

T H E S I S

NOTES ON SOME EXTERNAL INSECTA AND ACARINA
PARASITES OF THE RODENT FAMILY
SCIURIDAE OF COLORADO

Submitted by

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In partial fulfillment of the requirements
for the Degree of Master of Science
Colorado Agricultural College
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PARASITES OF THE RODENT FAMILY SCIURIDAE OF COLORADO
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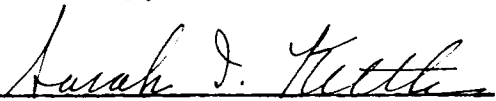
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This is to certify that S. C. McCampbell has translated for me assigned passages of technical French, bearing upon his graduate Entomological work.

Respectfully,


Head of Department of
Modern Languages

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NOTES ON SOME ANOPLURA PARASITES OF THE
RODENT FAMILY SCIURIDAE OF COLORADO

INTRODUCTION

Kellogg and Ferris (1) have called attention to the importance, from the economic and medical point of view, of a knowledge of the blood-sucking parasites of mammals.

Special attention has been given to parasites of the SCIURIDAE of Colorado. The literature on ANOPLURA of this host family is not extensive. This paper attempts to summarize these records and list those made by the author.

ANOPLURA constitutes one of the smallest orders of insects, containing six families according to Ewing (3), and comprised of about 200 species and subspecies.

In speaking of the sucking lice infesting the SCIURIDAE of Colorado, or of North America, we are concerned with but one family, the HAEMATOPINIDAE. This family has by far the largest number of species in the order. In it are included twenty-nine genera and more than half of the species of sucking lice.

Of the family HAEMATOPINIDAE we are concerned with the three genera, Neohaemotopinus, Enderleinellus and Hoploplura. If we considered the SCIURIDAE of the United States, a fourth genus, Microphthirus, would be discussed, as members of this group are found on flying squirrels which do not occur in Colorado, but are

found as close as Wyoming.

I wish to express my appreciation to Dr. C. P. Gillette, who has given so generously of his time and council on this work; to Dr. G. F. Ferris, who has looked over all ANOPLURA material and checked all determinations, and to Mr. W. L. Burnett, who has accompanied me on field trips and assisted in the identification of host material.

MATERIALS AND METHODS

Host Material:-

ANOPLURA have been collected from animals killed in the field and from study skins that were in the rodent collection of the Colorado Agricultural College. Of the 28 species and subspecies of SCTURIDAE that occur in Colorado, 177 individuals, representing 22 species and subspecies, have been examined for ANOPLURA. Although lice were taken from only 11 species and subspecies, there is no reason to believe that a single species in the State is free from sucking lice.

Methods:-

ANOPLURA were removed from dried skins by use of a brush and fine comb. Freshly killed hosts were dusted with Derris or insect powder before combing the hair. The dusts usually caused the lice to release their attachment to the skin of the host and crawl about on the

hair, where the larger ones were removed with the aid of small forceps. Specimens taken in the field were preserved in 70 percent alcohol.

Specimens were prepared for study by mounting on slides. The technique for the preparation of material was similar to that given by Ferris (2).

SPECIES RECORDS

According to the present data, the most common genus of ANOPLURA, infesting the SCIURIDAE of Colorado, is Neohaematopinus. This genus is characterized by Ferris (4) as follows:

Genus Neohaematopinus Mjoberg

"Anoplura without eyes; with five-segmented antennae which are usually sexually dimorphic, the third segment in the male having the distal preaxial angle more or less produced and bearing one or two stout, recurved setae, some species having the first segment in both sexes with distal post-axial angle bearing a very stout seta or with such seta near the posterior margin of this segment; with the anterior legs small and weak, the middle and posterior legs much larger, sub-equal and with stout claw; pleural plates always present on the second to eighth segments and at times in vestigial forms on the first segment, the plates of the second segment showing no traces of a longitudinal division; females with two (exceptionally three) rows of setae on the second to seventh tergites and the second to sixth sternites of the abdomen, these either accompanied wholly or in part by, or entirely without, chitinized plates; males always with two rows of setae on the second tergite and the second to the sixth sternites of the abdomen, exceptionally with two rows on the second to sixth tergites, the second plate of the second tergite always more or less emarginate posteriorly; sternal plates of the third abdominal segment never, and of the second rarely, extending from pleuete to pleurite; head usually with strong post-antennal angles and a distinctly constricted occipital region; genitalia of the males of

no constantly distinctive type."

The systematic position of Neohaematopinus seems between Polyplax and Eulinognathus. There are fifteen species and subspecies. Seven species and subspecies occur in the United States on members of the family SCIURIDAE. Two species and one subspecies have been recorded from Colorado. Only two, however, were taken by the author.

Neohaematopinus sciurinus sciurinus (Mjoberg) has been recorded from Sciurus aberti ferreus True, at Colorado Springs, but the author has not been able to duplicate this record.

Neohaematopinus laeviusculus (Grube)

Previous records for Colorado are as follows:

Cynomys leucurus Merriam, Routt County, (Ferris); Western gray squirrel, Ft. Collins, (Osborn); rock squirrel, Boulder Canon, (Kellogg & Ferris); Citellus elegans elegans Kenn., Colorado Springs, (Kellogg & Ferris).

Of the four previous records for Colorado listed above, only one is correct as to host. The record of Citellus elegans elegans is in error as Colorado Springs is far out of the range of this species. The western gray squirrel is probably Sciurus aberti ferreus, but, as Otospermophilus g. grammurus (Say) occurs in the same locality, the record cannot be definite as to host.

Quite likely the "rock squirrel" was Otospermophilus g. grammurus.

Records by Author

Two records from Citellus t. pallidus Allen, are as follows: Round Buttes, Larimer County, Sept. 22, 1926 (Colo. Acc. No. 4204), and Divide, June 19, 1905 (Colo. Acc. No. 4652). Four records from Citellus elegans elegans are as follows: Virginia Dale, June 30, 1926 (Colo. Acc. No. 4236); Alma, July 12, 1927 (Colo. Acc. No. 4357); Kremmling, Aug. 15, 1928 (Colo. Acc. No. 4487); Craig, May 29, 1928 (Colo. Acc. No. 4461). One record of Cynomys leucurus, Jackson County, July 12, 1926 (Colo. Acc. No. 4234). One record of Cynomys ludovicianus ludovicianus Ord., Round Buttes, Larimer County, June 18, 1928 (Colo. Acc. No. 4536). One record of Callospermophilus lateralis lateralis Say, Jackson County, July 13, 1926 (Colo. Acc. No. 4253).

