, fewer species were involved in parasitizing deer mice than in the other life zones. Only four were taken in significant numbers. *Monopsyllus wagneri* disappears completely from the mice in the tundra and is replaced by *M. thambus* (51 percent of total fleas at Site 1 and 44 percent at Site 2). Overlapping of the two species occurred at Rainbow Curve, elevation approximately 3290 m. This scenic overlook consists of an exposed rocky slope with large boulders bordered by subalpine forest.

TABLE 3. Species of fleas from *Peromyscus maniculatus* in all life zones in Rocky Mountain National Park in 1974–1975.

Species	1974 Number of fleas—1,018		1975 Number of fleas—1,357	
	Percent of total fleas	Percent of animals with species	Percent of total fleas	Percent of animals with species
CERATOPHYLLIDAE				
<i>Malaraeus euphorbi</i>	1	1.3	1.5	1.3
<i>M. telchinum</i>	5.9	7.3	14.5	17.5
<i>Megabothris abantis</i>	< 1	< 1	< 1	< 1
<i>Monopsyllus eumolpi</i>	< 1	< 1	< 1	< 1
<i>M. thambus</i>	4.1	3.6	< 1	< 1
<i>M. wagneri</i>	64.8	60.8	70.3	60
<i>M. vison</i>	< 1	< 1	< 1	< 1
<i>Opisocrostis labis</i>	< 1	< 1	< 1	< 1
<i>Opisodasys keeni</i>	9.9	9.5	5.8	7.3
<i>Orchopeas leucopus</i>	< 1	< 1	—	—
<i>Oropsylla idahoensis</i>	1	1.7	< 1	1.6
HYSTRICHOPSYLLIDAE				
<i>Callistopsyllus deuterus</i>	—	—	< 1	< 1
<i>Catallagia calisheri</i>	< 1	< 1	< 1	< 1
<i>C. decipiens</i>	4.4	3.9	1.8	3
<i>C. neweyi</i>	< 1	< 1	< 1	< 1
<i>Epitedia wenmanni</i>	2.4	4.1	2	3.6
<i>Hystrichopsylla occidentalis</i>	< 1	< 1	< 1	< 1
<i>Megarhthroglossus</i> sp.	< 1	< 1	—	—
<i>M. divisus</i>	—	—	< 1	< 1
<i>Rhadinopsylla sectilis</i>	< 1	< 1	< 1	< 1
LEPTOPSYLLIDAE				
<i>Amphipsylla sibirica</i>	< 1	< 1	< 1	< 1
<i>Peromyscopsylla hesperomys</i>	4.2	4.5	< 1	1.9
<i>P. selenis</i>	< 1	< 1	—	—

TABLE 4. Summary of flea collections from *Peromyscus maniculatus* from all life zones in Rocky Mountain National Park, 1974-1976.

Year	Number of mice examined for fleas	Number of mice with fleas	Percent of mice infested	Total number of fleas	Number of fleas/mouse	Number of fleas/infested mouse
1974	955	431	45.1	1,018	1.1	2.4
1975	957	507	53.0	1,357	1.4	2.7
1976	178	80	44.9	183	1.0	2.3
TOTALS	2,090	1,018	48.7	2,558	1.2	2.5

Peromyscopsylla hesperomys was the second most prevalent *P. maniculatus* flea in the tundra (35 percent of the total fleas at Site 1 and 26 percent at Site 2). This flea is found on deer mice in all life zones of the RMNP but in much smaller numbers at the lower elevations, making up <5 percent of the total fleas collected in the park.

The third most common species on deer mice in the tundra, *Malaeraeus euphorbi* (7 percent of the total fleas at Site 1 and 21 percent at Site 2) was also more prevalent than at lower altitudes. Less than 2 percent of total fleas collected in the park were this species.

A nest flea, *Catallagia calisheri*, was a poor fourth on tundra deer mice. However, the fact that 4 percent of the fleas at Site 1 and 5 percent at Site 2 were this species is indicative of much greater numbers in the nests. *Catallagia calisheri* was not taken below the tree line. At lower elevations in RMNP, the common deer mouse nest *Catallagia* was *decipiens*. Single specimens of the nest fleas, *Callistopsyllus deuterus* and *Megarhroglossus* sp. (female) were taken from deer mice in the tundra. Both genera were also rarely encountered in other RMNP life zones. *Orchopeas leucopus*, a common *Peromyscus* parasite at lower elevations, was rare in the park. It was taken but once in the tundra and once in other RMNP life zones. The only other fleas taken from deer mice in the tundra were a few *Megabothris abantis* and *Peromyscopsylla selenis*, strays from heather voles.

CONCLUSIONS

Our data concerning the fleas of *P. maniculatus* support the conclusions of Wenzel

and Tipton (1966) that the altitudinal ranges of many ectoparasites do not necessarily coincide with those of the hosts. *Peromyscus maniculatus* is prevalent in the RMNP at all elevations. However, vertical stratification is evident in the species of fleas parasitizing them, especially at the upper levels. In the tundra, around 3475 m, the number of flea species on *P. maniculatus* was greatly reduced from the lower elevations, but the mean number per animal was somewhat higher. Only four species were encountered in significant numbers on *P. maniculatus* in the tundra. *Monopsyllus thambus* and *Catallagia calisheri*, found only on the tundra, replaced *M. wagneri* and *C. decipiens* of lower elevations, respectively. *Peromyscopsylla hesperomys* and *Malaraeus euphorbia*, found at all elevations studied in RMNP, were significantly more prevalent on *P. maniculatus* in the tundra than at lower elevations.

ACKNOWLEDGMENTS

Excellent cooperation has been received from naturalists of the National Park Service, U.S. Department of Interior, during these studies. Ray Bailey, Vector-Borne Diseases Division statistician, was most helpful in supplying computerized data. Gary Maupin took the tundra photograph. Numerous persons, presently and formerly with VBDD, contributed to the field investigations. Included were Dr. R. G. McLean, Dr. A. M. Barnes, Ronald Shriner, Karen Pokorny, Gary Maupin, Leon Carter, Edwin Heidig, William Archibald, and David Pegg.

Taxonomic assistance was kindly provided by the following authorities: Dr. J. E. Keirans (ticks), Dr. R. B. Loomis (chigger mites), and Dr. K. C. Emerson (sucking lice).



Eads, Richard B. and Campos, E. G. 1983. "DEER MOUSE, PEROMYSCUS MANICULATUS, AND ASSOCIATED RODENT FLEAS (SIPHONAPTERA) IN THE ARCTIC-ALPINE LIFE ZONE OF ROCKY MOUNTAIN NATIONAL PARK, COLORADO." *The Great Basin naturalist* 43, 168–174.

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