Of the five different species of hosts recorded for laeviusculus for Colorado, all except Cynomys leucurus, are new records.

The distribution of laeviusculus as to hosts is confined to members of the rodent family SCIURIDAE. Geographically their distribution is not confined to the United States. Records from Siberia (Grube) (4) and Alaska (Kellogg & Ferris) (4) have been established.

Neohaematopinus marmotae Ferris

The systematic position of marmotae is very close to laeviusculus, however, Ferris saw fit to erect a new species rather than form a subspecies to laeviusculus. The following description is quoted from the original written by Ferris (4):

"Female. Length 2.3 mm. In general quite closely resembling N. laeviusculus but differing notably in its much larger size, heavier chitinization of all parts, in having the sternal plate of the thorax (Fig. 171C) quite differently shaped and more weakly chitinized and in having the thoracic spiracles (Fig. 171F) strikingly large, these spiracles in laeviusculus being very small (Fig. 171G).

"Male. Length 1.7 mm. Differing in the same respects as does the female. With the third segment of the antennae (Fig. 171H) slightly modified and bearing a single stout seta. With the genitalia (Fig. 171E) slightly different, the parameres (par) being heavier and tapering sharply near the tips instead of tapering gradually, the pseudopenis (pp) with the arms less expanded.

"Notes. This seems to be sufficiently distinct from N. laeviusculus to merit full specific standing. The specimen from Marmota aurea is evidently quite close to this but is not in good condition and is referred here only tentatively.

"Previous Records.-From Marmota flaviventer (= flaviventris) sierrae, Yosemite National Park, Calif.

"Specimens Examined. -The types (holotype a male) from the above. Also from 'ground hog', Marmota sp., Florence, Montana (F. C. Bishopp).

"A single male from Marmota aurea, Tagdumdash, Pamir, Asia (U.S.N.M. 62116) is doubtfully referred here."

The following records by the author are all from Marmota flaviventris luteola Howell; Pingree Park, Larimer

County, Aug. 18, 1926 (Colo. Acc. No. 4243); Virginia Dale, June 6, 1926 (Colo. Acc. No. 4246); Jackson County, July 14, 1926 (Colo. Acc. No. 4247); Jackson County, near Rabbit Ears Pass, Aug. 15, 1928 (Colo. Acc. No. 4486).

The above records by the author are new for Colorado as marmotae has not been reported from this state. The host records are also new.

Genus Enderleinellus Fahrenholz

Description of genus from Ferris (5).

"Anoplura without eyes; with five-segmented antennae which are not sexually dimorphic; with the anterior and middle pairs of legs of equal size, small and weak and with weak claws, the posterior pair very stout with broad, heavy claws; second sternite of the abdomen usually with a pair of small sclerites, each of which bears a backward-pointing, chitinous process; pleural plates present on a variable number of segments; each segment of the abdomen both dorsally and ventrally, with at the most a single transverse row of spines or hairs; tergites and sternites of the abdomen without chitinized plates or with these very small; head more or less cylindrical, never with well marked anterior-lateral and posterior-lateral angles; genitalia of males of various types.

"Hosts confined, as far as known, to members of the rodent family Sciuridae."

Ferris (5) states that the affinities of this genus are at present extremely rare. The genus is composed of nineteen species, eight of which are listed for the United States. One species Enderleinellus tamiasis has been inadequately described, and if discarded, reduces the United States records to seven

species. Three species of Enderleinellus have been recorded from Colorado. They are as follows: Enderleinellus suturalis Osborn; Enderleinellus longiceps Kellogg & Ferris; Enderleinellus nitzschi Fahrenholz.

The author has taken the first two species listed, E. nitzschi has been recorded from Sciurus f. fremonti Audubon and Bachman by Ferris(5). None of the ten specimens of fremonti examined carried lice.

Enderleinellus suturalis Osborn

Previous Colorado records are as follows: Citellus elegans elegans, Sulphur Springs, Colo.; Cynomys gunnisoni, Florissant, Colo., Cynomys leucurus, Routt County, Colo. These records were published by Ferris (5) but he did not give the name of the collector.

Colorado Records by the Author

Two records of Citellus t. pallidus, one at Ft. Collins, June 14, 1923 (Colo. Acc. No. 4651); one at Ft. Collins, (Colo. Acc. No. 4653); one record Cynomys g. gunnisoni Baird, Alma, July 12, 1927 (Colo. Acc. No. 4358); one record Citellus t. parvus, La Jara, June 23, 1926 (Colo. Acc. No. 4254).

Citellus t. parvus is a new host record, while pallidus is a new record for Colorado hosts, having been recorded previously in Kansas.

Enderleinellus longiceps Kellogg & Ferris

This species has been previously recorded from Sciurus aberti ferreus, Estes Park, Colo. The author took this species from Sciurus a ferreus, Livermore, Larimer County, Aug. 5, 1926 (Colo. Acc. No. 4206).

Genus Hoplopleura Enderlein

This genus was described by Ferris (6) as follows:

"Anoplura without eyes; with five-segmented antennae which are not sexually dimorphic; with the anterior legs small and weak and with weak, slender claw, the middle legs somewhat larger and with stouter claw, the posterior legs still larger, more or less flattened and with stout, blunt claw and usually with a tooth-like 'olecranon process' at the outer proximal angle of the tibia; pleural plates always well developed, present on at least the first to seventh segments, the first pair always small and lying upon the dorsum; female usually with the third to seventh abdominal tergites and sternites bearing three transverse rows of setae (and usually with a like number of chitinized plates), but occasionally with three rows of setae on the third tergite and sternite only, the other segments with not more than two; male always with two rows of setae on the third to seventh sternites, and the third tergite usually with but one row of setae on the remaining tergites, but occasionally with two on the fourth to seventh; first plate of the third sternite in both sexes usually extending from pleurite to pleurite and usually with two pairs (or occasionally two groups of three) of conspicuously enlarged setae; head usually with slight post-antennal angles and without a constricted occipital region; genitalia of the males of a quite uniform type, the basal plate undivided, the parameres large and usually enclosing the pseudopenis.

"Hosts. Occurring as far as known only on rodents of the families Muridae (the rats and mice, Sciuridae (the squirrels), Petauristidae (the flying squirrels), and Octodontidae (the coypus and tucotucos). The genus appears to be especially characteristic of the first two families named."

This is a rather large genus containing forty-six species and subspecies. Seven species and subspecies have been recorded from the United States. Four of the United States species occur on SCIURIDAE, but none of the four have been previously recorded from Colorado. The only previous record for Hoplopleura in Colorado was from the "grasshopper mouse", Onychomys leucogaster arcticeps (Rhoads), Colorado Springs.

Hoplopleura erratica arboricola Kellogg & Ferris

I believe this is the first record for Colorado for this parasite. The host records appear to be new for this species.

Three records for Eutamias m. operarius Meriam, are as follows: Conejos River, Conejos County, June 23, 1926 (Colo. Acc. No. 4225); Elkhorn, Larimer County, Nov. 12, 1911 (Colo. Acc. No. 4677); Virginia Dale, Nov. 12, 1912 (Colo. Acc. No. 4678). Two records for Eutamias g. quadrivittatus Say as follows: Palmer Lake (Colo. Acc. No. 4654); Larimer County (Colo. Acc. No. 4655). Two records for Eutamias sp. as follows: Willow Creek Pass, Grand County, Aug. 14, 1928 (Colo. Acc. No. 4488); Jackson County, July 14, 1926 (Colo. Acc. No. 4255).

	<u>Hoplopleura e. arboricola</u>	<u>Enderleinellus nitzschi</u>	<u>Enderleinellus longiceps</u>	<u>Enderleinellus suturalis</u>	<u>Neohaematopinus marmotae</u>	<u>Neohaematopinus laeviusculus</u>	<u>Neohaematopinus s. sciurinus</u>
<u>Marmota f. luteola</u>					4		
<u>Otospermophilus g. grammurus</u>						1?	
<u>Callospermophilus l. lateralis</u>						1	
<u>Citellus e. elegans</u>				1		4	
<u>Citellus t. pallidus</u>				2		2	
<u>Citellus t. parvus</u>				1			
<u>Cynomys l. ludovicianus</u>						1	
<u>Cynomys leucurus</u>				1		2	
<u>Cynomys g. gunnisoni</u>				2			
<u>Eutamias m. operarius</u>	3						
<u>Eutamias q. quadrivittatus</u>	2						
<u>Eutamias sp.</u>	2						
<u>Sciurus f. fremonti</u>		1					
<u>Sciurus a. ferreus</u>			1			1?	1

List of Anoplura of the Rodent Family SCIURIDAE
of Colorado and Sciurid hosts.
Numerals indicate number of records.

DISCUSSION

The systematic position of the ANOPLURA has been a point of much discussion. Their mouth parts were homologized with those of HEMIPTERA by Enderlein(7). Most writers place them near the MALLOPHAGA. The author's study of the sucking lice has not been such as to warrant the formation of an opinion concerning the systematic position of the order.

The geographic distribution of ANOPLURA is world wide, many forms have been recorded from both temperate and tropical regions. The head louse, Pediculus capitis De Geer, has been recorded from Eskimos in the most isolated sections of the North. According to Ewing (3) "Sucking lice are confined entirely to mammals and are particularly abundant on such rodents as rats and mice, and on many ungulates and most of the primates. Upon insectivores but few species are found; while marsupials, bats and a few other groups are not known to harbor them."

The author has found ANOPLURA especially abundant on members of the family SCIURIDAE in Colorado. Sucking lice are rather common on domestic cattle.

Ewing (3) lists six species and varieties that infest man. During periods of war, members of this group are of great economic importance, as camp conditions are especially favorable for their increase.

Ewing (3) states that "Blood of mammals constitutes practically the exclusive diet of the sucking lice, and it is largely because of this habit that such diseases of man as typhus, relapsing fever and trench fever are transmitted by these parasites. When the louse feeds it breaks the skin and sets up an irritation. This irritation causes scratching and the scratching crushes the lice, and rubs into the wound the infective contents of the louse's body."

To the best of the author's knowledge, a complete life history study has not been published of any of the species of ANOPLURA that infest the SCIURIDAE. The size and habits of the parasite, as well as difficulties encountered in handling the host, makes such a study especially difficult. The following life history notes were made by the author in the course of collecting parasites, and are included here as a contribution to the meager knowledge we have concerning the life history of the ANOPLURA of the SCIURIDAE of Colorado.

The most common point of infestation on the body of Sciurids was the pectoral region, altho the entire ventral side of the body seemed a favored habitat. The dorsal side of the body in the shoulder region was not an unusual point of infestation. In no case were sucking lice found in the ear, which seems to be a

avored region for certain species of ticks.

In some cases eggs, immature lice and adults were found in abundance on an individual Sciurid. Eggs are attached to hairs, usually on the ventral side of the body; the pectoral region seems preferred, however, the inside of the fore and hind legs often being heavily infested.

Neohaematopinus laeviusculus

Eggs, immature lice, and adults on Citellus e. elegans were taken at Kremmling, Aug. 15, 1928. Eggs were found to be abundant on hairs in the pectoral region and quite a few on inner sides of fore and hind legs. Immature lice were also found abundant in the same regions. Only two adult lice were found on this host. Another squirrel shot in this vicinity yielded the same relative abundance of eggs, immature lice and adults. The proportional large number of eggs and immature lice, and the scarcity of adults, seemed a rather strange condition.

Eggs, immature lice and adults were found to be abundant on Citellus e. elegans taken at Alma, July 12, 1927. The heaviest infestation was found to be in the pectoral region.

Immature lice only were found on Cynomys l. ludovicianus, Larimer County, July 18, 1928.

Eggs, immature lice and adults were found present in numbers on Citellus e. elegans, Virginia Dale, Larimer County, June 30, 1926.

Neohaematopinus marmotae

Eggs, immature lice and adults were found to be abundant on Marmotae f. luteola taken in Jackson County, Aug. 15, 1928.

Enderleinellus suturalis

Adult lice are the only stage observed on Citellus t. parvus, La Jara, June 23, 1926.

Hoplopleura e. arboricola

Eggs, immature lice and adults found present on Eutamias species, Jackson County, Aug. 14, 1926. Adult lice were found to be abundant under the chin, neck and pectoral region, and scattered over other parts of the body. Immature lice most abundant on dorsum in shoulder region. Eggs most abundant in pectoral regions.

SCIURIDAE List of Colorado

The following list is of the 28 species and subspecies of the rodent family SCIURIDAE that have been recorded from Colorado. Of this group 22 species and subspecies have been examined by the author for ANOPLURA and are so indicated by one star. ANOPLURA have been collected by the author from 12 species and subspecies and are so indicated by 2 stars.

Genus Marmota Blumenbach

(Woodchucks)

**Marmota flaviventris luteola Howell

Marmota flaviventris campioni Figgins

Marmota flaviventris warreni Howell

Marmota flaviventris obscura Howell

Genus Otospermophilus Brandt

(Rock Squirrel)

*Otospermophilus grammurus grammurus (Say)

Genus Callospermophilus Merriam

(Golden Mantle Ground Squirrel)

**Callospermophilus lateralis lateralis (Say)

Callospermophilus wortmani (Allen)

Genus Citellus Oken

(Ground-squirrel)

*Citellus cryptospilotus (Merriam)

**Citellus elegans (Keenicott)

*Citellus obsoletus (Keenicott)

*Citellus spilosoma major (Merriam)

**Citellus tridecemlineatus pallidus (Allen)

**Citellus tridecemlineatus parvus (Allen)

Citellus tridecemlineatus arenicola Howell

Genus Ammospermophilus Merriam

(Antelope-squirrel)

*Ammospermophilus leucurus cinnamomeus (Merriam)

Genus Cynomys Rafinesque

(Prairie-gos)

**Cynomys ludovicianus ludovicianus (Ord)

**Cynomys leucurus Merriam

**Cynomys gunnisoni gunnisoni (Baird)

*Cynomys gunnisoni zuniensis Hollister

Genus Eutamias Trouessart

(Western Chipmunk)

*Eutamias minimus minimus (Bachman)

*?Eutamias minimus caryi Merriam

*Eutamias minimus consobrinus (Allen)

**Eutamias minimus operarius (Merriam)

*Eutamias quadrivittatus hopiensis (Merriam)

*Eutamias dorsalis utahensis Merriam

Genus Scuirus Linnaeus

(Squirrels)

**Scuirus fremonti fremonti Audubon and Bachman

**Scuirus aberti ferreus True

Key to the Families of Sucking Lice

After Ewing(3)

1. Head not drawn out into any tubular process; tibiae of at least one pair of legs broadened distally and forming a spine-like or thumb-like process appposable to tarsal claws.....2

Head produced into a tubular beak which is much longer than the head proper; tibiae of all the legs not broadened distally or formed into any process appposable to tarsal claw. On elephants
.....Haematomyzidae

2. Body sparsely clothed with setae the most of which are in definite rows, scales usually wanting. Parasitic on land mammals.....3

Body thickly studded with short stout spines and in some cases with setae or scales in addition. Parasitic on marine carnivores...Echinophthiriidae

3. Eyes wanting; pleural plates sometimes vestigial or wanting.....4

Eyes or eye tubercles present; pleural plates usually well developed. On primates.....5

4. Antennae five segmented.....Haematopinidae
Antennae three segmented...Haematopinoididae, new family

5. First pair of legs similar to the others in structure but sometimes smaller; segmentation of the abdomen typical of the order; first and second pairs of abdominal spiracles lateral in position; abdominal tubercles wanting.....Pediculidae

First pair of legs much more slender than the others; abdominal segments III-V fused; first and second pairs of abdominal spiracles dorsal in position; lateral abdominal tubercles present..Phthiridae, new family

Family HAEMATOPINIDAE

After Ewing(3)

" This family is by far the largest of those in the order ANOPLURA. In it are included twenty-nine genera and more than half of the species of sucking lice. These lice are confined largely to rodents, insectivores and ungulates. Enderlein (1904) divided the family into three subfamilies; Haematopininae, Trichaulinae and Euhaematopininae. Ferris (1916) accepts these three divisions, but reduces the genus Trichaulus to the synonymy of Linognathus thus changing the subfamily name Trichaulinae to Linognathinae.

"In the classification here given, the genus Euhaematopinus Osborn is reduced to the synonymy of Haematopinoides Osborn and taken out of the Haematopinidae and placed in a family of its own, the Haematopinidae. The genus Acanthopthirus Perkins, established for an immature specimen from a bat, needs further study as its status is very uncertain. The number of subfamilies recognized is increased to six. The characters used for their differentiation as well as for their genera are made evident in the following key: "

Key to the Subfamilies and Genera of
Haematopinidae

1. First pair of legs smaller than one or both of the other pairs.....2
Legs all subequal, the tarsus and tibia of each forming a hair-clasping apparatus. On ungulatesHaematopininae.6
2. First pair of legs smaller than either the second or third pair.....3
First two pairs of legs of the same size and much smaller than the last pair. On rodents.....
...Enderleinellinae, new subfamily.....7
3. Abdomen provided with distinct pleural plates on some of its segments.....4
Abdomen without pleural plates, or with only slight rudiments of the same.....5
4. Tarsus I with 2 claws and apparently 2-segmented; third antennal segment longest....Hybophtirinae, new subfamily.13
Tarsus I with 1 claw and unsegmented; second antennal segment usually longest..Hoplopleurinae, new subfamily.14
5. Six pairs of abdominal spiracles present; abdomen clothed with normal setae.....Linognathinae.29
Only one pair of abdominal spiracles present; abdomen studded with short setae and pointed scalesNeolinognathinae, new subfamily.34
6. Only one genus.....Haematopinus Leach
7. Antennae bearing several toothlike processes; abdomen elongate.....Microphthirus Ferris
Antennae without toothlike processes; abdomen very broad usually subcircular.....8
8. Tibiae and tarsi of legs I & II of about the same width throughout; tarsal claws I & II each provided with a conspicuous tooth on its inside near the tip.....Hoplophthirus, new genus

- Tibiae I & II broadened at their distal ends and tarsi I & II at their proximal ends, and forming with tarsal claws clasping structures; claws of tarsi I & II with or without tooth.....9
9. Second abdominal segment without any ventral plates, or discs; 7 distinct pairs of abdominal pleural plates present.....Proenderleinellus Ewing
- Second abdominal segment provided ventrally with a pair of tubercle-bearing plates; less than 7 distinct pairs of abdominal pleural plates present.....10
10. Tubercle-bearing plates of second abdominal segment sub-circular and disclike and each tubercle cylindrical and setigerous.....11
- Tubercle-bearing plates of second abdominal segment not sub-circular and disclike and tubercles themselves not cylindrical; abdomen sub-circular; tarsal claws I & II each with a tooth.....
.....Cyclophthirus, new genus
11. Pleural plates present either on abdominal segment V or VI or on both these segments...Enderleinellus
Fahrenheit
- Pleural plates absent on both abdominal segment V & VI.....12
12. Tarsal claws I & II bifurcate at their tips; forehead longer than broad, coneshaped, with lateral margins about straight.....Rhinophthirus, new genus
- Tarsal claws I & II simple; forehead broader than long, domeshaped, with lateral margins rounded
.....Euenderleinellus, new genus
13. Segment of antennae equal to or longer than IV & V taken together; head not expanded into angular lateral lobes immediately behind the antennae
.....Scipio Cummings
- Third segment of antennae less than IV & V combined; head expanded immediately behind the antennae into lateral angulate lobes.....Hybophthirus Enderlein

14. Pleural plates of second abdominal segment divided, one of the parts of each plate being dorsal in position and one ventral. On "kangaroo" rats and mice.....Fahrenholzia Kellogg & Ferris
Pleural plates of second abdominal segment, when present, not divided in such a manner. Not on "kangaroo" rats and mice.....15
15. Typical abdominal segments of female each with but a single transverse row of setae.....16
Typical abdominal segments, at least in the female, with more than one transverse row of setae.....17
16. Abdominal segments I to V provided with pleural plates; setae of abdomen truncate..Eulinognathus Cummings
Abdominal segments I & II without pleural platesRatemia Fahrenholz
17. Not more than two transverse rows of setae above and below on typical abdominal segments.....18
Some of the abdominal segments at least in females with three transverse rows of setae above and below.....22
18. Forehead truncate in front; underside of head with several large recurved hooklike processes....
.....Docophthirus Waterston
Forehead more or less outwardly rounded; head without ventral hooklike processes.....19
19. Both males and females with tergal and sternal plates.....20
Females without tergal and sternal plates...
.....Linognathoides Cummings
20. First antennal segment with a heavy posterior spine, usually surmounting a tubercle; third antennal segment of male modified and bearing one or more short, stout spines....Neohaematopinus Mjoberg
First antennal segment without such a spine of tubercle..... 21

21. Antennae of the two sexes the same; last pair of abdominal spiracles not reduced or vestigial
.....Ahaematopinus, new genus

Antennae of male either with the third segment modified or with one or more stout spines; pseudopenis simple.....Polyplax Enderlein

22. Transverse rows of abdominal setae of two types, the posterior, marginal row being made up of foliaceous setae while the interposed row or rows are of normal setae; abdomen with six pairs of spiracles.....Ctenophthirus Ferris

Transverse rows of abdominal setae not so constituted.....23

23. Sternal plate of second abdominal segment greatly enlarged, overlapping most of the third segment and divided at the median line; six pairs of abdominal spiracles present.....Schizophthirus Ferris

Sternal plate of second abdominal segment differently constituted; last, or sixth, pair of abdominal spiracles usually reduced in size, rarely vestigial or wanting.....24

24. Second pair of pleural plates not lobed, but greatly enlarged and winglike and each bearing the pleural setae near the dorsal margin..Pterophthirus Ewing

Second pair of pleural plates bilobed posteriorly and each bearing on its posterior margin between the lobes a pair of setae.....25

25. Third abdominal sternite without spines; typical pleural plates with two posterior lobes
.....Ferrisella, new genus

Third abdominal sternite with at least one pair of spines.....26

26. Third abdominal sternite with only one spine on each side of the median plane; tergites of male very large and touching or overlapping each other; posterior margin of abdomen of female with a comb of seta-bearing tubercles....Ctenura, new genus

- Third abdominal sternite with more than one spine on each side; tergites of male not touching; posterior margin of abdomen of female without comb of seta-bearing tubercles.....27
27. Third abdominal sternite with only 2 divergent spines on each side of the median line.....Hoplopleura
Enderlein
- Third abdominal sternite with 3 divergent spines on each side of median line.....28
28. Typical pleural plates with only 2 posterior lobes; pseudopenis of male genital armature articulating with the ends of parameres. On Petauristid rodents.....Euhoplopleura, new genus
- Typical pleural plates with four posterior lobes; pseudopenis does not articulate with ends of parameres.....Ctenopleura, new genus
29. Typical abdominal segments never with more than a single transverse row of setae.....30
- Typical abdominal segments with more than a single transverse row of setae; six pairs of abdominal spiracles present.....33
30. Abdominal spiracles situated in tubercles. On cattle.....Solenopotes Enderlein
- Abdominal spiracles not situated in tubercles....31
31. Last two segments of antennae fused together; dorsal and ventral abdominal setae arranged into two dorsal longitudinal and two ventral longitudinal rows. On Procaviidae.....Prolinognathus, new genus
- Last two segments of antennae distinct; abdominal setae not so arranged.....32
32. Temples not swollen and with postero-lateral angles; no vestiges of pleural plates present. On deersCervophthirus Mjoberg
- Temples more or less swollen and without postero-lateral angles; vestiges of pleural plates present. On hares and rabbits.....Haemodipsus Enderlein

33. Head at least three times as long as thorax, the latter very short and apparently composed of only two segments.....Microthoracius Fahrenholz

Head not over twice as long as the thorax, the latter normal.....Linognathus Enderlein

34. Only one genus included....Neolinognathus Bedford

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NOTES ON SOME ACARINA PARASITES OF
THE RODENT FAMILY SCIURIDAE OF COLORADO

The object of this paper is to present a few records of ACARINA parasites of Colorado SCIURIDAE.

The ACARINA constitute an order of the class ARACHNIDA. Members of the order may be divided into two general groups, the ticks, and the mites. A brief key for the separation of these two groups is given by Essig in "Insects of Western North America", p. 16., as follows:

Hypostome or tongue large and armed with sharp teeth; exoskeleton leathery; bodies quite large.....Ticks

Hypostome or tongue small and hidden in the body, not armed; exoskeleton not leathery; bodies minuteMites

TICKS

Ticks are ectoparasites that infest many of the mammals, birds and reptiles that occur in the warmer regions of the world. Many of the ticks transmit diseases to man and other animals. Dermacentor andersoni Stiles, is a transmitter of Rocky Mountain spotted fever, and Margaropus annulatus (Say) is a transmitter of Texas fever to cattle. These two illustrations are mentioned to call attention to the economic importance of certain members of this group. Many other important citations could be made.

The following list of ticks and their hosts are

records established by the author. Acknowledgment is here given to Dr. F. C. Bishop for making determinations of all tick material.

Superfamily IXODOIDEA

Family IXODIDAE

Ixodes sculptus Neum.

Four records for this species are as follows:

Three records from Citellus t. pallidus, Rattlesnake Springs, Weld County, May 27, 1927 (Colo. Acc. No. 4210); Fort Collins, June 21, 1926 (Colo. Acc. No. 4212); Boyero, July 28, 1926 (Colo. Acc. No. 4256).

One record from Cynomys g. zunniensis, Cortez, 1925. This material was given to Dr. F. C. Bishopp.

Ixodes kingi Bishopp

This species was taken from Cynomys g. zunniensis at Cortez, 1925. The material was presented to Dr. F. C. Bishopp.

This species is called the "Rotund Tick" and occurs in the western part of the United States. It infests wild animals and has been recorded from dogs.

Dermacentor parumapertus var. marginatus Banks

Three records for this species are as follows:

One record from Cynomys e. elegans, Alma, July 12, 1927 (Colo. Acc. No. 4357), ticks attached in ears.

One record from Cynomys g. gunnisoni, Alma,

July 12, 1927 (Colo. Acc. No. 4358). Ticks attached under chin and on posterior portion of hind legs.

One record from Callospermophilus l. lateralis, Fairplay, June 13, 1927 (Colo. Acc. No. 4360).

This species is considered of importance because of its ability to transmit Rocky Mountain spotted fever.

Parker, in the Seventh Biennial Report, State Board of Entomology, 1927-1928, p. 42, states that marginatus occurs throughout the northern range of andersoni, and must be considered as a possible factor in maintenance of Rocky Mountain spotted fever in that section of the Rocky Mountains. Maver is credited with having shown transmission of Rocky Mountain spotted fever by adult ticks of this species, infested as nymphs.

The comparatively few tick records from Sciurids as compared with those of Anoplura and Siphonaptera, are thought to be due largely to the season of the year when collecting was done. Evidently the summer months have marked light infestations of adult ticks.

MITES

Mites are a group of the ACARINA that have widely diversified habits. Some are parasitic on other animals, some on plants and others are free living. Of those that parasitize man and domestic animals, many forms of economic importance are known. Sarcoptes scabiei De Geer

is an important parasite on man. The Sheep Scab Mite, Psoroptes communis ovis (Hering), is an important parasite of sheep and cattle.

The following list of mites and their hosts are records established by the author. Acknowledgment is here given to Dr. H. E. Ewing for determinations of all mite material.

Superfamily PARASITOIDEA

Family PARASITIDAE

Laelaps californicus Ewing

Five records for this species are as follows:

One from Cynomys l. ludovicianus, Round Buttes, Larimer County, Sept. 22, 1926 (Colo. Acc. No. 4222).

Four records from Citellus t. pallidus as follows: Purcell, April 23, 1926 (Colo. Acc. No. 4182); Weld County, April 20, 1926 (Colo. Acc. No. 4209); Larimer County, September 22, 1926 (Colo. Acc. No. 4207); Fort Collins, Sept. 22, 1926 (Colo. Acc. No. 4205).

Family DERMANYSSIDAE

Liponyssus occidentalis Ewing

One record of this species from Sciurus a. ferreus, Livermore, Oct. 5, 1926 (Colo. Acc. No. 4206). Mites were taken from the host 20 hours after death. They were quite plentiful and crawling about over the hair as though preparing to leave the body.

The genus Liponyseus is one of considerable economic importance. It contains the following species: The Tropical Rat Mite, L. bracoti (Hirst); The Tropical Fowl Mite, L. bursa (Berlese); and the Northern Fowl Mite, L. sylviarum C. & F.

None of the mites that have been recorded in this paper, from the Colorado rodent family SCIURIDAE, are known to harbor or transmit disease.

Because of their minute size no doubt many records of mites were missed in the course of collecting.

NOTES ON SOME SIPHONAPTERA PARASITES OF THE
RODENT FAMILY SCIURIDAE OF COLORADO

The object of this paper is to present a few records of SIPHONAPTERA parasites of Colorado SCIURIDAE. The SIPHONAPTERA or fleas comprise an order of the class INSECTA. During the adult stage they are temporary ectoparasites of mammals and birds. The egg, larval and pupal stages are usually found in the neighborhood of the host, in its lair, or in its nest. The food of the adult flea consists of blood which is obtained from the host by means of its piercing, sucking mouth parts.

Because of the role certain species of fleas play in the transmission of bubonic plague and other diseases of man, the group is of considerable economic importance. Ewing (1) divides the order into six families. This paper is concerned with but two families; the DOLICHOPSYLLIDAE and the PULICIDAE. The total number of described species probably ranges between 500 and 600.

Altho literature on this group is not extensive, several papers have not been available for study.

Credit is here given to Dr. F. C. Bishopp and Dr. H. E. Ewing for generic determination of material submitted, and for specific determination of specimens of Rhadinopsylla fraterna Baker and Hoplosyllus anomalus (Baker). Credit for all specific determinations other

than those already mentioned, is due Mr. M. A. Stewart of the Rice Institute. Mr. Stewart has also furnished information concerning distribution and host records that has been of much assistance in preparing this paper.

Family DOLICHOPSYLLIDAE

This family contains the greatest number of species of any of the families of the SIPHONAPTERA. In it, Ewing (1) has placed 28 genera, comprising 3 subfamilies. This paper records eight species representing four genera, from Colorado SCIURIDAE.

Oropsylla fotus Jordon

One record of this species has been made from Citellus t. pallidus, Rattlesnake Springs, Weld County, April 20, 1926 (Colo. Acc. No. 4208). This is thought to be a new host record for this species.

Oropsylla montanus Baker

Baker (2) records this species as originally taken from gray squirrel in the northern Colorado mountains, and as being abundant on rock squirrel at Arboles, Colorado, and also in Arizona. Essig (3) lists it as occurring on gray squirrel in Colorado and Arizona.

Dr. C. P. Gillette collected specimens from Marmota f. luteola, Estes Park, July 16, 1897. Mr. L. C. Bragg collected specimens from Otospermophilus g. grammurus, Spring Canon, Larimer County, March 19, 1912.

The following records by the writer are thought to be new host records with the exception of that from Marmota, which duplicates the record established by Dr. Gillette.

Two records from Citellus e. elegans are: Craig, May 29, 1928 (Colo. Acc. No. 4661) and Kremmling, Aug. 15, 1928 (Colo. Acc. No. 4487). One record from Cynomys l. ludovicianus, Round Buttes, Larimer County, June 18, 1928 (Colo. Acc. No. 4536). One record from Callospermophilus l. lateralis, Craig, Colorado, July 21, 1928 (Colo. Acc. No. 4536). One record from Marmota f. luteola, Jackson County, Aug. 15, 1928 (Colo. Acc. No. 4486). One record from Citellus t. pallidus, Round Buttes, Larimer County, Sept. 22, 1926 (Colo. Acc. No. 4205).

Oropsylla tuberculatus Baker

This species was described by Baker (2) from Citellus columbianus taken at Moscow, Idaho.

The records given here are thought to be the first for Colorado for the species. All the host records are thought to be new. Mr. J. L. Hoerner is credited with a record from Citellus e. elegans: Virginia Dale, Larimer County, April 4, 1925.

The following records were made by the author. One record from Cynomys g. gunnisoni, Alma, Colorado,

July 12, 1927 (Colo. Acc. No. 4358). One record from Cynomys leucurus, Price Creek, Moffat County, April 11, 1928 (Colo. Acc. No. 4658). One record from Cynomys l. ludovicianus, Round Buttes, Larimer County, June 18, 1928 (Colo. Acc. No. 4536).

Oropsylla labis Jordan & Rothschild

All of the following records for this species were made by the writer, and are thought to be new host records, as well as the first record of the occurrence of the species in Colorado. One record from Citellus e. elegans, Alma, July 12, 1907 (Colo. Acc. No. 4357). One record from Cynomys g. gunnisoni, Alma, July 12, 1927 (Colo. Acc. No. 4358). One record from Callospermophilus l. lateralis, Fairplay, July 13, 1927 (Colo. Acc. No. 4360). One record from Cynomys leucurus, Price Creek Moffat County, April 11, 1928 (Colo. Acc. No. 4658).

Oropsylla idahoensis Baker

Baker (2) described this species from Citellus columbianus from Moscow, Idaho. Essig (3) states that this species occurs on ground squirrels in Idaho. Several records have been published by Dunn and Parker (4) for idahoensis from rodents in Montana. No published records have been found for this species from Colorado, and the three records given here are thought to be all new host records. They are the following: One record from

Citellus e. elegans, Alma, July 12, 1927 (Colo. Acc. No. 4357). One record from Cynomys g. gunnisoni, Alma, July 12, 1927 (Colo. Acc. No. 4358). One record from Callospermophilus l. lateralis, Fairplay, July 13, 1927 (Colo. Acc. No. 4360).

Ceratophyllus petiolatus Baker

Baker (2) described this species from Lynx canadensis from Moscow, Idaho. The following record by the writer is thought to be a new host record, and the first record of the species in Colorado. It is from Cynomys l. ludovicianus, Round Buttes, Larimer County, June 18, 1928 (Colo. Acc. No. 4536).

Paradoxopsyllus abantis Rothschild

Baker (5) gives the habitat of this species as British Columbia and Alberta, Canada. Essig (3) states that this species attacks meadow mice and skunk in California and north to British Columbia.

The following record from Citellus e. elegans, Kremmling, Sept. 15, 1928 (Colo. Acc. No. 4487) is thought to be new for Colorado as well as for host.

Rhadinopsylla fraterna Baker

The type of this species was taken at Brookings, South Dakota, by Prof. J. M. Aldrich, the host was not given but Baker (2) expresses the opinion that quite likely it was a mole.

The following Colorado record is thought to be new, Cynomys leucurus, Pearl, Jackson County, Aug. 13, 1926 (Colo. Acc. No. 4250).

Family PULICIDAE

This is one of the largest of the families of fleas, and includes several species that attack man. The hosts of this group are widely diversified in habit and form.

Hoplopyllus anomalus (Baker)

This species is of special interest because of its role as a plague carrier. Essig (3) states that it infests ground squirrels in Colorado and California. The following host record for this species is thought to be new: Cynomys g. zuniensis, Cortez, April 27, 1925 (Colo. Acc. No. 4662).

Literature Cited

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General Discussion of External Parasites
of Colorado SCIURIDAE

Most of the records of collecting parasites were made between April 1st. and Oct. 1st. Data collected in this study seems to indicate that Colorado SCIURIDAE normally harbor external parasites during the period collections were made.

A larger percentage of the hosts examined were infested with fleas than with either lice, mites or ticks.

None of the individual SCIURIDAE examined seemed to be suffering from the ill effects of parasitism. Host No. 4358 was infested by three species of fleas, one species of lice and one species of ticks, yet this animal seemed to be in good health, and carried considerable fat. It is interesting to note that half the number of individual hosts found infested with fleas were infested with two or more species. None of the individual hosts found infested with lice, mites or ticks were infested with more than one species of the same order.

There has been no evidence noted that would seem to indicate that one order of parasites interferes with the presence or welfare of another order of parasites on the same hosts.

This list of parasites is thought to be of importance because of the specific determination of hosts.

In literature many parasites have been described and

others recorded from hosts that were not specifically determined. From an immediate economic standpoint this work contributes little. It is of interest, however, to note records of Dermacentor parumapertus var marginatus because of its ability to transmit Rocky Mountain spotted fever, also of Hoplopsyllus anomalus one of the bubonic plague fleas.

The author has made special study of the Anoplura from a systematic point of view. All Anoplura material was determined and then sent to an authority for verification. Two mistakes were found in the original determinations.

Special study in technique of mounting ticks and determination of species under supervision of Dr. R. F. Bourne has been followed.

Little study of a systematic nature has been made of mites and fleas. The fleas have proven an especially difficult group of which to obtain determinations. In the fall of 1926 much of the flea material was sent to Dr. F. C. Bishopp. This was returned in the fall of 1929 with specific determination on 2 species and generic determination on the remainder. Since that time Mr. M. A. Stewart has determined most of the material used in this paper. At least half of the flea material collected has not been used here, because only generic

determinations were available.

The following list of records of parasites collected from individual Colorado SCIURIDAE hosts includes all the species that have been recorded in this paper as collected by the author.

LIST OF RECORDS OF PARASITES COLLECTED FROM INDIVIDUAL COLORADO SCIURIDAE HOSTS

Marmota f. luteola (Park marmot)

- Host No. 4243 Neohaematopinus marmotae (Louse)
Host No. 4246 " " (Louse)
Host No. 4247 " " (Louse)
Host No. 4486 " " (Louse)

Oropsylla montanus (Flea)

Callospermophilus l. lateralis (Say's ground-squirrel)

Host No. 4253 Neohaematopinus laeviusculus (Louse)

Host No. 4360 Dermacentor parumapertus var
marginatus (Tick)

Oropsylla idahoensis (Flea)

Oropsylla labis (Flea)

Host No. 4533 Oropsylla montanus (Flea)

Citellus e. elegans (Wyoming ground-squirrel)

Host No. 4236 Neohaematopinus laeviusculus (Louse)

Host No. 4357 " " (Louse)

Oropsylla labis (Flea)

Oropsylla idahoensis (Flea)

Host No. 4487 Neohaematopinus laeviusculus (Louse)

Paradoxopsylla abantis (Flea)

Oropsylla montanus (Flea)

Host No. 4461 Neohaematopinus laeviusculus (Louse)

Oropsylla montanus (Flea)

Host No. 4356 Ixodes sculptus (Tick)

Citellus t. pallidus (Striped ground-squirrel)

- Host No. 4182 Laelaps californicus (Mite)
Host No. 4204 Neohaematopinus laeviusculus (Louse)
Host No. 4205 Oropsylla montanus (Flea)
Host No. 4207 Laelaps californicus (Mite)
Host No. 4208 Oropsylla fatus (Flea)
Host No. 4209 Laelaps californicus (Mite)
Host No. 4210 Ixodes sculptus (Tick)
Host No. 4212 Ixodes sculptus (Tick)
Host No. 4256 Ixodes sculptus (Tick)
Host No. 4651 Enderleinellus suturalis (Louse)
Host No. 4652 Neohaematopinus laeviusculus (Louse)
Host No. 4653 Enderleinellus suturalis (Louse)

Citellus t. parvus (Little striped ground-squirrel)

- Host No. 4254 Enderleinellus suturalis (Louse)

Cynomys l. ludovicianus (Plains prairie dog)

- Host No. 4222 Laelaps californicus (Mite)
Host No. 4536 Neohaematopinus laevisculus (Louse)
Oropsylla montanus (Flea)
Oropsylla tuberculatus (Flea)
Ceratophyllus petiolatus (Flea)

Cynomys leucurus (White-tailed prairie dog)

- Host No. 4234 Neohaematopinus laeviusculus (Louse)
Host No. 4250 Rhadinopsylla fraterna (Flea)
Host No. 4658 Oropsylla tuberculatus (Flea)

Cynomys g. gunnisoni (Gunnison's prairie dog)

Host No. 4358 Enderleinellus suturalis (Louse)

Dermacentor parumapertus var
marinatus (Tick)

Oropsylla tuberculatus (Flea)

Oropsylla labis (Flea)

Oropsylla idahoensis (Flea)

Cynomys g. zuninensis (Zuni prairie dog)

Host No. 4662 Hoplopyllus anomalus (Flea)

Eutamias m. operarius (Lesser Colorado chipmunk)

Host No. 4677 Hoplopleura e. arboricola (Louse)

Host No. 4678 Hoplopleura e. arboricola (Louse)

Eutamias q. quadrivittatus (Larger Colorado chipmunk)

Host No. 4654 Hoplopleura e. arboricola (Louse)

Host No. 4655 Hoplopleura e. arboricola (Louse)

Eutamias sp.

Host No. 4225 Hoplopleura e. arboricola (Louse)

Host No. 4255 Hoplopleura e. arboricola (Louse)

Host No. 4488 Hoplopleura e. arboricola (Louse)

Sciurus a. ferreus (Plain-backed squirrel)

Host No. 4206 Enderleinellus longiceps (Louse)

Liponyssus occidentalis (Mite)

SOME EXTERNAL INSECTA AND ACARINA PARASITES
OF THE RODENT FAMILY SCIURIDAE OF COLORADO

Abstract

There are 28 species and subspecies of SCIURIDAE that occur in Colorado. A total of 177 individual SCIURIDAE representing 22 species and subspecies have been examined for external parasites. While only 12 species and subspecies were found to harbor external parasites, there is no evidence to indicate that a single species is free from the attack of such external parasites as sucking lice, fleas, mites or ticks.

This paper has taken up the subject of external parasites by separating them into three divisions; i.e., ANOPLURA, the sucking lice; ACARINA, the ticks and mites; SIPHONAPTERA, the fleas.

Special study has been made of the ANOPLURA in regard to:

1. Systematic determination of species.
2. Technique in mounting material on slides.
3. Life history habits.
4. Literature of ANOPLURA workers.

Colorado records of ANOPLURA infested SCIURIDAE may be summarized as:

1. Previous records giving definite hosts.....5
2. Previous records giving indefinite hosts....3
3. Records by author giving definite hosts....22
4. Records by author giving indefinite hosts.. 2
5. New host records by author..... 8
6. New Louse records by author..... 1

Life history notes given in paper are in regard to egg, immature, and mature lice, their position on host, abundance and date observations were made.

None of the ANOPLURA studied have been recorded as carriers of disease, and none of the hosts examined appeared to be suffering from the effect of parasitism.

TICKS

Ticks were collected from 4 host species, and represented 3 tick species. Dermacentor parumapertus var. marginatus was recorded from 2 species of squirrel and one species of prairie dog. These records are thought of interest because the species has been found capable of carrying Rocky Mountain spotted fever. The relatively small number of tick records is thought to be due to the season of year that collecting was done.

MITES

Mites were collected from 3 host species, and represented 2 mite species. The relatively small number of mite records is thought to be due to the minute size of the parasite which made them especially difficult to see, and to their transitory habits.

FLEAS

Fleas were collected from 9 host species, and represented 9 flea species. One record of Hoplopsyllus anomalus, from a prairie dog, is thought to be of interest because it is one of the species that carries bubonic plague. Half of the total number of SCIURIDAE found infested with fleas, were infested with two or more species. None of the individual hosts found infested with lice, mites, or ticks, were infested with more than

one species of the same order.

None of the individual SCUIRIDAE examined appeared to be suffering from the ill effects of parasitism. Host No. 4358, a prairie dog, infested by three species of fleas, one species of louse and one species of tick, appeared to be enjoying the best of health. Evidently one order of parasites does not interfere with the presence or welfare of another order of parasites on the same host.

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